Nebraska Public Power District

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NLS2013011
January 14, 2013

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Subject: Response to Request For Additional Information Regarding License Amendment Request To Adopt National Fire Protection Association Standard 805
Cooper Nuclear Station, Docket No. 50-298, DPR-46

Reference:

1. Letter from Lynnea E. Wilkins, U.S. Nuclear Regulatory Commission, to Brian J. O'Grady, Nebraska Public Power District, dated November 14, 2012, "Cooper Nuclear Station - Request For Additional Information Re: License Amendment Request To Adopt National Fire Protection Agency Standard 805 (TAC ME8551)"

2. Letter from Brian J. O'Grady, Nebraska Public Power District, to U.S. Nuclear Regulatory Commission, dated April 24, 2012, "License Amendment Request to Revise the Fire Protection Licensing Basis to NFPA 805 Per 10 CFR 50.48(c)" (NLS2012006)

Dear Sir or Madam:

The purpose of this letter is for the Nebraska Public Power District to respond to a Nuclear Regulatory Commission (NRC) Request for Additional Information (Reference 1) related to the Cooper Nuclear Station (CNS) License Amendment Request to adopt National Fire Protection Association (NFPA) Standard 805 as the CNS Fire Protection licensing basis per 10 CFR 50.48(c) (Reference 2). This response is provided in Attachment 1. As previously agreed to with the NRC staff, certain responses will be provided in a subsequent 90-day and 120-day response. Attachment 2 provides associated conforming changes to the License Amendment Request, which remains bounded by the original No Significant Hazards Consideration and Environmental Review. There are no additional commitments made that are not bounded by those previously made in the License Amendment Request.

Should you have any questions concerning this matter, please contact Todd Stevens, CNS NFPA 805 Transition Project Manager, at (402) 825-5159.

A006
NRR

COOPER NUCLEAR STATION
P.O. Box 98 / Brownville, NE 68321-0098
Telephone: *(402) 825-3811 /* ***Fax:*** *(402) 825-5211*
www.nppd.com

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

Executed on 1/14/13
(Date)

Sincerely,

Kenneth Higginbotham
General Manager of Plant Operations

KH/wv

Attachments:
1. Response to Cooper Nuclear Station Request For Additional Information Regarding License Amendment Request To Adopt National Fire Protection Association Standard 805
2. Revisions to the Cooper Nuclear Station License Amendment Request To Adopt National Fire Protection Association Standard 805 Performance-Based Standard For Fire Protection For Light Water Reactor Generating Plants

cc: Regional Administrator w/ Attachments
USNRC - Region IV

Cooper Project Manager w/ Attachments
USNRC - NRR Project Directorate IV-1

Senior Resident Inspector w/ Attachments
USNRC - CNS

Nebraska Health and Human Services w/ Attachments
Department of Regulation and Licensure

NPG Distribution w/o Attachments

CNS Records w/ Attachments

Attachment 1

Response to Cooper Nuclear Station
Request For Additional Information Regarding
License Amendment Request To Adopt
National Fire Protection Association Standard 805

The Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) regarding the National Fire Protection Association (NFPA) Standard 805 Transition License Amendment Request is shown in italics. The Nebraska Public Power District (NPPD) response to the RAI is shown in block font.

Safe Shutdown (SSD)

Request - SSD RAI 01

By letter dated April 24, 2012, LAR Section 4.2.1.1 identifies that the nuclear safety capability assessment (NSCA) methodology review evaluated the existing post-fire safe shutdown analysis methodology against the guidance for transitioning to NFPA 805, provided in Nuclear Energy Institute (NEI) 00-01, Rev. 1, "Guidance for Post-Fire Safe Shutdown Circuit Analysis," and the subsequent performance of a gap analysis to identify impacts from NEI 00-01, Rev. 1 to Rev. 2. Please provide a summary of the technical issues from the gap analysis from NEI 00-01, Rev. 1 to Rev. 2., including the following:

a. *NEI 00-01, Rev. 2, Section 3.2.1.2 describes that any post-fire operation of a manual rising-stem valve that has been exposed to fire conditions should be well justified. Please identify instances where it is necessary to manually operate valves post-fire that are located in the fire area of concern and may have been exposed to the fire.*

b. *NEI 00-01, Rev. 2, Section 3.5.1, requires consideration of proper-polarity hot shorts in certain direct current (DC) control circuits for non-high-low pressure interface components. Please identify whether proper-polarity dc shorts in non-high-low pressure interfacing components are considered.*

NPPD Response

a. There are no instances at Cooper Nuclear Station (CNS) where it is necessary to manually operate valves post-fire that are located in the fire area of concern.

b. Most DC-powered devices are normally directly connected to the negative DC polarity, and only require a single positive DC hot short to energize. However, most DC-powered devices will spuriously operate regardless of how the DC polarity is connected to the device terminals (i.e., positive/negative or negative/positive).

The possibility of sustaining DC hot shorts of each polarity (positive and negative) was considered for both high/low and non-high/low pressure interface components with respect to internal shorting between target and source conductors in the same cable (where the cable contains source conductors of each DC polarity). This aligns with the statement in NEI 00-01 Revision 2, Section 3.5.1.1, 3rd bullet under "Circuits for Important to Safe Shutdown Components".

The possibility of sustaining one DC hot short of either polarity (positive or negative) was considered for non-high/low pressure interface components with respect to external hot shorts between target and source conductors in separate cables. The possibility of sustaining one DC hot short of each polarity (positive and negative) was not considered for non-high/low pressure interface components with respect to external hot shorts between target and source conductors in separate cables. No distinction is made for how the external hot short is physically developed between the DC source and the target conductors (i.e., cable-to-cable, or cable-to-ground-to-ground-to-cable). This aligns with the statement in NEI 00-01 Revision 2, Section 3.5.1.1, 3rd bullet under "Circuits for Important to Safe Shutdown Components".

The possibility of sustaining multiple DC grounds connected to the same source battery is always considered. This failure mode is generally presented as the loss of required DC power for the target circuit. This aligns with the statement in NEI 00-01 Revision 2, Section 3.5.2.2 under "Short-Ground on Ungrounded Circuits"

Removal of both DC control power fuses (or opening of the 2-pole DC feed breaker) for a DC circuit is a credible means to ensure that DC power is removed from a non-high/low pressure interface component such that it will assume its shelf state position (i.e., the fail position on loss of power).

Request - SSD RAI 02

LAR Section 4.2.1.2 describes actions necessary to achieve and maintain safe and stable conditions for the first 24 hours; however, no description is provided of the actions and resources required to maintain safe and stable conditions beyond the 24-hour coping period.

a. *Please describe the specific capabilities that will be required to meet the performance criteria beyond 24 hours.*

b. *Please describe any system or component capacity limitations and time-limited actions needed replenish systems, make repairs, or otherwise maintain safe and stable conditions, (e.g. nitrogen supply for automatic depressurization system safety relief valves (ADS SRVs), DC battery power, etc.).*

c. *Please describe whether there are any actions to recover nuclear safety capability analysis (NSCA) equipment to sustain safe and stable conditions. Please describe the resource (staffing) requirements and timing of these actions.*

d. *Please describe how the feasibility of the actions in b and c above are evaluated or addressed.*

e. *Please provide a more detailed discussion of the risk of failure of the actions necessary to sustain safe and stable conditions beyond 24 hours.*

f. *LAR Section 4.2.1.2 states, "For the plant to be in a safe and stable condition, it may not be necessary to perform a transition to cold shutdown as currently required under 10 CFR 50, Appendix R. Therefore, the unit may remain at or below the temperature defined by a hot shutdown plant operating state for the event." Please confirm that the NSCA does not require the plant to achieve cold shutdown to be in a safe and stable condition or confirm that the NSCA has included cold shutdown equipment and procedures in the analysis. Also, please define the term "event" in the context of the statement in Section 4.2.1.2 as it applies to achieving and maintaining safe and stable conditions.*

NPPD Response

a. The specific capabilities that will be required to meet the performance criteria beyond 24 hours include the availability of procedures and personnel to perform the necessary repair/recovery of NSCA equipment needed to maintain safe and stable conditions for the extended period of time. To accomplish this goal, existing Emergency Operating Procedures (EOP) and other emergency response procedures are currently in place to assist the plant operating staff with an option to proceed and implement such actions and/or repairs for the plant to transition to, and enter, Mode 4 (Cold Shutdown). Offsite resources (e.g., equipment, power, vehicles) are available as backups to primary methods of prevention and mitigation. The Emergency Response Organization would be activated and manned in 1 hour and therefore the Technical Support Center and Emergency Operating Facility staff would be in place with additional expertise and resources to address plant issues.

b. The following limitations are noted for system and component needed to maintain safe and stable hot shutdown conditions for an extended period of time:

DC Battery Power - 250V and 125V DC power is required immediately for High Pressure Coolant Injection (HPCI), Reactor Core Isolation Cooling (RCIC), and Emergency Diesel Generator (EDG) System operation. Station batteries have sufficient capacity to operate for 4.5 hours before battery chargers need to be repowered. A post-fire battery charger repair is required to ensure long term battery operation should a fire impact both sets of battery charger cables that run through the Auxiliary Relay Room (Fire Zone 8A). Replacement cables are pre-staged at the worksite and replacement instructions are provided in post-fire operating procedures (5.4FIRE-S/D, Fire-induced Shutdown from Outside Control Room, Attachment 7). Engineering Evaluation 10-05 provides the basis for post-fire repair implementation time adequacy.

Diesel Fuel Oil – sufficient fuel oil is available to support operation of the EDGs and the Diesel-Driven Fire Pump. For the EDGs, two storage tanks are provided having a fuel oil capacity sufficient to operate a single EDG for a period of 7 days while that EDG is supplying maximum load demand. Fuel for the Diesel Engines is stored in two 33,575 gallon underground storage tanks. This onsite fuel oil capacity is sufficient to operate the EDGs for longer than the time to replenish the onsite supply from outside sources. A transfer pump is located in the manhole of each storage tank. Each transfer pump is capable of automatically supplying fuel to both EDG fuel day tanks. Each day tank holds approximately 2,500 gallons of fuel, enough to exceed the initial full load operational requirements post-fire for ~ 4 hours. It is also noted that a post-fire fuel oil transfer pump repair is available should a fire impact control or power cable for either of the pumps. Replacement cables are pre-staged at the worksite and replacement instructions are provided in post-fire operating procedures (5.4FIRE-S/D, Fire Induced Shutdown from Outside Control Room, Attachment 9). Engineering Evaluation 08-009 provides the basis for post-fire repair implementation time adequacy.

For the Diesel-Driven Fire Pump, sufficient fuel is available for 8 hours of pump run. The 8 hour limit is based on full pump rated flow of 3000gpm, thus at lower flow rates operators should have about two additional hours (~10 hours total) time to replenish diesel fuel. The fuel tank for the Diesel-Driven Fire Pump is nominally rated at 550 gallons capacity.

There are 5 diesel fuel tanks that are used by Facilities for vehicle fuel. Each tank has the ability to hold ~300 gallons. Two tanks are located inside the protected area, and the other three tanks are located outside the protected area. These tanks are checked and filled every week by the local vendor who brings his fuel truck on-site. The vendor would top off a tank when level is close to about ¾ full. This provides a minimum 225 gallons of diesel fuel in each of the 5 tanks. The vendor is the same vendor that fills the Diesel-Driven Fire Pump Fuel Tank when necessary. Additionally, CNS has a portable tank with capacity of about 200 gallons that can be carried by truck, filled by gravity, and then pumped with truck battery driven pump to fill the fuel tank.

The fuel contained in the 300 gallons tanks is sufficient to replenish the Diesel-Driven Fire Pump more than twice to allow for more than additional 16 hours of run at full flow, hence allowing the pump to run and deliver injection flow for more than 24 hours, if needed as a backup source of inventory.

ADS SRV – Essential Air or Nitrogen - Accumulators provided on the ADS valves ensure air is available for initial valve operation. Calculation NEDC 85-012 establishes a basis for availability of ADS valves after isolation from back-up air or nitrogen systems. A minimum of 8 hours is identified for Accumulator 256G, with other accumulators maintaining adequate pressure for longer time frames. Back-up nitrogen or control air would be required after that time. Long term pneumatic supply for the SRVs in the Alternate Shutdown Cooling mode is provided via a repair procedure. Post-fire operating procedures (5.4FIRE-S/D, Fire Induced Shutdown From Outside Control Room, Attachment 11) direct restoration of a nitrogen as a long term supply to the ADS Accumulators. The basis for this repair is provided in Engineering Evaluation 08-033 and Calculation NEDC 08-048.

Emergency Condensate Storage Tanks (ECST) - The primary source of water to the HPCI and RCIC systems is the Emergency Condensate Storage Tanks. The two tanks, each with a 50,000 gallon capacity, are the preferred source of injection water to the reactor vessel. The suppression pool provides the secondary source of water to these two systems with both pumps provided with the capability to automatically shift suction to the suppression pool when low level signal in either ECST is received if no isolation signal is present.

c. Recovery actions are credited post-fire in a number of fire areas as documented in Calculation NEDC 11-004. Minimum shift staff levels are sufficient to carry out all required actions post-fire. Timelines are available to show shift staffing crews are capable of performing recovery actions for each area of the plant.

d. Calculation NEDC 10-041 provides the feasibility evaluation including timing requirements for each of the recovery action carried forward into the new licensing basis. In accordance with Frequently Asked Question (FAQ) 07-0030, the CNS feasibility assessment includes the following criteria:

- Demonstrations - demonstration via field verification walk-through of the feasibility for the credited NFPA 805 recovery actions.
- Systems and Indications – Confirmation that adequate instrumentation is available in the control room or at Alternate Shutdown (ASD) Panels to monitor and verify the credited actions are effective.
- Communications - Confirmation that communications (during the field verification walk-through) is adequate between the controlling location and recovery action locations.
- Emergency Lighting – Confirmation that adequate lighting (either fixed or portable) is available for access/egress and for the component to be operated.
- Tools-Equipment – Confirmation that all components requiring recovery actions are physically accessible and can be performed by the operator(s). Tools and equipment needed, such as Self-Contained Breathing Apparatus and protective equipment, are available, staged, inventoried and tested as appropriate.
- Procedures – Procedures are in place for implementation of the recovery action. The guidance on the use of recovery actions shall be readily available, easily accessible and demonstrated to be effective.
- Staffing – Confirm that minimum shift staffing is adequate to implement the credited NFPA 805 recovery actions.
- Actions in the Fire Area - Confirm actions requiring entry into or travel through the affected fire area have been evaluated successfully based on factors such as ignition sources, location of combustibles, availability of detection and suppression equipment, and the physical properties of the component.

- Time – Time, manpower, and complexity will be assessed for the total population of recovery actions during the confirmatory demonstration (field verification walk-through).
- Training – The updated fire response procedures will be integrated into the CNS training schedules.
- Drills – Periodic drills regarding fire response are integrated into the CNS training processes.

The above criteria will be validated as part of Implementation Item S-3.6 using the Field validation forms, feasibility timelines and the revised CNS procedures. (Refer to SSD RAI 06 below for additional details on the validation process)

e. The risk impact of the failure of actions to sustain safe and stable condition beyond 24 hours is deemed to be very low since the requisite inventory and manpower for maintaining systems operable is not time critical. This conclusion is based on the long periods of time before depletion of commodities such as fuel oil and nitrogen before it becomes a concern combined with the activation of Emergency Response Facilities (as described in responses 2.a and 2.b above). The availability of additional resources and plans in place to perform any of these tasks further ensure that these longer-term actions will be reliably accomplished.

f. The NSCA does not require the plant to achieve cold shutdown to be in a safe and stable condition as stated and defined by NFPA 805 Section 1.6.56: "For fuel in the reactor vessel, head on and tensioned, safe and stable conditions are defined as the ability to maintain *Keff* <0.99, with a reactor coolant temperature at or below the requirements for hot shutdown for a boiling water reactor and hot standby for a pressurized water reactor. For all other configurations, safe and stable conditions are defined as maintaining *Keff* <0.99 and fuel coolant temperature below boiling." The term "event" in the context of License Amendment Request (LAR) Section 4.2.1.2 is the exact wording in the generic statement provided in the LAR Template. It applies to achieving and maintaining safe and stable hot shutdown conditions following a fire within any location of the plant.

Request - SSD RAI 03

LAR Attachment D describes the methods to identify and resolve pinch-points identified from the non-power operation (NPO) transition review. Please provide a response to the following:

a. Please provide a description of any actions being credited to minimize the impact of fire-induced spurious actuations on power operated valves (e.g., air-operated valves (AOVs) and motor operated valves (MOVs)) during NPO either as pre-fire configuring or as required during the fire response recovery (e.g., pre-fire rackout and isolation of air supplies).

b. *Please identify the locations where key safety functions (KSFs) are achieved solely by recovery actions (RAs) or for which instrumentation not already included in the at-power analysis is needed to support RAs required to maintain safe and stable conditions. Please identify those RAs and instrumentation relied upon in NPO and describe how RA feasibility is evaluated. Also, please include in the description whether these variables have been or will be factored into operator procedures supporting these actions.*

<u>NPPD Response</u>

a. Each fire area was analyzed for NPO Modes, as documented in CNS Calculation NEDC 11-003. Fire areas with identified pinch points were evaluated and plant strategies consistent with FAQ 07-0040 were considered for minimizing fire risk. The strategies referred to in the calculation are intended to be as flexible as possible and are not intended to be prescriptive in nature. It is intended that operations and outage planning personnel will use the results provided in the calculation as guidance to determine the protective measures consistent with FAQ 07-0040. As part of LAR Attachment S, Table S-3; Item S-3.4, revisions to applicable plant procedures will incorporate the insights and strategies documented in Calculation NEDC 11-003 for the plant to prevent and/or mitigate potential effects of a fire event during non-power operation and especially those instances of higher risk evolutions. These strategies will include, but are not limited to, the following:

- Prohibiting or limiting hot work in fire areas during periods of increased vulnerability.
- Verifying operable detection and /or suppression in the vulnerable areas.
- Prohibiting or limiting of combustible materials in fire areas during periods of increased vulnerability.
- Modifying system status (e.g., removing power from equipment once it is placed in its desired position).
- Providing additional fire patrols at periodic intervals or other appropriate compensatory measures (such as surveillance cameras) during increased vulnerability.
- Using recovery actions, where feasible, to mitigate potential losses of key safety functions.

Per Calculation NEDC 11-003, Pre-emptive actions were recommended for two components to preclude short cycling of the fuel during the shutdown cooling mode of operation:

- RR-MOV-MO43B pre-stage to closed position with power removed
- RR-MOV-MO53B pre-stage to closed position with power removed

Other recommended strategies to either align a system or minimize the potential impact of fire-induced spurious operations include the operation of the following power operated valves during fire response recovery:

CRD-SOV-SO31A	MS-SOV-SPV71H	RHR-MOV-MO25B
CRD-SOV-SO31B	RCIC-MOV-MO15	RHR-MOV-MO27A
CS-MOV-MO12A	REC-MOV-714MV	RHR-MOV-MO27B
HPCI-MOV-MO15	RHR-MOV-MO12B	RHR-MOV-MO39B
MS-AOV-AO80A	RHR-MOV-MO13B	RHR-MOV-MO57
MS-AOV-AO80B	RHR-MOV-MO13D	RHR-MOV-MO66B
MS-AOV-AO80C	RHR-MOV-MO15A	RHR-MOV-MO67
MS-AOV-AO80D	RHR-MOV-MO15B	RWCU-MOV-MO15
MS-MOV-MO74	RHR-MOV-MO15C	RWCU-MOV-MO18
MS-SOV-SPV71A	RHR-MOV-MO15D	SW-AOV,TCV451B
MS-SOV-SPV71B	RHR-MOV-MO16A	SW-AOV-TCV451A
MS-SOV-SPV71C	RHR-MOV-MO16B	SW-MOV-37MV
MS-SOV-SPV71D	RHR-MOV-MO17	SW-MOV-MO89A
MS-SOV-SPV71E	RHR-MOV-MO18	SW-MOV-MO89B
MS-SOV-SPV71F	RHR-MOV-MO20	
MS-SOV-SPV71G	RHR-MOV-MO25A	

These recommendations will be evaluated for implementation into applicable operating and/or outage procedures as part of implementation per LAR Attachment S, Table S-3; Item S-3.4.

b. The goal of the NPO analysis was to demonstrate that for any given deterministic (complete burn-out) fire in any given fire area, at least one successful path for each required KSF remains free of fire damage or is capable of performing required functions despite fire damage (i.e. no "Pinch-Points"). Identified pinch points were evaluated and resolved as necessary to create KSF success. Equipment failures were resolved as needed by considering resolutions having the least impact first (e.g. circuit analysis shows that the failed cable cannot cause spurious operation) to those with the most impact (e.g. a recovery action is required to position the equipment). Where compatible, existing deterministic and NSCA at-power resolutions, including recovery actions, were applied in the NPO analysis to resolve equipment failures. RA were used whenever possible to show that the KSF could be recovered. Once identified, the specific nature of each RA was further evaluated to determine its feasibility. For example, where a repair or local operation of a component specifically to restore shutdown cooling (i.e. local operation of Residual Heat Removal (RHR) loop suction valves) was initially identified, the RA was reconsidered and replaced with an alternate protective strategy (i.e., Administrative Controls) since the ability to perform the action within the available time period before the reactor coolant could commence boiling could not be guaranteed. Similarly, RA which required entry into the affected fire area were also replaced with alternate protective strategies since extinguishing the fire, restoring area habitability, and entering the area to perform an RA was also determined to not be feasible within the scope of time available before reactor coolant could commence boiling. From this evaluation process, a final set of RA was proposed for consideration and documented in NEDC 11-003. RA are only one option that could be credited as part of a fire contingency plan. If RA use is not desirable or feasible for a specific outage scenario, alternative protective strategies as outlined in response a) above would be considered, as appropriate.

As part of Implementation Item S-3.4, CNS procedures will be reviewed and revised to incorporate guidance from the NPO review. Procedures to be considered for revision include:

- 0-CNS-OU-100, Refueling Outage Preparation and Milestones
- 0-CNS-OU-101, Forced Outage Planning and Preparation
- 0-CNS-OU-103, Long Range Outage Planning
- 0-CNS-OU-104, Refueling Outage Scope Identification and Control
- 0-CNS-OU-105, Refueling Outage Execution
- 0.7.1, Control of Combustibles
- 0.7.1.1, Control of Flammable Materials Lockers
- 0.16 37, Control of Doors
- 0.23, CNS Fire Protection Plan
- 0.39, Hot Work
- 0.39.1, Fire Watches And Fire Impairments
- 0.40, Work Control Program
- 0.40.4, Planning
- 0.44, Housekeeping Cleanliness Controls
- 0.49, Schedule Risk Assessment
- 0.50.5, Outage Shutdown Safety

In preparing the revisions, NPPD will consider including direction to minimize transient combustibles, evaluate the need for fire rounds, evaluate hot work prohibition, and other fire preventive measures throughout the plant during non-power operations, especially in the areas identified as having pinch points. NPPD will follow the guidance of FAQ 07-0040 Revision 4, which contains a list of acceptable measures that provide a flexible framework to prevent fires and protect against potential impacts should a fire occur, while allowing outage activities to continue.

Request: - SSD RAI 04

Attachment V of the LAR, provides discussion of an incipient detection system to be installed (Attachment S, Implementation Item S-2.4), based on insights from analyses for two panels (9-32 and 9-33) in the Auxiliary Relay Room (ARR) (part of fire area CB-D). This incipient detection system is to provide indication in the Control Room (CR) so that an operator/auxiliary operator can respond to the ARR confirm that the incipient detector for one of these panels has activated, and inform the CR. Please describe the necessary immediate actions by the CR operators to these incipient detection alarms and how these actions mitigate the circuit failures of concern. Also, please describe the longer term RAs remaining given confirmation of activation of detector.

NPPD Response:

The biggest advantage to knowing that a fire could develop in one of these panels is to alert the Main Control Room (MCR) operators that MCR abandonment is not required even if a fire were to occur. There are no immediate actions required from the MCR or outside of the MCR. Detailed circuit analysis demonstrates that operators can operate at least one train of equipment from the MCR, with some limited, long term local manual actions (which would only be necessary if the panels actually experienced a fire), if procedures are changed and operators are alerted to the specific location of the potential fires. Thus, installation of incipient detection and changes to procedures are planned for panels 9-32 and 9-33. The purpose of the system is to provide early indication of the potential for a fire inside one of these panels. VEWFDS (Very Early Warning Fire Detection Systems) can be credited for electrical/electronic components with a voltage of less than or equal to 250VDC or 480 VAC and contain internal components that exhibit gradual degradation.

The system will provide indication in the MCR so that an operator/auxiliary operator can respond to the auxiliary relay room, confirm that the incipient detector for one of these panels has activated, and inform the MCR. The MCR operators can then respond in the MCR using procedures for these panels to reach safe and stable conditions.

Absent the incipient detection, there is an increased potential for the MCR operators to implement ASD as a fire in either of these panels would impact automatic operation of core cooling equipment and MCR instrumentation. In addition to installation of an incipient detection system, fire response procedures will be changed such that the MCR will be the command and control center for reaching safe and stable conditions (Implementation Item S-3.3).

The expected scenario, given correct response to the annunciator, is fundamentally a normal shutdown as all equipment would remain available. Even if operators are delayed in commencing a normal plant shutdown but are aware of the source of the fire, then the actions summarized below would be taken as the MCR has not been abandoned and even assuming maximum damage has occurred to components within the specific panel.

For a fire contained solely in Panel 9-32, the plant may be placed in a safe and stable condition without evacuation as follows:

- Desired but not necessary actions in MCR would be to verify open EE-CB-4160F-1FS breaker to ensure potential damage on the 4160F breakers/control power does not affect the 4160G bus and Emergency Transformer (Emergency Transformer and EDG2 not impacted). This will be called out specifically to ensure credited train of power is available. This would avert the need to use an EDG as a power source and would ensure the availability of both offsite and onsite alternating current (AC) power sources.

- The operations of the majority of NSCA equipment may then be performed from the MCR since relay logics and potential cable failures are overridden by MCR switches to allow the operator to control systems manually from the MCR. The exceptions to this are noted below:
    - Normal Power to MCC-R is from 4160F Bus which may not be available. Therefore, power will be locally switched to the alternate supply (credited 4160G Bus). This MCC provides power for several Reactor Equipment Cooling (REC), RHR, Reactor Water Clean-up (RWCU) and Service Water (SW) valves. Once power is shifted to alternate supply, these valves powered can be operated from the MCR, as needed. This is a long term action to support RHR cooling.
    - The following valves may spuriously operate/change positions due to relay logic failures thereby requiring valve to be repositioned from outside the control room (Long term action for RHR cooling):
        - RHR-MOV-MO27B
        - RHR-MOV-MO25B
        - SW-MOV-MO89B
    - Shift EE-PNL-AA3 to Emergency (For long term operations / recovery of the 4160F and 480F breaker control power, if second train of electrical power is desired)

For a fire contained solely in Panel 9-33 the plant may be placed in a safe and stable condition without evacuation as follows:

- Desired but not necessary actions in MCR would be to verify open EE-CB-4160G-1GS breaker to ensure potential damage on the 4160G breakers/control power does not affect the 4160F bus and Emergency Transformer (Emergency Transformer and EDG1 not impacted). This will be called out specifically to ensure credited train of power is available. This would avert the need to use an EDG as a power source and would ensure the availability of both offsite and onsite ac power sources.

- The operations of the majority of NSCA equipment may then be performed from the MCR since relay logics and potential cable failures are overridden by MCR switches to allow the operator to control systems from the MCR. The exceptions to this are noted below:
    - The following valves may spuriously operate/ change positions due to relay logic failures thereby requiring valve to be repositioned from outside the control room (Long term action for RHR cooling):
        - RHR-MOV-MO27A

- RHR-MOV-MO25A
- RHR-MOV-MO66A

- Shift EE-PNL-BB3 to Emergency (For long term operations / recovery of the 4160G and 480G breaker control power, if for second train of electrical power is desired)

Request: - SSD RAI 05

LAR Attachment G describes the method used to transition operator manual actions (OMAs) as RAs. Please provide additional discussion and details of the following RAs:

a. *Fire Area CB-D - VFDR CBD-07: repair of the 125VDC and 250VDC train B battery charger cables.*

b. *Fire Areas CB-D and RBCF - VFDRs CBD-10 and RBCF-05: lifting leads to secure power to valves: RW-AOV-A082, RW-AOV-AO94.*

c. *Fire Area CB-A - VFDR CBA-01 - please address why is there no RA for the repair of the fuel oil transfer pump, which is an existing action under Appendix R and included in the Fire Probabilistic Risk Assessment (FPRA) (Attachment V SR: SY-A24).*

NPPD Response:

a. 250V and 125V DC power is required immediately for HPCI, RCIC, and EDG System operation. Station batteries have sufficient capacity to operate for 4.5 hours before battery chargers need to be repowered. A post-fire battery charger repair is required to ensure long term battery operation should a fire impact both sets of battery charger cables that run through the Auxiliary Relay Room (Fire Zone 8A). Replacement cables are pre-staged at the worksite and replacement instructions are provided in post-fire operating procedures (5.4FIRE-S/D, Fire Induced Shutdown From Outside Control Room, Attachment 7). Engineering Evaluation 10-05 provides the basis for post-fire repair implementation time adequacy. This repair would be required for long term operations and lineup shifts after achieving safe and stable condition as discussed in SSD RAI 02.

b. The CNS NSCA addresses the potential for loss of containment overpressure (COP) due to spurious hot shorts that could result in the potential inability to maintain adequate Net Positive Suction Head (NPSH) for the emergency core cooling system (i.e., RHR) pumps. For Fire Area RB-CF, the ADS and Core Spray systems are credited and therefore, COP is required at 1.5 hours. For Fire Area CB-D, the HPCI system is credited and therefore, COP is required at 3.5 hours. RW-AOV-AO82 and RW-AOV-AO94 are part of the system logic associated with ensuring COP is maintained. Lifting the leads from left side of terminal strip in Terminal Board 1207 DIV 1 (R-881-NW Quad) will ensure these valves fail closed and isolate drywell sumps. The leads for these valves have been clearly identified with tools pre-staged at the worksite and appropriate instructions provided in post-fire operating procedures (5.4FIRE-S/D, Fire Induced Shutdown from Outside the Control Room, and 5.4POST-FIRE, Post-Fire Operational Information).

c. Under the current Appendix R licensing basis in Fire Area CB-A, EDG2 is credited with supplying AC power to the 4160G Bus in accordance with 5.4POST-FIRE, Attachment 3 and the fuel oil transfer pump is needed for long term EDG operation. However, under the NFPA 805 licensing basis, Offsite Power has been evaluated and determined to be available for this fire area. Therefore, since EDG2 is no longer considered the credited NSCA success path, loss of the associated fuel oil transfer pump was not considered a Variance From Deterministic Requirements (VFDR). However, the risk insights from the Fire Probabilistic Risk Assessment (PRA) indicate benefits can be gained thru the availability of a second AC power source. Therefore, credit was taken for the post-fire repair of the fuel oil transfer pump to ensure long term usage of the EDGs as a redundant source of power. The repair will remain in the plant procedures and be retained as a Fire PRA recovery action but it is not required to support the NSCA, therefore its additional risk does not need to be evaluated.

Request: - SSD RAI 06

LAR Attachment S, Implementation Item S-3.6 describes confirmatory walk downs of the feasibility of RAs following completion of procedure changes to incorporate NFPA 805 actions. Implementation Item S-3.6(2) addresses validation of execution times to physically perform the action. Please describe the extent to which the actions will be validated (e.g., opening of cabinets to access components and verifying the components can be operated as described). In addition, please describe whether there are procedures that address the performance and acceptance criteria for the procedure validations being performed during these confirmatory walk downs.

NPPD Response:

Recovery action validation will be performed to the extent practical using the field validation forms, feasibility timelines and the revised CNS procedures. Recovery Actions were verified feasible as documented in NEDC 10-041. Implementation Item S-3.6 will confirm that the NFPA 805 recovery actions determined to be required per Calculation NEDC 11-020, "Recovery Action Transition Methodology and Results," align with CNS procedure re-writes from Implementation Item S-3.3 and can meet the requisite feasibility acceptance criteria as documented in Calculation NEDC 10-41, "NFPA 805 Recovery Action Feasibility Assessment" and previously described in response to SSD RAI 02(d) above.

For new or revised CNS procedures that will contain RA, CNS Procedure 0.4, Procedure Change Process, has a Verification and Validation process that includes guidance for opening cabinets and verifying a component can be operated as described in the procedure. Additional Validation forms that are part of the SAFE software documentation will be used during the confirmatory walkdowns contain the following acceptance criteria:

FIELD VALIDATION REPORT

Fire Area: AREA TB-A

Equipment: EE-CB-4160F-1FA | Operator Action Reference No: EE-1FA-FUSES | Operator: OPERATOR 1

Location: CRITICAL SWITCHGEAR ROOM, 3A, 4160F BUS

Procedure: 5.4POST-FIRE | Procedure Step: 1.0

Action: REMOVE CONTROL POWER FUSES.

Provide explanation in comments block for any adverse answer below.		Comments:
Has permission been obtained from Control Room to enter panel or enclosure if required?	Yes / No / NA	
Can action be performed as written?	Yes / No	
Is the action worded clearly enough to avoid interpretation errors?	Yes / No	
Are components clearly identified and agree with actual plant labels?	Yes / No	
Is equipment location accurate / detailed enough?	Yes / No	
Does Operator Action match / summarize procedure?	Yes / No	
Is the correct Operator specified?	Yes / No	
Is the procedure correct including component lineups?	Yes / No	
Does the procedure correctly coordinate the action?	Yes / No	
Are pre-requisite conditions and limitations clearly defined in procedure?	Yes / No	
Is the procedure and sequence consistent with the intent of the related System Operating Procedure? – List in comments section.	Yes / No	
Is the procedure consistent with direction provided in the EOP flowcharts?	Yes / No	
Does the procedure provide for radiological concerns considering the probable EAL and the severity of the action being taken if in potentially high radiation area(s)?	Yes / No	

FIELD VALIDATION REPORT

Fire Area: AREA TB-A
Equipment: EE-CB-4160F-1FA
Location: CRITICAL SWITCHGEAR ROOM, 3A, 4160F BUS
Procedure: 5.4POST-FIRE

Operator Action Reference No: EE-1FA-FUSES

Operator: OPERATOR 1

Procedure Step: 1.0

GENERAL /PREPARATION				
Item Field Validated	Original Value	Actual Value	(✓)	Comments
Required Key(s) – List all keys needed.	NONE			
Required Tool(s) – List all tools needed.	FUSE PULLERS MANUAL BREAKER CHARGING RATCHET			
Tool Location	N/A			
Route – List path taken from previous step performed based on Fire Area or Control Room as appropriate.	10B, 19B, 3A			
E-Lights – List all lights used based on path and equipment location to complete action and/or portable lights as appropriate.	C19, O5, R35, R88			
Route specific remarks to include potential problems, concerns or information for future use.	NONE			
Notes – Items of specific note for completion of this action.	NONE			

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FIELD VALIDATION REPORT

Fire Area: AREA TB-A
Equipment: EE-CB-4160F-1FA
Location: CRITICAL SWITCHGEAR ROOM, 3A, 4160F BUS
Procedure: 5.4POST-FIRE

Operator Action Reference No: EE-1FA-FUSES

Operator: OPERATOR 1

Procedure Step: 1.0

ENVIRONMENTAL / ACCESS				
Item Field Validated	Original Value	Actual Value	(✓)*	Comments
Is the Equipment / Action located in the Fire Area?	NO	Yes / No		
Does the Operator have to traverse the fire area to reach the equipment or action location?	YES	Yes / No		
Is there a potential for Radiation level concerns based on equipment / action location?	NO	Yes / No		
Is there potential for Post-Fire debris / Obstructions from impacting ability of operator to reach or perform the action location?	NO	Yes / No		
Potential for Suppression Effects to impact ability to perform action?	NO	Yes / No		
Potential for temperature to impact equipment or operator ability to perform action?	NO	Yes / No		
Potential for Humidity to impact equipment or operator ability to perform action?	NO	Yes / No		
Does operator need to wait for smoke removal to perform action?	NO	Yes / No		
Are there other potential environmental impacts that may affect the equipment or the operator while performing the action? – specify in comments if Yes.	NO	Yes / No		

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FIELD VALIDATION REPORT

Fire Area: AREA TB-A
Equipment: EE-CB-4160F-1FA
Location: CRITICAL SWITCHGEAR ROOM, 3A, 4160F BUS
Procedure: 5.4POST-FIRE

Operator Action Reference No: EE-1FA-FUSES

Operator: OPERATOR 1

Procedure Step: 1.0

TIME REQUIREMENTS				
Item Field Validated	Original Value	Actual Value	(✓)	Comments
Moving Time (min) – how long to get from previous action / or location.	3.5			
Collect Special Tools (min) – how long to gather special tools / equipment to perform action.	2			
Collect Repair Material (min) – how long to gather repair material / equipment to perform action.	N/A			
Wait Time for habitability or access to the compartment or space (min).	N/A			
Access time to equipment (min) – how long does it take to open cover(s), panels etc. to gain access to equipment / component being operated.	3			
Performance time (min) – how long does it take to perform the actual action.	2			

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FIELD VALIDATION REPORT

Fire Area: AREA TB-A
Equipment: EE-CB-4160F-IFA
Location: CRITICAL SWITCHGEAR ROOM, 3A, 4160F BUS
Procedure: 5.4POST-FIRE

Operator Action Reference No: EE-IFA-FUSES

Operator: OPERATOR 1

Procedure Step: 1.0

Verify Response (min) – how long does it take to ensure the action produced desired results.	N/A			

* Check mark signifies that the actual or field value is consistent with the original value and Database update is not required. If not checked during the field validation then database update is/was required.

Field Validation complete: ____________________
Print / Signature   Date

SAFE Database updated: (If Required) ____________________
Print / Signature   Date

Request: - SSD RAI 07

LAR Attachment F, "Fire-Induced Multiple Spurious Operations Resolution," states (under Results of Step 2), "The analysis was updated in January 2011 without reconvening the expert panel." Please provide additional discussion of the January 2011 update of the multiple spurious operation (MSO) analysis and the process used for this update.

NPPD Response:

NEDC 09-080, Revision 1 was developed to address changes identified in addressing the Fire PRA Peer review and revision to NEI 00-01 which included an update to the Boiling Water Reactor Owner's Group Generic list of MSOs. Revision 1 to NEDC 09-080 contains the following noteworthy changes:

- Scenario 2c – Clarified scenario flowpaths with respect to impact on the HPCI steam supply.
- Scenario 2e –The consequence of this scenario (Control Rod Drive (CRD) Scram Discharge Volume (SDV) Header flow diversion) is reclassified from a medium Loss-of-Coolant Accident (LOCA) to a Break Outside Containment (BOC) because the SDV Header is located in the Reactor Building outside of the primary containment.
- Scenario 2k – Expanded the discussion on flow diversion for Low Pressure Coolant Injection (LPCI) to include both divisions of Torus Spray occurring simultaneously. MSO of five valves has been identified to potentially cause unavailability of LPCI. See peer review Facts and Observation (F&O) 2-13.
- Scenario 4b – Expanded consideration of flow diversion for the Suppression Pool Cooling (SPC) mode of RHR beyond the generic scenario. Flow diversion from SPC to the Reactor Vessel via LPCI piping, including cross-train flow diversion was evaluated and new flow diversion combinations identified.
- Scenarios 4r, 4s, 4t, and 4u – Revised the discussion on COP and impact on NPSH. Broke-out potential pathways in 4u that are more appropriately discussed under Scenarios 4s and 4t.
- Scenario 4s – Added the two-inch bypass line around PC-MOV-231MV, including MSO of valve PC-AOV-246AV and normally closed PC-MOV-306MV.
- Scenario 4u– Added the two-inch bypass line around PC-MOV-230MV, including MSO of valve PC-AOV-245AV and normally closed PC-MOV-305MV.
- Scenario 5i – EDG operation without cooling water was expanded to include a valid EDG start, faulted 4160 Bus, and no power to the associated Service Water pumps.
- Scenario 7e –Added steam flow diversion from HPCI via a main steam line resulting from simultaneous opening of the inboard (80A-D) and outboard (86A-D) Main Steam Isolation Valves (MSIV) on the same line. This flow diversion also results in a Level 2 concern, i.e., Containment Failure. Also, an additional flow path via the 1A RHR Heat Exchanger has been included. See peer review F&O 1-8.
- Scenario 7f - Added steam flow diversion from RCIC via a main steam line resulting from simultaneous opening of the inboard (80A-D) and outboard (86A-D) MSIVs. This flow

diversion also results in a Level 2 concern, i.e., Containment Failure. See peer review F&O 1-8.

- Revised Attachment A "Components to Include for Spurious Operation" to reflect changes and new component combinations applicable to MSO pathways that were revised in the scenarios identified above.
- Updated references as appropriate.

Due to the nature of the changes, it was determined that reconvening the panel was not necessary. In lieu of reconvening, the revised calculation was provided to applicable panel members for review and concurrence of the above changes. Any comments received were dispositioned and incorporated, as appropriate.

Request: - SSD RAI 08

LAR Attachment C describes a means of meeting ventilation cooling requirements for various components (e.g., VFDR CBD-05: EE-BAT-125-1B, EE-BAT-250-IB, EE-SWGR-125B, EE-SWGR-250B; VFDR CBA1-01: EE-SWGR-125B, EE-BAT-124B; VFDR CBB-01: EE-PNL-CDP1A, EE-MCC-LX) via open compartments. Please describe whether these compartments require actions to open doors or other features. If these actions are required, please describe whether feasibility has been reviewed and whether these actions should be included in LAR Attachment G as RAs. Also, please describe if any other heating ventilation and air conditioning (HVAC) RAs are credited.

NPPD Response

HVAC was modeled in the NSCA to protect credited equipment from overheating or to ensure habitability as described in Calculation NEDC 11-019. Upon loss of credited HVAC due to fire-induced circuit damage, VFDRs were created (i.e., VFDRs CBA-03, CBA1-01, CBB-01, CBD-05, TBA-03 and RBJ-02) and subsequently evaluated through the Fire Risk Evaluation (FRE) process. Through this process, it was determined that none of the noted VFDRs resulted in the need to carry forward previously credited actions to open doors or other features as NFPA 805 recovery actions.

Request: - SSD RAI 09

Numerous RAs identified in LAR Attachment G, document the removing of fuses and operation of MOVs using the motor starter. Use of the motor starter from the motor control center (MCC) bypasses the protective functions of the torque and limit switches. Application of stall thrust to MOVs may cause structural damage to the valve (stem, yoke, stem nut, etc.). Please describe the procedural guidance and training provided to the operators to assure that the valve will be positioned to the desired position. Also, please describe how the process prevents damage to the valve/actuator due to overtorque/overthrust.

NPPD Response:

The actions currently listed in Attachment G related to removing of fuses and operation of MOVs using the motor starter have been verified to work and was demonstrated during the NRC special audit (November 2011), are part of post-fire operating procedures (5.4FIRE-S/D, Fire Induced Shutdown From Outside the Control Room, and 5.4POST-FIRE, Post-Fire Operational Information) and evaluated for overtorque/overthrust conditions in EE 04-046. It should be further noted that an approved field modification (CED 6033461) has been approved to eliminate the existing credited method of operation, that installs new local control panels and cables to place the control circuitry back into the circuit. New Local Auxiliary Safe Shutdown Control Panels will be installed near the Motor Control Center (MCC) or DC starter for each of the MOVs that were previously required to be controlled by removing fuses and using the motor starter to control the valve. The new panels and cables have been analyzed for NFPA 805 impact and the applicable documentation including the NSCA fire area analysis will be updated to include a revised description for performing the recovery actions when the modification is completed. The new actions will not require the operator to locally operate contactors but rather using a local/remote isolation switch take control of the valve at a local control panel with indicating lights for position along with a control switch which will utilize the limit switches to preclude over driving the valve. It should also be noted that the installation of this modification does not eliminate the separation issues (VFDRs) for the valves in questions but instead provides a more feasible and reliable means to locally operate the valves in question. A new S-2 Table Implementation Item has been added for completion of CED 6033461 (see Attachment 2, Change 8). Changes to LAR Attachment G that eliminate the need of removing of fuses and operation of MOVs using the motor starter will be provided in the 90-day RAI response.

Fire Protection Engineering (FPE)

Request: - FPE RAI 01

LAR Section 4.1.2.3 lists NFPA 805 Chapter 3 elements for which approval is requested via 10 CFR 50.48(c)(2)(vii) but does not include Element 3.3.3. Chapter 3, Element 3.3.3 is included in Attachment A as "Submit for NRC Approval," and also in Attachment L as Approval Request 2. Please confirm that NRC approval is requested for NFPA 805 Chapter 3, Element 3.3.3.

NPPD Response:

It has been confirmed that NRC approval is requested for NFPA 805 Chapter 3, Element 3.3.3, as described in the Attachment A B-1 Table, and in Attachment L, Approval Request 2. A revision to LAR section 4.1.2.3 is provided in Attachment 2 (Change 1).

Request: - FPE RAI 02

LAR Attachment I identifies "Yard" as a Building /Structure in the Power Block. Please identify the structures and explicitly define the needed pieces of equipment included in the Yard in a more detailed list.

NPPD Response:

Specific structures in the Yard and those structures listed within FAQ 06-0019 have been reviewed and accounted for as either within or not within the Power Block, as described in the revision to LAR Attachment I, Table I-1 (see Attachment 2, Change 6).

Request: - FPE RAI 03

Table 4-3, (Fire Areas CB-D and RB-M), Attachment C, and Attachment S (Modifications S-2.5, -2.6, and -2.7) identify existing and planned installations of radiant energy and flame impingement shields (e.g., Promat-H board) as features required for risk. For each of the existing or planned installations of radiant or flame impingement shields, please provide additional information and a description regarding the design of the shields, the installation configuration, and the protection function that is credited in the NFPA 805 analyses. Include descriptions of the fire exposure assumed in determining the acceptability of the shields to meet the protection function. Describe the additional fire protection systems, if any, provided in these areas

NPPD Response:

Existing installations of radiant energy and flame impingement shields in Fire Area CB-D consist of two (2) Promat-H Board radiant energy shields in the Cable Spreading Room (Fire Zone 9A) and one (1) Promat-H Board flame impingement shield in the Cable Expansion Room (Fire Zone 9B). There are no existing installations in Fire Area RB-M.

Promat-H board is provided in the Cable Spreading Room on the northwest side of the column at column line 14.6 and J.3 and along the south wall of the room. The conduit at these locations are encased with two (2) layers of Promat-H board up to an elevation at which congestion precludes further protection. The enclosures protect vertical runs of required Division II conduit. A pre-action sprinkler system, automatic smoke detection system, and heat actuated devices (H.A.D.) are provided in the fire zone. The Promat-H board ensures that damage due to radiant heat flux from a floor-based transient fire would be delayed to provide time for detection and suppression system actuation prior to cable damage. Transient fires in the Cable Spreading Room are modeled as 69 kW fires based on credit for the planned modification to enhance combustible controls in this fire zone.

Promat-H board is provided in the Cable Expansion Room under the Division II ductbank. The conduit bank is protected from a floor-based transient fire by two (2) layers of Promat-H board under the bottommost conduit in the bank. An automatic wet pipe sprinkler system and smoke detection system are provided in the fire zone. The Promat-H board ensures that the conduit above is not damaged by plume or flame impingement from a floor-based transient fire. Transient fires in the Cable Expansion Room are modeled as 317 kW fires.

A fire rating cannot be assigned to the Promat-H board fire barriers in Fire Zone 9A and 9B as the configurations are not completely enclosed. However, the construction is the same as that of a 1-hour fire rated barrier per Modification DC 92-097, "Thermo-lag Barrier Replacement." The seam construction, barrier thickness, etc., are the same as that in an approved 1-hour rated barrier. The 1-hour fire rated resistance is adequate for these scenarios based on the fire duration of a transient fire being less than 1-hour with no additional secondary cable trays or other combustibles being involved in transient fire scenarios in these zones.

The planned installations in Fire Area CB-D (Modification S-2.7) are plume impingement shields above panels PMIS-MUX-LNK6 and PMIS-MUX-LNK7 in the Cable Spreading Room (Fire Zone 9A) to prevent damage to conduit and cable trays located directly above these panels.

The planned installations in Fire Area RB-M (Modifications S-2.5 and S-2.6) are radiant energy shields along the east wall (outside of the Critical Switchgear Room) south of column line K-11.7 of Fire Zone 3C to protect vertical conduit along the wall from a floor-based transient fire and radiant energy shields west of the elevator in Fire Zone 3C, just north of column line J-10.5, to protect vertical cable trays through the floor from a floor-based transient fire.

These "to be installed" shields will be constructed to 1-hour fire rated resistance based on the fire duration of these panels in Fire Area CB-D and the transient fires in Fire Area RB-M being less than 1-hour with no additional secondary cable trays being involved in the fire scenarios. The basis for these modifications was to support Fire PRA risk reduction, not as a resolution of a VFDR. Panels PMIS-MUX-LNK6 and PMIS-MUX-LNK7 are modeled as 464 kW electrical fires and transient fires in Fire Area RB-M are modeled as 317 kW fires. A pre-action sprinkler system, automatic smoke detection system, and H.A.D. are provided in the Cable Spreading Room. Smoke detection is provided in Fire Zone 3C but not in the vicinity of the "to be installed" shields and there is no fixed suppression in Fire Zone 3C.

Request: - FPE RAI 04

LAR Attachment A, Section 3.2.3, states, "Complies with Required Action." Attachment S, Table S3, Item S-3.1 states that performance based surveillance frequencies will be established as described in Electric Power Research Institute (EPRI) Technical Report 1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features." The use of performance-based methods to meet the requirements of NFPA 805, Chapter 3 requires NRC approval in accordance with 10 CFR 50.48(c)(2)(vii).

a. Please describe how the guidance in EPRI Technical Report 1006756 will be integrated into the NFPA 805 monitoring program.

b. Please discuss your plans for complying with 10 CFR 50.48(c)(2)(vii) regarding the use of EPRI Technical Report 1006756.

NPPD Response:

a. EPRI Technical Report TR-1006756 Section 11 contains the following guidance which ensures that reliability levels established are consistent with the Fire PRA and Maintenance Rule Program:

> In establishing reliability goals, each plant should determine if other programs, evaluations, or analyses have credited specific reliability values. For example, if the Fire PRA credits a specific level of reliability for a certain suppression system, the target reliability for surveillance optimization should not be below the credited value.

The frequency at which inspections, testing, and maintenance of the fire protection systems and features are performed will be evaluated using the EPRI Technical Report TR-1006756, and addressed within the NFPA 805 monitoring program.

b. NPPD concurs that NRC approval is required per 10 CFR 50.48(c)(2)(vii) to utilize EPRI Technical Report TR-1006756 to establish performance-based frequencies. The following LAR Sections have been revised in Attachment 2:

- Section 4.1.2.3 (see Change 1)
- Attachment A, Section 3.2.3(1) (see Change 4)
- Attachment L, Approval Request 11 (see Change 7)
- Attachment S. Implementation Item S-3.1 (see Change 9)

Request: - FPE RAI 05

LAR Attachment A, Section 3.3.5.1 and Attachment L, Approval Request 3, requests NRC approval for minor amounts of wiring located above suspended ceilings that does not meet qualification criteria and is not installed in conduit. Please provide the following additional information:

a. *Please describe the specific circuits associated with the unqualified wires or cables (e.g., type, voltage, communication, data, signal, etc.).*

b. *Please describe whether the areas above the suspended ceilings are provided with fire detection or suppression.*

c. *Please provide additional details describing the visual inspection for ignition sources above the suspended ceilings and indicate if the inspection was considered comprehensive.*

d. *Please state if the wires and cables that do not meet the qualification criteria of LAR Attachment A, Section 3.3.5.1, meet Institute of Electrical and Electronics Engineers (IEEE) 383, "Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," or other qualification standards. If so, please indicate the other standards.*

e. *Please provide additional discussion of "minimal amount" as used in the "Acceptance Criteria Evaluation."*

f. *Please describe the pathway for smoke above the suspended ceiling. If the area is a plenum, describe the exhaust path and whether it is part of a smoke purge system.*

g. *Please provide discussion of the subject wiring installations relative to fire areas containing nuclear safety capability systems and equipment. Also, identify if any NSCA cables are routed in the areas above suspended ceilings where unqualified cables are located.*

NPPD Response:

a. An inspection, as described in Response c below, identified only data communication (phone, computer, and security) wiring of -48 volts installed in the majority of the areas above the suspended ceiling. All other cables are routed in conduit above the suspended ceilings.

b. No areas above the suspended ceilings are provided with fire detection or suppression.

c. CM Order 4884647, "Inspect Areas Above Suspended Ceilings", was performed by CNS Maintenance to inspect the areas above suspended/dropped ceilings in Power Block Buildings. A member of the CNS Fire Protection Engineering Group was involved in the inspection to ensure that it was comprehensive of all areas and potential ignition sources. The inspections were performed in order to:

1. Verify areas above the suspended/dropped ceilings are maintained with limited combustible material and identify any potential ignition sources (transformers greater than 45 kVa or motors greater than 5 hp.
2. Inspect areas above suspended/dropped ceilings, and any combustible material found that is not fixed (e.g. wood, paper, rag, etc.) is to be removed or evaluated.
3. Identify any fixed combustible material including cabling not installed in conduit such as lighting/power receptacle circuits, Gaitronics cables, telephone cables and fire detection circuits.

The inspections confirmed that minimum combustibles are located above the suspended ceilings and that there are no sources located above the ceilings that would be binned as fire ignition sources (i.e., motors less than 5 hp and transformers less than 45 kVA). The majority of the areas contain no combustible materials or contain less than one (1) pound of Class A combustibles. The following two areas were identified as containing combustibles that are to be removed (Condition Report CR-CNS-2012-06556 was generated to remove these combustibles):

1. Plastic funnel located above the Electric Shop ceiling in the Turbine Building (Fire Zone 13C).
2. Drip catch and trash bag located above the ceiling in the Offgas Control Room in the Augmented Radwaste Building (Fire Zone 22B).

d. Qualified (IEEE-383 equivalent) cables are routed in conduit above these suspended ceilings and the only other cabling is data communication (phone, computer, and security) wiring. As of 2006, CNS cables are installed per Procedure 11.14, "Communication Cable and Component Installation Guidelines", which requires that communication cabling installed in the Power Block meets NFPA 262 requirements. Although no non-plenum rated wiring were identified during the plant walkdowns, there is a potential for a few non-plenum rated wiring to have been installed prior to implementation of Procedure 11.14 in 2006, however, these few cables would not produce significant smoke and would not be considered a potential fire source.

e. There is no significant wiring above the suspended ceilings. Only data communication (phone, computer, and security) wiring of -48 volts are installed in the majority of the areas above the suspended ceiling and this wiring is not routed in cable trays. All other cables are routed in conduit above the suspended ceilings.

f. There are no plenum (forms part of an air distribution system) areas above the suspended ceiling in these areas and therefore, there is no concern with smoke above the suspended ceiling.

g. The areas at CNS with suspended ceilings inside the NFPA 805 defined Power Block areas are offices, labs, corridors, and control rooms. Suspended ceilings were identified in the following Power Block areas:

- Control Building - Computer Room (Fire Zone 10A)
- Turbine Building - Crafts (Electrical and I&C) Shop Areas (Fire Zones 13C and 13D)
- Multi-Purpose Facility - Office Area (Fire Zone 24)
- Machine Shop - Office Area (Fire Zone 18A)
- Water Treatment Building - Control Room and Storage Room (Fire Zone 17)
- Radwaste Building - Chemistry Lab Areas (Elevation 932'-6", Fire Zone 21D, and Elevation 918'-0", Fire Zone 21C)
- Augmented Radwaste Building - Drum Handling Control Room, Offgas Control Room, and Auxiliary Radwaste Control Room (Fire Zone 22B)

Any NSCA, non-power operations, and Fire PRA credited cables located above the suspended ceilings in these areas are routed in conduit.

Request: - FPE RAI 06

LAR Attachment A, Section 3.6.1, and Attachment L, Approval Request 7, requests NRC approval of deviations from NFPA 14, "Standard for the Installation of Standpipe and Hose Systems," regarding the design and installation of standpipes and hose systems. The Attachment L Acceptance Criteria Evaluation for NFPA 14, Section 322, states that the subject fire zones can be reached with a maximum of 50 feet of hose in addition to the 100 feet required by the standard. Please confirm that the hydraulic calculations for the standpipe system demonstrates acceptable pressure and flow conditions at the nozzle with the head-loss associated with 150 feet of hose.

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: - FPE RAI 07

LAR Attachment A, Element 3.5.6 Compliance Statement, states, "Submit for NRC Approval"; however, this element is not cited in the Approval Request. Please clarify that Attachment L, Approval Request 6 also applies to NFPA 805, Section 3.5.6.

NPPD Response:

Upon further review by NPPD, NFPA 805 Element 3.5.6 does not indicate a requirement of "remote" or "local" manual stop capability. The Attachment L item is requesting approval for remote manual stop capability which is a deviation against the requirement of NFPA 20. Therefore, Attachment L Approval Request 6 should only be referenced in Section 3.5.3 of the B-1 Table. The Compliance Statement and Compliance Basis of NFPA Element 3.5.6 of the B-1 Table have been revised to remove reference to the Request for NRC Approval (see Attachment 2, Change 4). NPPD complies with the requirement that "Fire pumps shall be provided with automatic start and manual stop only."

Request: - FPE RAI 08

Attachment S, Table S-3, Implementation Item S-3.2 establishes "enhanced transient and combustible controlled zones" in high-risk Fire Zones 8A (cable spreading room (CSR)), 9A (Relay Room), 2C above the (traversing incore probe (TIP) Room, 3C, and 3D in the areas around instrument racks 25-5 and 25-6. Please describe the assumptions made for these "enhanced transient and combustible controlled zones" and the types of controls to be put in place relative to other combustible control zones.

Implementation Item S-3.25 identifies the designation of "enhanced transient and hot work controlled fire zones". Please define "enhanced transient and hot work controlled fire zones" and specify what controls will be put in place. Also, describe what it means to "restrict" hot work in the context of these enhanced zones.

NPPD Response:

The enhanced transient and combustible controlled zones/locations are being created to further enhance strict combustible controls in these areas beyond what is currently in place per Administrative Procedure 0.7.1, "Control of Combustibles." These enhanced controls will include designating the areas as "No Storage" which prevents combustibles from accumulating in the area. These areas are not expected to contain large combustible liquids since activities in the areas do not include maintenance of oil containing equipment. The areas around the Instrument Racks 25-5 and 25-6 are currently cordoned off with steel posts and chains, and the area above the TIP Room is accessible via stairs only. The Auxiliary Relay Room (Fire Zone 8A) is a locked room requiring keyed access through Work Control and the Cable Spreading Room (Fire Zone 9A) is a badge access required area.

Procedure 0.7.1 defines the combustible control zones which establish the level of controls required based on potential fire related damage to plant components. A "Level 1 Area" is a fire sensitive area of the plant where transient combustible loading is prohibited unless evaluated and approved via the procedure. A "Level 2 Area" is a plant area where combustibles are permitted, but only with strict combustible controls. Procedure 0.7.1 currently defines the Cable Spreading Room and the Auxiliary Relay Room as Level 1 Areas. Fire Zones 2C, 3C, and 3D are currently defined as Level 2 Areas.

Implementation Item S-3.2 includes revising Procedure 0.7.1 to designate the area above the TIP Room (Fire Zone 2C) and the areas around Instrument Racks 25-5 (Fire Zone 3D) and 25-6 (Fire Zone 3C) as a Level 1 Area. Additionally, the floor area around Instrument Racks 25-5 and 25-6 will be marked to designate the additional combustible controls. This will require the placement of combustibles in these areas to be evaluated and approved by the Fire Protection Group per the Level 1Area procedural requirements. If combustibles are added to the area above the TIP Room or around Instrument Racks 25-5 and 25-6 or if the transient combustible loading equivalent to a 69 kW fire were exceeded in the Cable Spreading Room (Fire Zone 9A) or in the Auxiliary Relay Room (Fire Zone 8A), additional actions will be implemented. These actions will include such things as requiring the combustible material to be constantly attended, stored in a noncombustible enclosure, posting of a continuous fire watch, or other adequate actions as determined by the Fire Protection Group or designee.

The Implementation Item to establish enhanced transient and hot work controlled fire zones include revising Procedure 0.39, "Hot Work" and Procedure 39.1 "Fire Watches and Impairments," to restrict "Hot Work" activities in the Cable Spreading Room (Fire Zone 9A), Auxiliary Relay Room (Fire Zone 8A), in the area above the TIP Room (Fire Zone 2C), and in the areas around Instrument Racks 25-5 (Fire Zone 3D) and 25-6 (Fire Zone 3C) while at power. Currently, Hot Work cannot be performed without a continuous fire watch in place with the fire watch having a fire extinguisher checked out for a continuous fire watch. In the event of a fire, the fire watch must immediately report the fire to the MCR and attempt to extinguish the fire. With this Implementation Item, for Hot Work to be performed in these restricted areas, approval will need to be obtained from the Fire Protection Group or designee. The purpose of the approval will be to determine alternatives to doing Hot Work in the restricted areas, or determine additional actions to reduce the hazard.

Request: - FPE RAI 09

LAR Section 4.5.2.2 and Figure 4-7 summarizes the approach to evaluating defense-in-depth (DID) and safety margin in the resolution of variance from deterministic requirements (VFDRs). Under the heading, "Disposition of VFDR," the LAR indicates the results of the risk evaluation, DID, and safety margin are summarized in Attachment C. Attachment C does not include discussion or summary of DID and safety margin for the individual VFDRs or on a fire area basis. Please provide additional discussion of the methods and criteria for evaluating DID and safety margins and summarize the results as required by NFPA 805, Section 4.2.4.2.

NPPD Response:

The wording in Section 4.5.2.2, "Disposition of VFDR," was transcribed from the generic NEI template for NFPA 805 LARs. It did not intend to communicate that the Attachment C, B-3 Table would describe a discussion or summary of DID and safety margin for the individual VFDRs or on a fire area basis. The VFDRs in each fire area were evaluated for safety margin and defense-in-depth and it was determined that the risk, safety margin, and defense-in-depth meet the acceptance criteria of NFPA 805 Section 4.2.4. The results of the defense-in-depth and safety margin review are documented in each individual fire area Fire Safety Assessment (FSA).

Refer to the response to PRA RAI 12 for the methods and criteria for evaluating defense-in-depth and safety margin.

Request: - FPE RAI 10

Attachment S, Item S-2.4, identifies a modification to install incipient detection in two panels in the ARR. Because of the various vendor types of "incipient detection systems," please provide a description of the incipient detection system that will be installed, including a discussion of the design, installation and testing criteria provided in frequently asked question (FAQ) 08-0046, "Incipient Fire Detection Systems" (ADAMS Accession No. ML093220426). Please describe the compensatory measures necessary in the period between post-transition and prior to completion of the modification, or during incipient detection outages, that will provide the necessary early detection and response as credited in the FPRA.

NPPD Response:

NPPD has not designed and developed the modification at this time to install incipient detection in the 9-32 and 9-33 Relay Panels in the Auxiliary Relay Room (Fire Zone 8A). However, the design will be based on FAQ 08-0046 and will meet the FAQ guidance, such as sensitivity, equipment voltage restrictions, and fast-versus-slow acting devices in regard to fire growth. The system will be tested in accordance with the manufacturers and code requirements, including sensitivity. A review of the panels indicates that these are 125VDC and 120V AC panels containing terminal boards, relays, lights, switches and associated cabling/wiring, which will exhibit incipient degradation (i.e., slow acting components) and there is no equipment that will exceed the 250VDC and 480 VAC restriction. The detection system configuration will consist of an alarm unit that is individually assigned to each relay panel. The system will be designed and installed in accordance with NFPA 72 and 76.

As part of Implementation Item S-2.4, Alarm Procedures will be developed to guide the Operator response to incipient detection alarm events. The procedures will provide guidance as to what actions are recommended in regard to diagnosing the cause of an incipient detection alarm, providing recommended compensatory measures, and identification of support resources. NPPD will have thermal imaging cameras and hand-held incipient detectors which will be available for use in responding to alarms associated with the incipient detection in these relay panels. The cameras and hand-held incipient detectors will be appropriately staged to be rapidly accessible by the first responders when needed. The Alarm Procedures will be designed to work in conjunction with existing operating procedures, abnormal operating, and emergency response procedures.

Implementation Item S-2.4 states that appropriate compensatory measures will be established per Procedure 0.23, as required, until the modification is implemented. More specifically, during the times when the incipient detection in Relay Panels 9-32 and 9-33 is out of service (including the period between post-transition and prior to completion of the modification, plant procedures will provide a continuous fire watch in the Auxiliary Relay Room. The continuous fire watch will utilize hand-held incipient detection which will provide compensatory measures equivalent to the incipient detection when the system is unavailable or inoperable.

Request: - FPE RAI 11

LAR Section 4.2.2 describes the process and criteria used to evaluate Existing Engineering Equivalency Evaluations (EEEEs) to determine that a fire protection system or feature is "adequate for the hazard." None of the summaries of the EEEEs cited in LAR Table B-1 or described in LAR Table B-3 state that the basis of acceptability of remains valid. Please provide an explicit statement that the credited EEEEs were determined to meet the NEI 04-02, "Guidance for Implementing a Risk-Informed, Performance Based Fire Protection Program Under 10 CFR 50.48(c)," criteria and that the basis of acceptability of previous EEEEs remains valid.

NPPD Response:

LAR Section 4.2.2 has been revised to include an explicit statement that the credited EEEEs were determined to meet the NEI 04-02 criteria and that the basis of acceptability of previous EEEEs remains valid (see Attachment 2, Change 2).

Request: - FPE RAI 12

There appears to be inconsistencies between LAR Attachment A (Table B-1) and Attachment S. Examples include:

> *Table B-1, Sections 3.3.1.2 Control of Combustibles, 3.3.1.3.1 Control of Ignition Sources, 3.4.2 Fire Pre-Plans, are affected by implementation items listed in Attachment S, but do not reflect the compliance category "complies with required action."*
>
> *Attachment S implementation Items S-3.2 and S-3.25 are associated with enhanced combustible and hot work controls, and Item S-3.20 is associated with pre-fire planning, but are not identified in the associated sections of Table B-1 described above.*

a. *Please clarify that these selected Table B-1 sections "comply with required action" as appropriate.*

b. *Please provide the results of an extent of condition review that identifies all situations where implementation items are identified and ensure that the appropriate compliance strategy ("complies with required action") is reflected as required in the transition report (B-1 Table).*

NPPD Response:

The purpose of the B-1 Table is to explain how CNS conforms to the fundamental fire protection program and design elements described in NFPA 805, Chapter 3. As noted in the RAI, NPPD has described Implementation Items that will effect future changes to certain documents cited in the B-1 Table. However, these Implementation Items are not being committed to in order to achieve compliance with NFPA 805, Chapter 3. Specifically:

- Implementation Items S-3.2 and 3.25 establish enhanced transient and combustible controlled zones to address high risk transient fire scenarios. While S-3.2 and 3.25 relate to the activities of B-1 Table Sections 3.3.1.2 and 3.3.1.3.1, they are not required for compliance with these NFPA 805 sections.

- Implementation Item S-3.20 revises the pre-fire plans to address the radioactive release requirements of NFPA 805. While Implementation Item S-3.20 relates to the activity of B-1 Table Section 3.4.2, it is not required for compliance with this NFPA 805 section.

The NPPD position is that the B-1 Table designation "Complies with Required Action" means actions are required to achieve compliance with the specific criteria listed in the NFPA 805 Chapter 3 Requirement. Other recently submitted NFPA 805 LARs have been reviewed, which confirm the NPPD understanding of this designation. Accordingly, it would not be appropriate to revise the Compliant Statements for B-1 Tables Section 3.3.1.2, 3.3.1.3.1, and 3.4.2 to "Complies with Required Action." Similarly, an extent of condition review does not appear to be warranted, in light of the previous discussion.

Request: - FPE RAI 13

LAR Attachment L, Approval Request 5, requests NRC approval of the bulk hydrogen storage configuration. NFPA 805, Section 3.3.7.2 applies to outdoor storage of high-pressure flammable gas containers. The licensee describes the bulk hydrogen storage as being in a separate structure. Please describe how the configuration of the bulk storage of hydrogen gas is a deviation from the requirements of NFPA 805, Section 3.3.7.2.

NPPD Response:

After further consideration, NPPD has determined that compliance with Section 3.3.7.2 is met based on the bulk hydrogen storage being located in a significant concrete structure. Accordingly, the LAR has been revised to:

- Delete Attachment L, Approval Request 5 (see Attachment 2, Change 7)
- Change the Compliance Statement and Compliance Bases in Attachment A, NFPA Element 3.3.7.2 (see Attachment 2, Change 4)
- Delete the NRC approval request for NFPA 805 Element 3.3.7.2 from LAR Section 4.1.2.3 (see Attachment 2, Change 1)

Request: FPE RAI 14

With regard to LAR Attachment L, Approval Request 6, please describe indications available to the CR operators in the event of electric fire pump failure to start while the diesel fire pump is locked out from starting. For example, please describe if there is an alarm or indication of low fire water system pressure.

NPPD Response:

Annunciator FP-4/D-4, FIRE SYSTEM LOW PRESSURE, will alarm when pressure switch FP-PS-651D senses a low pressure. Control Room Operators have pressure indicator, FP-PI-651E on VDB-FP to verify pressure. Annunciator FP-4/F-4, ELECTRIC FIRE PUMP E POWER FAILURE, will alarm when 480V AC power is not available to the E Fire Pump controller, and Annunciator FP-4/C-4, ELECTRIC FIRE PUMP E LOCKED OUT, will alarm when the control switch is not in AUTO.

Request: - FPE RAI 15

Please describe the post-transition NFPA 805 compliance basis for LAR Attachment A, Element 3.2.3, since the stated technical specification (TS) section cited in the compliance basis will be deleted during transition.

NPPD Response:

As discussed in LAR Attachment N, the deletion of TS 5.4.1 d. is acceptable because it is redundant to the requirements of 10 CFR 50.48(c)(1), which incorporates by reference the NFPA 805 requirements for Fire Protection procedures. Accordingly, 10 CFR 50.48(c)(1) provides the post-transition compliance basis for LAR Attachment A, NFPA 805 Element 3.2.3. The B-1 Table has been revised (see Attachment 2, Change 4).

Request: - FPE RAI 16

Attachment L, Request 3 states that it is similar to the request made by Arkansas Nuclear One (ANO), Unit 2. However, that request contains an error, as stated below:

> *Power and control cables at ANO are IEEE-383-1974 or equivalent. FAQ 06-0022 identified acceptable electrical cable construction tests. Plenum rated cable is tested to NFPA 262, "Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces," and the FAQ concluded that the NFPA 262 test is equivalent to the IEEE-383-1974 test. Therefore, IEEE cable is inherently equivalent to plenum rated cable and acceptable to be routed above suspended ceilings. [emphasis added]*

While FAQ 06-0022, "Electrical Cable Flame Propagation Tests" (ADAMS Accession No. ML091240278), documented the fact that NFPA 262 is a more stringent fire test than IEEE-383, *the reverse is not true. Just because a cable passes the IEEE-383 flame test does not mean that it can pass NFPA 262.*

Please describe whether the assumption of equivalence between the IEEE-383-1974 and NFPA 262 tests is relied upon. If the assumption is relied upon, please revise the request as needed (i.e., clarify that this is no longer the case).

NPPD Response:

Attachment L, Approval Request 3 does not rely on the assumption of equivalence between IEEE-383-1974 and NFPA 262. The basis for the request is the limited cabling and wiring above the ceiling and the lack of ignition sources in the plenum areas. The statement in Approval Request citing ANO Unit 2 was a general statement of precedent, and not intended to convey that the justifications provided by ANO were applicable to CNS. However, since the ANO Unit 2 application was rejected for docketing by the NRC, NPPD has revised Approval Requests 2, 3, and 4 to delete the ANO Unit 2 precedent statements (see Attachment 2, Change 7).

Request: - FPE RAI 17

Please provide the NRC citations that establish the previous approval for LAR Attachment A, Elements 3.4.1(a) and 3.6.4.

NPPD Response:

LAR Attachment A, Section 3.4.1(a) provided a summary of the NRC citation establishing previous approval. The full citation is the Safety Evaluation Report to License Amendment 59, dated November 29, 1977, which amended Technical Specification 6.1.3(g) to state the following:

> Fire Brigade composition may be less than the minimum requirements for a period of time not to exceed 2 hours in order to accommodate unexpected absence of Fire Brigade members provided immediate action is taken to restore the Fire Brigade to within the minimum requirements.

LAR Attachment A, Section 3.6.4 also provided a summary of the NRC citation establishing previous approval. The licensing of CNS preceded the issuance of NUREG-75/087, Section 9.5-1, Rev. 1, which required the fire suppression system to be capable of delivering water to manual hose stations located within hose reach of areas containing equipment required for safe plant shutdown following the safe shutdown earthquake. However, in response to Final Safety Analysis Report (FSAR) Question and Answer 10.15, NPPD committed in FSAR Amendment 15 that whenever fire protection piping passes over or near the Class IS piping or equipment in the Reactor Building, Control Building, or Intake Structure (the building containing Essential Class IS equipment necessary for safe shutdown serviced by the Fire Water System), it will be supported and restrained to withstand a Class IS seismic occurrence and maintain structural and pressure integrity.

In Section 9.3.4 (Service Water and RHR Service Water Booster System) of the Safety Evaluation of the Cooper Nuclear Station, dated February 14, 1973, the Atomic Energy Commission (AEC) provides the full citation:

> The staff also required the applicant to analyze the effect on plant safety of failure of the Class II (seismic) Fire Protection System. The intake structure area was of particular concern where Fire Protection System piping and equipment, including a diesel-driven fire pump is in close proximity to service water pump and Piping. The applicant agreed to modify Fire Protection System piping to Class I (seismic) standards in all areas where it passed over or near the Class I (seismic) systems.
>
> We conclude, subject to the modifications proposed by the applicant, that the Service Water and RHR Service Water Rooster System is acceptable.

In Section 10.5 (Circulating Water System) of this Safety Evaluation, the AEC provided this additional cross-reference to the preceding citation:

> As a result of failures of the circulating water system line of Quad Cities Unit No. 1 which caused flooding of some engineered safety system, the applicant analyzed the potential for failure of Class I equipment in the event of a circulating water system failure. It was determined that no safety related equipment could be damaged by circulating water system failure. (The effect of failure of the fire protection system is discussed in Section 9.3.4.)

Request: - FPE RAI 18

Please describe and justify why the dry well is not included in LAR Attachment C (B-3 Table) and Table 4-3. Alternatively, revise the tables to include this fire area.

NPPD Response:

LAR Attachment C and Table 4-3 have been revised to include Fire Area DW to document assessment of the drywell (see Attachment 2, Changes 5 and 3).

Probabilistic Risk Assessment (PRA)

Request: - RAI-01 Internal Events PRA F&Os

Please clarify the following dispositions to Internal Events (IE) PRA Facts and Observations (F&Os) identified in Attachment U of the LAR that appear to have the potential to noticeably impact the FPRA results and do not seem fully resolved:

a. F&O against HR-G7: Dependencies between multiple human actions in the same cutset appear not to be evaluated in all cases. Please discuss in more detail the F&O examples. Include a discussion of the use of Human Error Probability (HEP) "floors" in the Human Reliability Analysis (HRA) dependency analysis.

NPPD Response:

Each of the HEP combinations identified in the subject F&O was reexamined following the Peer Certification of the CNS Internal Events PRA and prior to use of this modeling for the NFPA 805 application. This reexamination found that each example identified was composed of independent HEPs that led to combined probabilities above the applicable floor. As a result dependency modeling for these HEPs was not required, and the PRA modeling was acceptable for use in PRA applications.

The CNS PRA includes use of HEP "floors" in the HRA analysis. Aside from evaluation and modeling of HRA dependency, the CNS Internal Events PRA model placed an artificial floor on the combination of human errors that are explicitly quantified. It is judged based on past PRA experience that combination of operator actions which lead to HEPs below 1E-7 are extremely difficult to justify. Therefore, an artificial minimum of 1E-6 is used for actions which must be complete before 24 hours even if the actions are judged "independent". If the action time for one of the actions is greater than 24 hours, a floor of 5E-7 is used.

Dependency analysis done for the examples of multiple human actions included in this RAI's subject F&O are discussed in more detail below.

F&O Example 1

Basic Event	Description	HEP
%FLSWRBM	Moderate SW Rupture (RB-859' or above)	1.43E-04
FLD-XHE-FO-MSWRB	Operator Fails to Isolate Moderate SW Rupture (RB859' or above)	1.40E-03
FLD-XHE-FO-SWRS1	Operator Fails to Realign SW for Support After Flood	5.30E-02
SWS-XHE-FO-SWNHP	SW Xtie Alignment Fails in Time Allowed	1.00E+00

The two operator actions, FLD-XHE-FO-MSWRB and FLD-XHE-FO-SWRS1, are judged to occur within the same time frame. The probability assigned to the FLD-XHE-FO-SWRS1 (5.3E-2) is representative of the recognition that this action would be taken in a flood sequence and therefore it already incorporates the assessment of dependence (i.e., it is a conditional probability).

F&O Example 2

Basic Event	Description
FPS-XHE-FO-RPVIN	Operator Fails to Align FPS for RPV Injection
HVC-XHE-FO-ALTQC	Operator Fails to Initiate Alternate Room Cooling

This combination of HEPs was assessed as independent because of the following:

- The time for both actions was in the 2 to 10 hour time frame
- The symptoms for actions were completely different
- The crews responsible for the actions were likely different
- The Technical Support Center Emergency Response Facility would be operational

Therefore, these two actions were found to be independent. Note that application of the HEP floor limit is not required as this HEP combination is greater than the applicable HEP floor used in the HRA dependency analysis.

F&O Example 3

Basic Event	Description
ADS-XHE-FO-TRANS	Operator Fails to Initiate Emergency Depressurization
HVC-XHE-FO-CB7A	Operator Fails to Initiate Room Cooling

This combination of HEPs was assessed as independent because of the following:

- The time for these actions span the 0 to 10 hour time frame
- The symptoms for actions were completely different
- The crews responsible for the actions were likely different
- The Technical Support Center Emergency Response Facility would be operational

Therefore, these two actions were found to be independent. Note that application of the HEP floor limit is not required as this HEP combination is greater than the applicable HEP floor used in the HRA dependency analysis.

F&O Example 4

Basic Event	Description
ECS-XHE-FO-TRANS	Operator Fails to Initiate ECCS
SWS-XHE-FO-SWBPS	Operator Fails to Initiate SW Booster Pumps

This combination of HEPs was assessed as independent because of the following:

- The time for both actions spanned the 0 to 10 hour time frame
- The symptoms for action were completely different
- The crews responsible for the actions were likely different
- The Technical Support Center Emergency Response Facility would be operational for the 2nd action

Therefore, these two actions were found to be independent. Note that application of the HEP floor limit is not required as this HEP combination is greater than the applicable HEP floor used in the HRA dependency analysis.

F&O Example 5

Basic Event	Description
ADS-XHE-FO-3ALEG	Failure of Cognitive Recognition of Leakdown
ADS-XHE-FO-COND	Cond Prob of Moderate Depend Between Injection Initiation & Depress
SWS-XHE-FO-SWBPS	Human Error Fail to Manually Initiate Service Water Booster Pump System

The combination of the first two events (ADS-XHE-FO-COND/ADS-XHE-FO-3ALEG) were assessed and modeled for their dependency; hence the conditional probability of the ADS-XHE-FO-COND HEP.

The combination of the three HEPs was assessed as independent because of the following:

- The time for the last action was in the 2 to 10 hour time frame
- The symptoms for actions were completely different
- The crews responsible for the actions were likely different
- The Technical Support Center Emergency Response Facility would be operational

Therefore, these three actions were found to be independent except for the explicitly modeled conditional probability of ADS-XHE-FO-COND. Note that application of the HEP floor limit is not required as this HEP combination is greater than the applicable HEP floor used in the HRA dependency analysis.

Request: - RAI-01 Internal Events PRA F&Os (continued)

b. *F&O against HR-13. DA-E3. IE-D3. IF-F3. and SC-C3: The requirement to document key assumptions and sources of uncertainty appears not to have been met for a number of PRA elements. Please describe how key assumptions and sources of uncertainty were identified and documented for the PRA elements cited in these F&Os. Include in this description, identification of criteria used to judge the importance of assumptions and whether any sensitivity studies were performed as a result.*

NPPD Response:

Documentation of key assumptions and sources of uncertainty has been provided for the CNS Internal Events PRA. NUREG-1855 was issued after the CNS internal events peer certification to better define approaches in this area. Insights from this NUREG guidance were used to verify that the CNS approach and documentation provided the uncertainty insights and conclusions required by the applicable American Society of Mechanical Engineers (ASME) Supporting Requirement (SR) areas including SR HR-13, DA-E3, IE-D3, IF-F3, and SC-C3.

A description of how key assumptions and sources of uncertainty were identified and documented for the PRA elements cited in these F&Os is summarized as follows. The ASME PRA Standard and EPRI TR-1016737 were followed to evaluate PRA uncertainty. Upon its issuance, NUREG-1855 was also reviewed for guidance in this area. Application of these documents resulted in addressing uncertainty for the CNS Internal Events PRA in the areas of data (parametric), modeling, and completeness. Conclusions from the uncertainty evaluations were documented as part of the "Cooper PRA Notebooks." Specifically, key assumptions and uncertainty is discussed in detail in the PRA Summary Notebook (CNS-PSA-013 Revision 0 Appendices A, B, and E).

Additionally, criteria were established to judge the importance of modeling uncertainties. Candidate modeling uncertainties were identified using various inputs that included NUREG 1150, Plant Specific PRAs, NUREG/CR-4550, LERs, NRC Accident Sequence Precursors (ASP), Westinghouse Owners Group Uncertainty Evaluation, 5 Regulatory Guide 1.200 Pilot Plant Uncertainty Evaluations, NUREG 1560, and SPAR model Comparisons. Criteria, detailed in the table below, were then used to screen candidate uncertainties to identify sources of uncertainty for the CNS PRA. Sensitivity analyses were then performed on the applicable model uncertainties to inform users of significance.

Consensus Model or Approach	Impact on Application of a Reasonable Alternate Hypothesis is Negligible	Source of Uncertainty
Yes	Yes	No
Yes	No[1 2]	Yes[1 2]
No	Yes	No
No	No	Yes

Parametric uncertainty of PRA results was also reviewed and found to be acceptable. Range, mean value and 95% bounds were identified, evaluated and found to be within industry accepted criteria.

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[1] The candidate sources of uncertainty are only those that could increase risk.
[2] This case is not considered generally applicable. There may be specific instances where there is an exception to this rule.

Request: - RAI-01 Internal Events PRA F&Os (continued)

c. *F&O against QU-E3: Please discuss the F&O disposition and why the finding has no impact. Specifically, please clarify if a state-of-knowledge correlations (SOKC) of failure rates using plant specific data was performed. Please clarify that for component failures based on the same plant-specific data, SOKC was taken into account.*

NPPD Response:

The CNS disposition of this F&O concludes that the state of knowledge correlations appropriately considered plant specific data, and therefore parametric uncertainty analysis and its conclusions for the internal event PRA are valid. Because plant specific data was considered and addressed there was no impact to PRA model uncertainty analysis. This F&O was dispositioned during review of the draft peer certification report. This disposition verified that plant specific failure data was included in the parametric uncertainty analysis and that state of knowledge correlations were performed correctly. This was done through use of a separate CAFTA database that ensured that the state-of-knowledge groupings were formulated and distributions and error factors were properly applied.

In conclusion, component failures based on the same plant specific data were taken into account for SOKC. This was done prior to any parametric uncertainty analysis, and therefore reflected in the PRA uncertainty evaluation results and conclusions.

Request: - RAI-01 Internal Events PRA F&Os (continued)

d. *F&O against AS-A2: Please confirm that examination of thermo-hydraulic analysis demonstrates that event sequences modeled in the PRA reach a stable state.*

NPPD Response:

CNS thermal-hydraulic analysis includes several different scenario evaluations, which collectively are utilized to define success criteria for ensuring event sequences reach a stable state. The specific event sequence referred to in the subject F&O is associated with HPCI and SPC success criteria. NPPD review of the results of the referenced thermal-hydraulic calculation (1A-L1-HPCI) indicate that wet-well temperature is trending downward starting at the 10^{th} hour from the start of the postulated accident scenario, and drywell temperature peaks at the 22nd hour. The drywell temperature graph has flattened out at the 24 hour point and is more than 25 °F below the high drywell temperature Emergency Depressurization EOP requirement. This confirms a stable state is reached for containment heat removal and pressure control function.

Impacts associated with high drywell temperature and other EOP related actions for Reactor Pressure Vessel (RPV) depressurization, as discussed in this F&O, have been analyzed for impacts on mitigation equipment and the corresponding results applied utilizing time phased approaches to event sequence modeling. For example, detailed thermal-hydraulic calculations were performed for sequences relying on HPCI or RCIC without SPC available to determine when containment parameters may limit the ability of these systems and the event trees require other systems to prevent core damage and attain a stable state.

Therefore, examination of the detailed thermal-hydraulic analysis associated with functional level success criteria and application of the results to event tree sequences confirms that event sequences modeled in the PRA reach a stable state.

Request: - RAI-01 Internal Events PRA F&Os (continued)

e. *F&O against SY-A4: It is not clear that since the individual plant evaluations (IPEs) if walkdowns and interviews with plant engineers and operators have been specifically performed to support the PRA. Please describe the system walkdowns and interviews that have been performed to confirm that the PRA system analysis reflects the as-built, as-operated plant.*

NPPD Response:

As part of the CNS 2007 PRA update for internal events, several actions were completed to ensure the system analysis reflects the as-built, as-operated plant. These include;

- Interviews were conducted with System Engineers and documented as part of each system analysis notebook. System Engineer walk-down their assigned systems on a regular basis and candidates for additional required walk downs to support the PRA were identified via these interviews.
- System operating experience was reviewed and System Engineer operating experience interviews were conducted and documented as part of each system analysis notebook.
- An engineering study (PRA–ES081) has been conducted documenting the review of station modifications from 1998 to May 2008 for possible PRA impact. The PRA configuration control process was updated in 2008 to require review of modifications for potential impact to the PRA.
- Operator interviews were conducted and documented as part of the Human Reliability Analysis. These interviews included system operating/response characteristics, methods of control, indications available, and potential accident sequence limitations of systems.
- Operator response and control of systems were observed in the simulator for selected accident sequences and the results documented.
- Walk downs utilizing both PRA and plant operator resources were conducted and documented for evaluation of internal flooding and system vulnerabilities to flooding.

Request: - RAI-01 Internal Events PRA F&Os (continued)

f. *F&O against QU-D4. Please describe the reasonableness review performed on the non-significant cutsets for the PRA results supporting the LAR.*

NPPD Response:

Reasonableness reviews and assessment of contributors to risk were performed by examining the cutsets of those scenarios that contributed greater than 1 percent to core damage and large early release. This low threshold, set at 1%, allowed review of non-significant cutsets.

In addition, cutsets of those scenarios with high conditional core damage probabilities and conditional large early release probabilities were reviewed. The scenarios were discussed as a team that included PRA experts, safe shutdown experts, and fire modeling experts so that all aspects of the scenario could be evaluated including component failures, spurious operations, and human actions. Numerous low contributors to risk were evaluated to ensure that they correctly represented the risk contribution. Sensitivity studies of human actions were also performed as part of the fire risk evaluation process. The evaluations and sensitivity studies mentioned above were used to determine what component, human action, and spurious actuation were dominant contributors to risk and the sensitivity for these items to the results.

Request: - RAI-01 Internal Events PRA F&Os (continued)

g. *F&O against QU-S5[3]: Please describe the limitations that were identified for the quantification process and how they are addressed in the PRA.*

NPPD Response:

No other limitations were identified, as the peer certification final conclusions included no other exceptions to meeting SR QU-F5. The limitation identified by the peer certification has been dispositioned appropriately.

Note that it is the nature of PRA to have inherent limitations. However, limitations have been minimized for the CNS PRA because it has been performed with the latest state-of-the-technology approaches. These techniques include:

- A comprehensive list of initiating events and a Bayesian update of the plant specific initiating event frequencies using applicable priors from NUREG/CR-5750
- Event trees that realistically reflect the sequence of events
- A plant specific thermal hydraulic analytic basis for success criteria
- Plant-specific component data
- HRA techniques using the EPRI HRA Calculator
- Dependent failure analysis using the latest common cause data and approaches
- The latest CAFTA quantification approaches

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[3] The actual SR listed in the peer certification report and LAR is QU-F5. QU-S5 is listed here to reflect wording from the RAI being addressed.

Other limitations for quantification are dispositioned as part of the modeling uncertainty evaluation completed and documented in PRA Manual CNS PSA-013. Truncation is also addressed as a limitation that is dispositioned through:

- Verification that truncation is low enough to demonstrate convergence,
- Ensuring truncation is 4 orders of magnitude below the Core Damage Frequency (CDF)/Large Early Release Frequency (LERF) values.

Request: - PRA RAI-02 Fire PRA F&Os

Please clarify the following dispositions to FPRA F&Os and supporting requirement (SR) assessment identified in Attachment V of the LAR that appear to have the potential to noticeably impact the FPRA results and do not seem fully resolved:

a. F&O 4-1 against PP-B2: In response to this F&O, a review of the justification of partitioning between fire zones was performed for screened fire zones. Please describe the criteria used to determine whether a barrier is "substantial enough to preclude fire spread to adjacent fire zones within the fire compartment." Please clarify the difference, if any, between barriers defined for zones and those defined for fire compartments (i.e., the physical analysis units). Include in this clarification a discussion of how elements of partitioning were considered for fire zones. In particular, please discuss how ducting, spatial separation, and localized protection features were considered.

NPPD Response:

The Fire Compartment definitions were based on the previous Safe Shutdown Analysis Areas, with certain exceptions such as the boundaries between Analysis Areas of the Reactor Building which were identified as not meeting the criteria of fire compartment boundaries without further detailed justification.

Fire zone boundaries are utilized for documentation purposes since ignition sources, Fire PRA targets, equipment, and fire protection systems are maintained at the fire zone level. Initial "full zone" failure scenarios were developed as part of the initial quantification to identify the risk significant fire zones. Based on the results of these full zone failures, detailed fire modeling was performed and documented at the fire zone level. The detailed fire modeling assessed the potential for Fire PRA target failures in the adjacent fire zones. For fire zones that did not require detailed fire modeling, the fire zone boundaries were assessed to determine if the barrier was substantial to contain the fire to the "full zone" failure scenario.

The boundaries between fire zones of the same fire compartment were assessed, during plant partitioning and detailed fire modeling walkdowns, to confirm that the barriers are substantial enough to preclude fire spread to adjacent fire zones within the fire compartment. These plant walkdowns considered the construction of the barrier (i.e., concrete, steel, etc.), any potential openings or unrated/unprotected features with respect to the fire hazards and combustibles in the fire zone. Based on the nature and configuration of the fire hazards and combustibles in the fire zone, the barriers were assessed qualitatively to determine if they were robust enough to prevent target damage on the other side of the barrier. The Multi-Compartment Analysis was performed at the Fire Zone level to assess the potential failure of these fire zone barrier features.

Plant Partitioning did not credit spatial separation or localized protection features as Fire Compartment boundaries. Rated active fire barrier elements were credited as Fire Compartment boundaries. Non-rated elements were only credited as compartment boundaries provided that they have been included in the fire protection program and justified as acceptable in engineering equivalency evaluations. The Multi-Compartment Analysis assessed the potential failure of fire dampers and also the spread of fire/smoke between fire zones via interconnected ductwork.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

b. *F&O 5-2 against CS-A7: The disposition to this F&O states that Kerite was treated as thermoset material with respect to flame spread and heat release rate (HRR) but treated as thermosplastic with respect to damaging heat flux. The FPRA peer review report provides the following reviewer's elaboration on this F&O:*

> *FAQ 08-0053 was generated by CNS to justify consideration of Kerite cable as thermoset. Recent testing conducted by NRC tends to indicate that Kerite cable should be treated as thermosplastic. However, a final determination has not been made as FAQ 08-0053 is still open.*

FAQ 08-0053, "Kerite-FR Cable Failure Thresholds," has now been finalized and a closure memo dated June 6, 2012, issued by the NRC (ADAMS Accession No. ML121440155). The closure memo recommends, based on experimental evidence from NUREG/CR-7102, "Kerite Analysis in Thermal Environment of Fire (KATE-Fire); Test Results-Final Report," December 2012 (ADAMS Accession No. ML11333A033), "that a temperature of 477 °F (247°C [degrees Celsius]) be assumed as the minimum threshold of electrical failure for Kerite-FR cables. Please discuss the following:

i. *Please describe the use of Kerite, identify locations it is credited in the PRA, and explain how Kerite cables are treated in the FPRA. Specifically, please clarify what damaging heat flux values (e.g., 205 °C or 372 °C) and what HRR values (see Section 7.4 of NUREG/CR-7102) were used (e.g., 150 or 250 kiloWatt (kW) per square meter (m^2)) for the justification for these values.*

ii. *Please provide the results of a sensitivity analysis showing the impact on the PRA results (total and delta core damage frequency (CDF) / large early release frequency (LERF)) from evaluating Kerite-FR as thermoplastic material using the recommended temperature from the FAQ 08-0053 closure memo.*

NPPD Response:

CNS contains cables with Kerite FR jacketing which are primarily associated with power cables for low voltage electrical distribution and 5 kV electrical distribution, control cables, and instrumentation cables. A sensitivity study was performed to calculate the fire scenario/fire damage state frequencies and target impacts based on the reduced failure criteria of Kerite FR cables. The sensitivity study utilized the Sandia National Laboratories report "A Preliminary Look at the Fire-Induced Electrical Failure Behavior of Kerite FR Insulated Electrical Cables" released July 2010, which documented recent small-scale testing of various Kerite cables. The report recommends 250°C as a lower-bound estimate of the cable's failure threshold, in lieu of the 205°C value for thermoplastic materials or 330°C for thermosetting materials.

The sensitivity study was conducted to determine impact of modeling fire scenarios with a Kerite cable failure temperature of 250°C. This value has been utilized for determining the damaging heat release rate in the sensitivity study in the Task 14 Final Quantification for fire modeling applications at CNS. Because this preliminary report does not contain information on a damaging heat flux value, the thermoplastic damaging heat flux threshold has conservatively been used in the sensitivity study.

First, the locations of Kerite FR cables required for Fire PRA and NSCA were determined through searches conducted in EDISON, using "bill of material" information. Fire modeling calculations for the fire zones containing Kerite FR cables were then reviewed using a failure temperature of 250°C.

The following fire zones contained Kerite-FR credited cables:

Fire Zone	Description
1A	RCIC and Core Spray B Pump Room
2A-2	CRD Units – North
2A-3	903'-6" South Corridor
3A	Critical Switchgear Room 1F
3B	Critical Switchgear Room 1G
3E-2	RWCU Recirc Pumps and Corridor
4C	Fuel Pool HX, CRD Repair Room and Raw Water Cleanup Areas
4D	Reactor MG Set Oil Pump Area
8A	Auxiliary Relay Room
9A	Cable Spreading Room
9B	Cable Expansion Room
13B	Non-Critical Switchgear Room
13C	Electrical Shop

The final test results of the Kerite cable testing were issued in NUREG/CR-7102, "Kerite Analysis in Thermal Environment of FIRE (KATE-Fire)." This final report recommends that Fire PRA applications assume a nominal fire-induced failure threshold of Kerite FR cables of 247°C. Although this new recommended failure temperature is less than that utilized in the Task

14 Quantification sensitivity assessment of 250°C, this difference is minor. The difference of the 3°C in plume failure temperature of the cabling will have minimal effects on the impacts to the detailed fire modeling calculations as reported in the sensitivity study.

Kerite FR cables that are routed in cable trays are located outside of the zone of influence of the fire sources utilizing the reduced failure temperature and reduced heat flux. Therefore, there is no ignition of cable trays containing Kerite FR cables involved in this sensitivity study, thus a heat release rate (kW/m^2) for cable trays was not necessary.

Kerite FR sensitivity results are provided in Attachment D table D-9 of NEDC 09-085, "Fire Risk Quantification", Revision 1. Kerite affected approximately 10% of all fire scenarios by either the fire scenario's frequency or the scenario's targets. Kerite specific failure reports with revised Kerite impacts were used in the sensitivity study. The fire risk quantification for Kerite for the Pre-NFPA 805 plant resulted in calculated CDF of 8.25E-05/yr and calculated LERF of 3.80E-05/yr, which is an increase of approximately 4% for CDF and 7% for LERF and thus not significant.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

c. *F&O 4-10 against PRM-B11: The FPRA peer review report presents the reviewers' recommended resolution to this F&O: that instrument indication requirements be added directly the fault tree logic in an AND-gate with the corresponding operator actions. The disposition to this F&O explains that instruments (i.e., indication) required for diagnosis are addressed in the HRA, and if the cables for those indications have not been traced the failure of the corresponding HEP is set to 1.0. Please clarify how indications needed for diagnosis, and associated instrumentation, are identified and documented in the fire PRA, and explain how random failures of those instruments are addressed.*

NPPD Response:

For each of the existing EOP actions in the Internal Events PRA and retained in the Fire PRA, the instrumentation required for cognition was identified in the Internal Events PRA human reliability analysis. Instrumentation needed for those fire response actions included in the Fire PRA are provided by the Emergency Procedure 5.4POST-FIRE for each fire analysis area. Instrumentation needed by the operators was documented in NEDC 09-078, "Task 7.2 Cable Selection." Instrumentation was cable traced and the failed instrumentation for each fire scenario was listed in the Level 1 Failure Reports in the same manner as other fire-impacted equipment.

If all instrumentation used for a particular action was available a HEP was determined based on this assumption and tagged as "ALL – All Instrumentation Available." If any of the instrumentation used for a particular action was impacted by the fire and assumed lost, an HEP was determined based on only the minimum set needed being available and tagged as "MIN – Minimum Instrumentation Available." If the instrumentation cable routings were not known or less than the minimum instrumentation was available, the HEP was set to 1.0. It was conservatively assumed that instruments with unknown cable routing would be unavailable for every fire, and with no instrumentation available for diagnosis the HEP is 1.0.

The exceptions to setting HEP to 1.0 when all instrumentation is impacted by a fire are the EOP actions to depressurize the RPV and initiate low pressure injection. If the RPV level is unknown, which could be the case for fire impacted RPV level instruments, the operators are instructed to depressurize and flood the core using any low pressure Emergency Core Cooling System (ECCS) and alternate injection alignments. For those fire zones where all RPV level instrumentation was failed, the human error probability associated with "Minimum Instrumentation Available" was used for the actions to depressurize the RPV and use low pressure systems to flood the core. In this case, the minimum instrumentation needed is actually none.

NEDC 09-083, "Task 7.12 Fire Human Reliability Analysis," Table 12, "Existing EOP HFEs and Instrumentation Required For Diagnosis," shows the Human Factors Evaluations (HFE) retained in the Fire PRA and the instrumentation required for diagnosis for each HFE. HFEs that are fire damage state or fire area dependent are identified, with their respective value for each affected area listed in Table 3 of NEDC 09-083.

A special case for instrumentation occurs in safe shutdown analysis areas CB-D and RB-FN. For fires in CB-D and RB-FN, procedure 5.4POST-FIRE can direct the operators to 5.4FIRE-S/D, which entails control room abandonment. In the Fire PRA, abandonment is only required when the habitability criteria listed in NUREG/CR-6850 are met or it was determined that the fire caused a loss of command and control when shutting down from the control room. There are some Fire PRA scenarios where the fire procedures direct the operators to abandon although the control room remains habitable and operators retain sufficient command and control. For these cases, some control room instrumentation will be impacted by the fire but the fire procedures do not provide a listing of available instruments because Appendix R assumes that the operators will abandon. Based on operator interviews, the operators stated that if the control room remains habitable, they will not abandon but instead send an operator to locally read RPV level if they cannot determine this from the control room. A detailed analysis was performed to model sending an operator to locally determine the RPV level using the ASD Panel.

Random failures of instruments are not addressed since HEPs dominate random failures, typically by two or more levels of magnitude as indicated by comparison of the HEP values with failure values for sensor/transmitter components (see tables in A.2.43 of NUREG/CR-6928, "Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants").

In summary, loss of instrumentation is accounted for in determining the HEPs and different HEPs are used for the same operator action in different fire scenarios based on fire impacts. This meets PRA Standard requirements and prevailing good practices.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

d. *F&O 5-12 against FSS-F1: In response to this F&O an update to Calculation NEDC 09-090 (Exposed Structural Steel) was performed that addresses fire impact on the steel columns caused by oil cascading to a lower elevation. Please describe the update to the calculation, assumptions made about the size of the oil spill, and the basis for those assumptions.*

NPPD Response:

Calculation NEDC 09-090 was revised to include lumped capacitance calculations on the unprotected trusses and columns located on the Turbine Generator Operating Floor (Fire Zone 13A) supporting the turbine building roof. Section 3.4.4 and Attachment A of the calculation provide the detailed analysis for the exposed steel columns. The evaluation concluded that when the entire length of the unprotected column and steel beams are exposed to direct flame impingement for the calculated fire duration, the final temperature of the unprotected steel is well below the failure threshold of 1100°F. The size of the oil spill was based on an unconfined 100% oil spill (no curbing considered).

There are no unprotected steel columns in the Turbine Building fire zones located below the operating floor. The only unprotected steel is located at Fire Zone 13A, therefore, lumped capacitance calculations were only performed for this zone. The fire impacts due to a cascading oil spill to lower elevations are bound by the analyses performed for Fire Zone 13A.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

e. *F&O 6-2 against FSS-E4: This F&O indicates that the uncertainty and sensitivity report (Task 7.15 Uncertainty and Sensitivity Analysis) makes no mention of assumed cable routes, even though it states that cable routing could be the source of uncertainty. Please discuss the extent to which assumed cable routes are factors in the FPRA and, if the cable routes are assumed, describe the impact of these assumptions on risk estimates.*

NPPD Response:

Fire zone locations were identified for all required NSCA and Fire PRA cables via plant tray and conduit layout drawing reviews. Occasionally there were small gaps that were resolved using engineering judgment based on to/from endpoints. These assumptions were only used for minor inconsistencies (e.g. within a single fire zone) with confirmation provided by locating additional cables that listed the same endpoint.

Where cable routes were not detailed on plant raceway or conduit layout drawings, the associated Fire PRA components were conservatively treated as failed or other methods were used to definitively determine cable routes. The assumptions associated with cable routes result in uncertainty biased toward over predicting CDF and LERF. The following examples provide the extent of cable routing assumptions utilized in the Fire PRA detailed fire modeling and their associated impact on estimating the risk:

In a very few cases, the Detailed Fire Modeling Calculations identified where Fire PRA target cable (and equipment) failures are due to assumed target routing locations and assumed failures. Several Fire PRA credited components utilize unscheduled cables which are not provided with detailed routing locations (i.e., conduit or cable tray) within a fire zone. For these cases, previous plant walkdowns and modification reviews were utilized to identify the fire zones which contain the cables supporting the Fire PRA components. The following sections document the assumed failures of Fire PRA equipment (REC-FIS-24-ASD, REC-TIC-451A, REC-TIC-451B, and RPS-ELECT) in the Detailed Fire Modeling Calculations based on lack of specific location information for the unscheduled cables. Since these are assumed cable failures, there is uncertainty related to these additional equipment failures in several fire scenarios. If the specific cable location within the fire zone was known, these cables may not be within the zone of influence of these fire scenarios and therefore, the Fire PRA credited components would not be considered failed resulting in a lower CDF and LERF.

Fire PRA component REC-FIS-24-ASD was failed in all fire scenarios in Fire Zone 2C. The power cable from panel EE-PNL-LPR1G to the panel EE-LTG-R84 outlet is unscheduled. Plant walkdowns determined the cable routing to be located in Fire Zones 1E, 1D, and 2C. The indicating switch is physically located in Fire Zone 1E, however, REC-FIS-24-ASD was considered a PRA target in these fire zones to account for the unscheduled cable and the component was assumed failed in all fire scenarios in Fire Zone 2C.

REC-TIC-451A was failed in each transient scenario in Fire Zone 2A-1 due to a lack of cable routing information. Cables from the temperature element to the controller and from the controller to the valve are unscheduled. Plant walkdowns determined the cable routing to be (from the temperature element (TE) to the temperature indicating controller (TIC) and from the TIC to the valve) in Fire Zones 3C, 2A-1, 1A, and 1F. The controller is physically located in Fire Zone 3C, however, REC-TIC-451A was considered a PRA target in these fire zones to account for the unscheduled cables and the component was assumed failed in all transient fire scenarios in Fire Zone 2A-1.

REC-TIC-451B was failed in each transient scenario in Fire Zone 2A-1 due to a lack of cable routing information. Cables from the temperature element to the controller and from the controller to the valve are unscheduled. Plant walkdowns determined the cable routing to be (from the TE to the TIC and from the TIC to the valve) in Fire Zones 3D, 3C, 2A-1, 1A, and 1F. The controller is physically located in Fire Zone 3D, however, REC-TIC-451B was considered a PRA target in these fire zones to account for the unscheduled cables and the component was assumed failed in all transient fire scenarios in Fire Zone 2A-1.

Detailed cable routing information was not available for cable RC29X in Fire Zone 2A-1 which was installed via Modification DC 94-267. The modification identified the fire zone only and the routing of the cable between the RCIC 125VDC Starter Rack to MCC K which are both located in Fire Zone 2A-1. Since the detailed location of the cable within Fire Zone 2A-1 could not be identified, the cable was failed in all transient fire scenarios (there are no fixed propagating fire scenarios in Fire Zone 2A-1) in the fire zone. Based on the assumed cable failure, there is uncertainty related to additional equipment failures supported by this cable in the transient fire scenarios in Fire Zone 2A-1. If the specific cable location within the fire zone was known, this cable may not be within the zone of influence of the transient fire scenarios and therefore, the Fire PRA credited components supported by cable RC29X would not be considered failed resulting in a lower CDF and LERF.

The detailed fire modeling in the ASD Room in Fire Zone 2C created a scenario for the full room failure of the ASD Room due to the electrical panels in the zone and a transient scenario for the floor area within the room. The cable targets damaged for this ASD Room scenario was developed based on the termination points of the cables. The scenario failed all cables within Fire Zone 2C that have equipment termination points located in the ASD Room. Since the location of each of these cables within the ASD Room was not visually verified during plant walkdowns, there is uncertainty with respect to potential errors in the termination point information. However, the termination point of each cable located within Fire Zone 2C was reviewed to determine the location of the endpoint equipment. Cable and conduit drawings were utilized to validate that the cables identified as terminating in the ASD Room were routed in such a manner that the termination point was logical.

Fire PRA credited component RPS-ELECT is a dummy SCRAM component created to address IN 2007-07 concerns. This equipment failure was included in all fire scenarios in Fire Zones 8A, 9A, and 9B, as required to address initiation of SCRAM by isolating power from affected SCRAM circuitry locally at the RPS MG Sets.

For fire zones in which fire modeling consisted of assessment of a refined set of targets, the remaining Fire PRA targets (i.e., non-refined targets) were assumed failed in each scenario. This refined fire modeling was performed to assess the impact on risk significant targets and to reduce the time required to perform detailed modeling, including detailed routing, of all Fire PRA credited cables in these fire zones. Based on the assumed cable failures of these "less significant" Fire PRA credited cables, there is uncertainty related to the equipment failures supported by these cable in the fire scenarios in these refined fire modeling zones. If the specific cable location within the fire zone was fully assessed, these cables may not be within the zone of influence of the fire scenarios in the zone and therefore, the Fire PRA credited components supported by these cables would not be considered failed resulting in a lower CDF and LERF.

The lack of routing information for these cables and components and these other assumed cable failures is a source of uncertainty as these assumed failures added to multiple scenarios results in minor over-conservatism. This minor over-conservatism is considered acceptable for this Fire PRA and the assumed cable routes are not a factor in the Fire PRA.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

f. *F&O 6-15 against FSS-H5: The disposition to this F&O cites NEDC 08-041 (Main Control Room Abandonment) as addressing the fire spread between Main Control Board (MCB) panels and electrical panels in the main control room (MCR). Please discuss the modeling of both MCB and electrical panels, including the following:*

   i. *Where it is assumed that fire does not propagate between open back cabinets, please confirm that there is no cable run between the exposing and exposed panels.*

   ii. *Neither NEDC 08-041 nor NEDC 10-001 discuss the treatment of sensitive electronics. Please explain the extent to which sensitive electronics are installed, both in the MCR and elsewhere in the plant, and how sensitive electronics were treated in the PRA. Please clarify if the treatment of sensitive electronics is in accordance with NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," and discuss the sensitivity of the PRA results to the NUREG/CR-6850 treatment of sensitive electronics.*

NPPD Response:

f(i) CNS NFPA 805 Project personnel walked down open back MCB and other open back MCR electrical panels to confirm that no cables run between exposing and exposed open back panels. The walkdown determined that cables run between adjacent open back panels through the base or platform of some of the open back panels. Only two adjacent MCR electrical cabinets, Panels 9-2 and 9-21, were identified as having a cable pass between them at a higher location than the panel base (approximately 5 feet above the floor).

Based on these results, the approach for the Fire PRA from Appendix S of NUREG/CR-6850 is to assume no fire spread if either:

1. Cabinets are separated by a double wall with an air gap, or
2. Either the exposed or exposing cabinet has an open top, *and* there is an internal wall, possibly with some openings, *and* there is no diagonal cable run between the exposing and exposed cabinet

For open back panels with no cables communicating between that panel and an adjacent panel or for cables that may communicate at the base of the panel, the fire is assumed not to propagate to adjacent panels because open back panels have a vented "plenum" area such that the hot gases will not collect in the cabinet.

While fire propagation between MCR electrical cabinets 9-2 and 9-21 may be possible due to a cable run at a higher elevation in the cabinet this event does not present any additional risk contribution, not already accounted for, for two reasons. First, the potential increased heat release rate (HRR) and duration resulting from inter-cabinet fire propagation has already been captured in the HRR profiles assumed in the detailed fire modeling in Calculation NEDC 08-041 when considering target damage and MCR abandonment probabilities. Second, the PRA components affected are unchanged in the event of fire propagation between cabinets 9-2 and 9-21 since none of the electrical cabinets in the row of open back electrical cabinets which include these two cabinets contain PRA components.

f(ii) The results of the sensitive equipment analyses included as Appendix C and Appendix D of Calculation NEDC 10-020, "Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and FPRA Applications" were used for all fire zones in which the Detailed Fire Modeling Workbooks were developed in order to determine the potential impact on Fire PRA credited equipment failures. Fire Zones 3A, 3B, 8A, 8B, 8C, 8D, 8G, 8H, 9A, and 13B were identified as containing sensitive equipment.

The fire zones that could contain sensitive plant equipment (i.e., solid-state control components) which could be susceptible to lower thermal damage thresholds were assessed to determine whether the equipment could be immersed within temperature exposure above the damage threshold recommended by NUREG/CR-6850. Based on a walkdown of these fire zones, it was determined that the equipment is located at the floor level and will only be exposed to the lower gas layer. Based on the geometry of these fire zones, the lower gas layer is not estimated to exceed 65 °C (150 °F).

Damage to this sensitive equipment caused by radiant heat from a fire is bounded by the approach for damage to other plant equipment (thermoset cabling termination at equipment). Sensitive plant equipment located within the radiant heat ZOI for thermoset equipment will fail similarly to that equipment. For distances outside the thermoset radiant heat ZOI, the Fire Dynamics Simulator (FDS) analysis performed in Appendix C of Calculation NEDC 10-020, "Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and Fire PRA Applications", indicates that the steel housing of sensitive equipment is effective in reducing damaging heat fluxes and the internal equipment will remain at operable temperatures.

Sensitive electronics in the MCR were not evaluated explicitly in Appendix C of Calculation NEDC 10-020. However failure of this equipment is not considered risk significant for the following reasons:

a) NUREG/CR 6850 Appendix L prescribes the accepted method for determining the propagation of fire damage to all types of components within the MCB. This is based on spatial separation within the MCB and cable type. This prescribed method for predicting the likelihood and extent of damage within the MCB has been applied at CNS.
b) Sensitive electronics are typically not capable of being damaged by the descending hot gas layer before MCR abandonment criteria is reached. As identified in the MCR Abandonment Calculation NEDC 08-041, the hot gas layer at 6 feet above the floor

does not reach 65°C, which is the damage threshold for sensitive equipment prior to abandonment conditions being reached.

c) Transient fires that could impact the MCB are unlikely as the MCB cabinet walls will protect temperature sensitive equipment within the panel for a sufficient period of time such that the likelihood of not suppressing the fire prior to damage is low. Appendix C of Calculation NEDC 10-020 has shown that a metal housing (i.e., a cabinet) protecting temperature sensitive equipment significantly reduces the damaging heat flux to internal components as well as preventing a rapid rise in the internal temperature.

d) A sensitivity study of transient fires near "pinch points" of the open backed MCB and MCR electrical cabinets was performed. This will be addressed in the response to PRA RAI-11 b, which is a 90-day response action.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

g. *F&O 1-9 against HR-G1: This F&O indicates that there was a number of significant human failure events (HFEs) for which screening values were applied. Please clarify what significant HFEs were assigned high failure probabilities and provide the bases for those values.*

NPPD Response:

As results were refined following the initial peer review, significant HFEs were refined. No significant HFEs were assigned screening values.

Existing EOP operator actions were identified from a review of the December 2007 internal events HRA notebook. Specifically, the event trees and fault trees associated with the fire-induced initiating events identified in the component selection task (NUREG/CR-6850 Task 2). HFEs in event trees that were not associated with fire-induced initiating events were excluded from the Fire PRA model, and are documented in Table 11 of NEDC 09-083. The Fire PRA assumes that HFEs related to the following list are set to fail:

- HFEs associated with ATWS
- HFEs associated with Large LOCAs (both steam and water)
- HFEs associated with Internal Flooding Scenarios
- HFEs associated with loss of the Instrument Air System
- HFEs associated with a loss of the Turbine Equipment Cooling System
- HFEs associated with the Control Rod Drive System
- HFEs associated with alternate RPV injection alignments (Fire Protection, enhanced CRD flow, Service Water, etc.)
- HFEs for restoration of feedwater
- HFEs for alignment of the swing battery charger

Additionally, if the HEP in the Internal Events PRA was set to 1.0, it was initially set to 1.0 in the Fire PRA. If during detailed quantification the HFE was considered important it was re-examined for fire.

The CNS Internal Events PRA has several actions based on empirical data, if the data was applicable to fire then the HFE was retained in the Fire PRA. Otherwise it was screened from further consideration. For example, the basic events associated with offsite power recovery are based on empirical data and these basic events were set to an HEP of 1.0 in the Fire PRA.

For each of the existing operator actions, the instrumentation required for cognition was identified. If the instrumentation cable routings were not known, the HEP was set to 1.0. See the response to PRA RAI-02 c for additional discussion of instrumentation vs. HEPs. Table 12 of NEDC 09-083 "*Task 7.12 Fire Human Reliability Analysis*" shows the HFEs retained in the Fire PRA and the instrumentation required for diagnosis for each HFE.

Table 2 of NEDC 09-083 lists the fire response HFEs that are credited in the Fire PRA. In order for an action to be credited in the Fire PRA it must be feasible in that there is enough time to diagnose and execute the action, there is enough crew to perform the action, and there must be cues and indications. Appendix M, "*Operator Manual Action Time Lines,*" from the CNS Appendix R report, shows that all actions in the fire procedures have been walked down and demonstrated to be feasible per Appendix R requirements. The times are listed in Table 12 of NEDC 09-083, which lists the fire zone where the action is credited and the location where the execution is taking place. No action was credited where the environment would be affecting operator performance. Additionally, the equipment that is credited can be restarted following a fire provided it is not an NRC Information Notice (IN) 92-18 valve affected by a fire in the zone where credited. No credit is taken for valves affected by fires that impact cables causing the IN 92-18 issues.

Screening values were initially used for the Fire PRA credited HFEs. If an action had a significant contribution to fire risk, a detailed human reliability analysis was performed. Approximately 97 HFEs were modeled in detail in the Fire PRA. Screening HEPs were retained for those HFEs that did not have a significant contribution to fire risk.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

h. *F&O 1-17 against QU-E3: The disposition for this F&O provides a detailed explanation of why quantitative uncertainty results are not provided as part of the FPRA results and appears to present an informal estimate of the risk uncertainty that concludes with the following statement: "a reasonable estimate of the uncertainty interval is minus 10 to plus 5 on the calculated mean value, where the mean is estimated to be on the order of a factor of 5 to 10 lower than calculated." Attachment W of the LAR states that "calculated values are estimated to be conservative by a factor of 5 to 10 ..... Thus better estimates of CDF and LERF are <~1E-5/yr and <~2E-6/yr." This statement in Attachment W seems to indicate that parametric data uncertainty was propagated and that the risk estimates in Attachment W are a calculated mean based on propagation of parametric uncertainty* *referred to in the F&O disposition. Please clarify how parametric uncertainty was propagated and how the risk values in LAR Attachment W were determined.*

<u>NPPD Response</u>:

Parametric uncertainty was not propagated and does not need to be propagated to meet the noted SR for Capability Category II. The SR requires an estimate of the uncertainty intervals. Please see response to F&O in Table V-1 SR QU-E3 which provides a summary of the estimated uncertainty intervals and basis for concluding the calculated mean CDF and LERF values utilized in the CNS Fire PRA are conservatively biased by a factor of 5 to 10.

The statement contained in Attachment W regarding better estimates of Fire CDF and LERF being <~1E-5/yr and <~2E-6/yr is only utilized to show that the total CDF and total LERF can reasonably be considered < 1E-04/yr and <1E-05/yr respectively. These reasonable estimates of Fire CDF and LERF were obtained by dividing the mean values by the lower estimate of conservative bias. All other risk values contained in Attachment W and associated tables are based on calculated mean Fire CDF and LERF values without propagation of uncertainty. Since correlation between probabilities is not significant, propagation of parameter uncertainties is not required, as noted in the peer review report assessment of supporting requirement QU-A3 meeting Capability Category II.

Attachment W shows there is a net decrease in total CDF and LERF associated with this application. The better estimates of fire related CDF and LERF referred to in this RAI where utilized to show total CDF and LERF values justify use of total delta risk criteria of 1E-5/yr and 1E-6/yr for CDF and LERF respectively. This was only done to provide perspective of the margins to acceptance guidelines for this application.

<u>Request</u>: - PRA RAI-02 Fire PRA F&Os (continued)

i. *<u>Assessment against SY-A24</u>: This SR assessment comes from the FPRA peer review SR Summary assessment table (i.e., Appendix B) against SY-A24. (Attachment V-2 of the LAR does not attribute an F&O to this SR assessment.) The disposition to the assessment of this SR acknowledges that the fire PRA includes repair of battery charters* [sic] *and diesel generator fuel oil transfer pumps which are supported by procedures, pre-staged equipment, and timing assessments. The requirement of SR SY-A24 is "DO NOT MODEL the repair of hardware faults, unless the probability of repair is justified through an adequate analysis or examination of data." Repairing equipment damaged by fire would appear to be difficult to proceduralize. Please describe the basis for the determination of the HEPs for these repairs. As part of this description, please discuss the procedure for performing these repairs and how it addresses the variability and uncertainty presumably associated with fire damage. Additionally, please discuss to what extent examination of data was performed to support determination of these HEPs.*

NPPD Response:

The ASME standard defines repair as "restoration of a failed SSC by correcting the cause of failure and returning the failed SSC to its modeled functionality."

"Repair" types of actions have not been modeled in the Fire PRA. Internal events PRA modeling was reviewed and HEPs judged to be repairs were modeled to fail in the Fire PRA. However, two HFEs in the fire model recognize the ability to provide procedurally directed field actions to restore functionality of battery chargers and diesel fuel oil transfer pumps.

Human action EDC-XHE-FI-CHGRRPR models the replacement of cables damaged by a fire for recovery of the Train B battery chargers. For this action, the needed equipment is pre-staged and operators are not required to diagnose the cause of the failure. This action is a replacement action as opposed to a repair action. This replacement is proceduralized in 5.4POST-FIRE, Attachment 25. Based on "*Appendix R to 10CFR Post-Fire Repair Required Implementation Times,*" June 1991, the time to execute is 90 minutes and there are 270 minutes available. This is documented in NEDC 09-083 "*Task 7.12 Human Reliability Analysis,*" Attachment B.

Human action EAC-XHE-FI-DGFOTP models replacement of cables damaged by a fire for recovery of the diesel generator fuel oil transfer pumps. For this action the equipment is pre-staged and operators are not required to diagnose the cause of the failure. This action is replacement action as opposed to a repair action. This replacement is proceduralized in 5.4POST-FIRE, Attachment 26. Based on "*Appendix R to 10CFR Post-Fire Repair Required Implementation Times,*" June 1991, the time to execute is 90 minutes and there are 300 minutes available. This is documented in NEDC 09-083 "*Task 7.12 Human Reliability Analysis,*" Attachment B.

Supporting Requirement SY-A24 has only F&O 4-11 against it. LAR Attachment V provides a discussion of SY-A24 on page V38 and a discussion of F&O 4-11 on pages V-11 and V-12. The discussion in Attachment V, page V-38 follows:

> Current CC: Met All.
>
> Table 4-4 was updated to Table 4 of NEDC 09-083, "Task 7.12 Fire Human Reliability Analysis," and these specific repairs modeled in internal events no longer apply and have been removed from Table 4.
>
> Disposition of HFEs noted: SPC-XHE-FO-RCVR & SWS-XHE-FO-RCVR - Internal events values are set to 1.0 (always failed). The HEP of 1.0 is retained for the Fire PRA.
>
> The Fire PRA did include repair of battery chargers and diesel generator fuel oil transfer pumps. These repairs are included in the fire response procedures, have the needed parts and equipment pre-staged, and include timing assessments. A detailed human reliability analysis was performed to determine the HEP.

The fire scenarios were further reviewed and additional detailed analysis was performed. This included not only detailed fire modeling and fire human reliability analysis, but also detailed circuit analysis and circuit failure likelihood analysis.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

j. *Assessment against SY-A6: This SR assessment comes from the FPRA peer review SR Summary assessment table (i.e., Appendix B) assessment SY-A6 (Attachment V-2 of the LAR does not attribute an F&O to this SR.) This assessment indicates that instrumentation may need to be added to system boundary definitions for the FPRA. The disposition to this SR noncompliance explains that new components were added to system definitions for the FPRA. Please describe what components were added to the system boundary definitions, whether instruments were included, and the criteria for adding new components.*

NPPD Response:

The only F&O against SY-A6 is F&O 2-3. This F&O is discussed in LAR Attachment V on pages V-7 and V-8.

This RAI is similar to PRA RAI-23. The response to PRA RAI-23 discusses specific cases of differences between the Internal Events PRA and the Fire PRA. The criteria for adding new components are described in NEDC 09-079 and are summarized below.

All equipment credited in the Fire PRA was assessed after a fire by determining the component's location, cable selection, and cable tracing.

Fire-related events were inserted into the Internal Events PRA fault trees along with any logic necessary to represent the fire-system interactions. These Internal Events PRA fault trees were enhanced where necessary based on the following:

- Modeled operator actions included the necessary hardware, which must be cable traced. If the Internal Events PRA excluded hardware based on the dominance of the human interaction, the associated hardware was added to the model.
- Instrumentation signals for all components required to change state in the PRA were modeled to include the signals, sensors, or interlocks.
- Fault trees for instrument systems were enhanced to adequately represent fire effects.
- Spurious instrumentation signals for equipment were included as necessary. If spurious operation of a component has no effect on system function, they were omitted.
- Operator actions included in the Internal Events PRA model were reviewed to determine if their reliability could be significantly degraded by fire-induced instrumentation failures. If true, a new human error probability for fire conditions was determined in NEDC 09-083 "Task 7.12 Fire Human Reliability Analysis."

- Components with a probability of spurious actuation caused by fire have their spurious actuation probability set to 0.3 for components with Control Power Transformers (CPTs), and 0.6 for those without CPTs.
- For those components for which there is no Internal Events PRA basic event, the equipment is identified that the component supports and a fire initiating event in that location is added to the model.
- Common cause failure (CCF) or test and maintenance (TM) basic events are not failed due to fire.
- Any additions/modifications to the fault trees which are only applicable to the Fire PRA were made in a manner such that they a) would not interfere with quantification in the Internal Events PRA, or b) could be turned off by a single set of flags.
- Modeling simplifications made in the internal events model which did not address certain potential alignments were revised where a potential impact to the Fire PRA was identified. For example, normally closed valves that receive a close signal were not always included in the Internal Events PRA model. A fire could cause these valves to spuriously open. Logic was included in the Fire PRA for this failure mode.
- Interfacing System Loss-of Coolant Accident (ISLOCA) pathways and Inadvertent Open Relief Valves (IORV) caused by spurious component operation were added.
- Failure modes resulting from fire for components in the IE PRA were added.
- Fire-induced spurious operation was added for subcomponents (i.e., solenoid valves).
- Subcomponents of existing PRA components were added. For example, pump circuit breakers failures as a result of fire were added.

Additional fire modeling was performed within the system boundary to accommodate spurious operations due to fire and other fire impacts are described in PRA RAI-23.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

k. *Assessment against PRM-B9: This SR assessment comes from the FPRA peer review SR Summary assessment table (i.e., Appendix B) assessment PRM-B9 (Attachment V-2 of the LAR does not attribute an F&O to this SR). Significant changes were made to the Internal Events PRA (IEPRA) models to produce the FPRA models, but it is difficult to review and judge completeness of these models given that this information resides in various reports not parallel to the internal events systems analysis. As a result, it is difficult to determine that this SR and associated ones (e.g., SY-A2, SY-A3, SY-A4, SY-A6, SY-A12, and SY-A24) are met. Please discuss the extent of PRA model changes made since the peer review and whether these changes constitute a "PRA Upgrade" as defined in the American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) PRA standard and clarified in NRC Regulatory Guide (RG) 1.200, "An Approach For Determining the Technical Adequacy of Probabilistic Risk Assessment Results For Risk-Informed Activities."*

NPPD Response:

Please see LAR Attachment V, Tables V-1 and V-2, SR PRM-B9, which address applicable F&Os and provide a discussion of resolution related to the subject Fire PRA peer review SR Summary assessment table item.

The only changes made to the Fire PRA model since the peer review are those associated with F&Os generated during the peer review and further refinements. The changes made to the model, including both changes made to address F&Os and model refinements, used the same methodologies that were used for development of the Fire PRA prior to peer review. No additional components were added. Detailed human reliability analyses were performed for some human error probabilities that had been set to screening values. Some additional detailed fire modeling was performed.

These changes to the Fire PRA model subsequent to the peer review do not constitute a PRA Upgrade as established in the ASME/ANS PRA Standard or Regulatory Guide 1.200.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

l. *F&O 4-5 against PRM-B9: If the failure mode "Fails to Remain Open/Closed" is not modeled in the IEPRA model, please discuss how it is assured that this failure mode is considered for the FPRA model.*

NPPD Response:

Section 4.4 of NEDC 09-078, "*Task 7.2 Component Selection,*" describes the process for identifying fire-induced spurious operations ["fails-to-remain-open" / "fails-to-remain-closed"]. As noted in the NEDC 09-078 text, this *identifies new failure pathways (not included in the [Internal Events] PRA), which can degrade or fail a PRA system/train due to spurious actuation.* This failure mode is considered in the FPRA model as discussed next. The process used to identify spurious operations is summarized below:

- Diversion of the ECSTs inventory
  - Any pathway that will drain the ECSTs over a period of 24 hours
- Failure of minimum flow recirculation lines
  - Failure leading to flow diversion (inadvertently open)
  - Pump failure due to dead-heading of pump (inadvertently closed)
- Loss of offsite power due to spurious breaker operation
  - Opening of the breaker feeding the emergency busses due to control failure, protective actions, or failure of the equipment downstream of the breaker
- Failure of standby Service Water pump actuation
  - Failure to start
- High-Low pressure interfacing LOCA paths
  - Same as defined in Internal Events PRA

- Containment leakage paths resulting in LERF
  - Pathways in contact with the containment atmosphere to systems outside the containment
  - Exclude any systems that have a heat exchanger boundary inside containment
  - Use same criteria for breach size as in the Internal Events PRA
  - Consider all failures occur at the time of core damage
  - Do not include evacuation models for LERF
- Blockage of cooling water system paths
  - Spurious closure of any path that will block cooling of essential heat loads
- Loss of HVAC due to damper failure closure
  - Spurious closure of DG room dampers, or any other dampers in HVAC systems required for operation
- Inadvertent drainage or overfill of closed cooling water systems
  - Any path that will result in reducing the system inventory to the level where it cannot provide its function for the 24 hour mission time
- Main Steam Isolation Valve failure to function
  - Spurious open of MSIV, drain lines, bypass lines, or any other pathway that is greater than 2 inches which provides an uncontrolled steam release path
  - Closure of MSIV and bypass lines that prevent use of the Main Condenser for heat removal
- Safety Relief Valves (SRVs) failure to function (open & reclose)
  - Failure to open
  - Failure to reclose
- Diversion of the Suppression Pool inventory
  - Any path that will drain the Suppression Pool over a 24 hour period
- LOCA pathways from the RCS through SRVs and reactor head vents
  - SRV fail to close or spurious open and fail to be isolated
  - Head vent spurious open
- Inadvertent isolation of RHR train suction
  - Any failure which isolates the suction paths for the RHR trains
- Isolation of a HPCI suction source
  - Any failure which isolates the suction paths for HPCI
- Core spray flow diversion to suppression pool
  - Any failure which diverts core spray flow to the suppression pool
- Inadvertent ADS operation
  - ADS valve spurious open and fail to be isolated
- Flow diversions from HPCI, RCIC, LPCI, core spray, or RHR paths
  - Spurious operation leading to flow diversion (inadvertently open)
- Blockage of HPCI, RCIC, LPCI, core spray, or RHR paths
  - Spurious closure of any path that will block delivery of flow
- Steam to RCIC turbine isolated
  - Spurious closure of steam supply
- Steam to HPCI turbine isolated
  - Spurious closure of steam supply

- RHR train flow diverted to drywell spray loop
  - Any failure which diverts RHR flow to the drywell sprays
- Drainage of RPV to suppression pool
  - Any pathway that will drain the RPV to the suppression pool

Using the flow diagrams (i.e., Piping & Instrumentation Diagrams), pathways were examined for those that could result in any of the conditions described above.

If a passive failure (i.e., a spurious operation) could place the component in an undesirable configuration, logic for the passive failure was included in the FPRA model. However, if a passive failure will place a component in an acceptable configuration, modeling was not included because the spurious operation would be similar to modeling a "failure" as a "success." For example, the internal events model may have a basic event for a valve Fails-To-Close; the fire model would have a corresponding Fails-To-Close Due-To-Fire basic event. There would not be a passive failure (Spurious Close) for this valve in this branch of the fault tree, as the success position is "closed." Failures that place components in a successful position are not modeled in the fault tree logic.

The potential for both single and multiple spurious operations was assessed using the process described above. In addition, an Expert Panel was convened and an examination for MSOs was performed using the generic list of MSOs in NEI 00-01. T he MSO examination process and the results of the Expert Panel are documented in the report NEDC 09-080, "*Multiple Spurious Operation Expert Panel Results.*"

Therefore, fire-induced failure modes "Fails to Remain Open/Closed" have been evaluated, modeled, and documented for the FPRA model.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

m. F&O 1-30 against FSS-E3: Please provide detailed justification describing why only meeting Cat I, and not Cat II, is acceptable for this application.

NPPD Response:

Supporting Requirement FSS-E3 of the ASME/ANS PRA standard requires identification of numerical uncertainty bounds for fire modeling parameters in order to meet Capability Category II. Capability Category I allows for a qualitative assessment of uncertainty. The F&O indicates the CNS Fire PRA has met Capability Category I, but has not provided numerical uncertainty bounds for fire modeling parameters, and thus does not met Capability Category II.

Several sources of uncertainty were considered in the fire modeling. These are discussed quantitatively and qualitatively through the documented reports of the CNS NFPA 805 Transition Project.

The following discussion and identification of uncertainty bounds is sufficient to attain Capability Category II. There is no SR to incorporate the fire modeling uncertainties into the CDF/LERF equation uncertainty.

Fire modeling performed in support of the transition has been performed within the Fire PRA utilizing codes and standards developed by industry and NRC staff which have been verified and validated in authoritative publications, such as NUREG-1824, "*Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications,*" Final Report, April 2007. In general, the fire modeling performed in support of the Fire Risk Evaluations has been performed using conservative methods and input parameters that are based upon NUREG/CR-6850, "*Fire PRA Methodology for Nuclear Power Facilities,*" Final Report, September 2005. This pragmatic approach is used given the current state of knowledge regarding the uncertainties related to the application of the fire modeling tools and associated input parameters for specific plant configurations. A characterization of uncertainties associated with detailed fire modeling has been documented in Section 7 of each fire compartment-specific Detailed Fire Modeling Report and is summarized below:

The detailed fire modeling task develops a probabilistic output in the form of target failure probabilities and are subject to both aleatory and epistemic uncertainty.

Appendix V of NUREG/CR-6850 suggests that to the extent possible, modeling parameters should be expressed as probability distributions and propagated through the analysis to arrive at target failure probability distributions. These distributions should be based on the variation of experimental results as well as the analyst's judgment. In addition, to the extent possible more than one fire model can be applied and probabilities assigned to the outcome which describe the degree of belief that each model is the correct one.

The propagation of fire for each non-screened fire source has been described by a fire model (represented by a fire growth event tree) which addresses the specific characteristics of the source and the configuration of secondary combustibles.

Aleatory uncertainties identified within the fire modeling parameters include:
- Detector response reliability and availability
- Automatic suppression system reliability and availability
- Manual suppression reliability with respect to time available

Epistemic uncertainties which impact the zone of influence and time to damage range include:
- Heat release rates (peak HRR, time to reach peak, steady burning time, decay time)
- Number of cabinet cable bundles
- Ignition source fire diameter
- Room ventilation conditions
- Sprinkler Response Time Index (RTI), C factor, and activation temperature
- Detector activation temperature, geometry and obscuration activation
- Soot yield

- Fire growth assumptions (cable tray empirical rule set, barrier delay)
- Cable fire spread characteristics for horizontal and vertical trays
- Transient fires (peak HRR, time to reach peak, location factor, detection time)
- Oil fires (spill assumptions)
- Assumed target location
- Target damage threshold criteria
- Manual detection time
- Mean prompt suppression rate
- Manual suppression rate
- Welding and cutting target damage set
- Transient target impacts

With respect to the PRA, a quantitative characterization has not been developed as the quantitative results are conservatively biased for key contributors. Rather than developing a quantitative characterization, an alternate estimate of the mean value for CDF and LERF can be estimated to be a factor of 5 to 10 lower than calculated with a 90 percentile range of a factor of 10 on the lower end and 5 on the higher end. Due to the uncertainty with each of these parameters, the fire modeling task has selected conservative values for each. Examples of conservative values selected can be seen in Section 7.11.2 of Engineering, Planning, and Management, Inc. (EPM) Procedure EPM-DP-FP-001, *"Detailed Fire Modeling,"* Revision 3, April 2011, which discusses safety margin, and is shown below:

> Fire models should be created with a substantial safety margin. Per NEI 04-02, there is no clear definition of an adequate safety margin. However, it should be sufficiently large so as to bound the uncertainty within a particular calculation or application. The analyst should provide a list of items that are modeled conservatively and that provide safety margin. Some examples of safety margin include the following items:
>
> - Fire scenarios involving electrical cabinets (including the electrical split fraction of pump fires) utilize the 98th percentile HRR for the severity factor calculated out to the nearest FPRA target. This is considered conservative.
> - The fire elevation in most cases is at top of cabinet or pump body. This is considered conservative, since the combustion process will occur where the fuel mixes with oxygen, which is not always at the top of the ignition source.
> - The radiant fraction utilized is 0.4. This represents a 33% safety margin over the normally recommended value of 0.3.
> - The convective heat release rate fraction utilized is 0.7. The normally recommended value is between 0.6 and 0.65, and thus the use of 0.7 is conservative.
> - For transient fire impacts, a large bounding transient zone assumes all targets within its ZOI are affected by a fire. Time to damage is calculated based on the most severe (closest) target. This is considered conservative, since a transient fire would actually have a much smaller zone of influence and varying damage times. This approach is implemented to minimize the multitude of transient scenarios to be analyzed.
> - For hot gas layer calculations, no equipment or structural steel is credited as a heat sink, since the closed-form correlations used do not account for heat loss to these items.

- Not all cable trays are filled to capacity. By assuming full, this provides conservative estimates of the contribution of cable insulation to the fire and the corresponding time to damage.
- As the fire propagates to secondary combustibles, the fire is conservatively modeled as one single fire using the fire modeling closed-form correlations. The resulting plume temperature estimates used in this analysis are therefore also conservative, since in actuality, the fire would be distributed over a large surface area, and would be less severe at the target location.
- Target damage is assumed to occur when the exposure environment meets or exceeds the damage threshold. No additional time delay due to thermal response is given.
- The fire elevation for transient fires is 2-feet. This is considered conservative since some transient fires occur at the floor.
- Oil fires are analyzed as both unconfined and confined spills with 20-minute durations. Unconfined spills result in large heat release rates, but usually burn for seconds. The oil fires have been conservatively analyzed for 20-minutes to account for the uncertainty in the oil spill size.
- High energy arcing fault scenarios are conservatively assumed to be at peak fire intensity for 20-minutes from time zero, even though the initial arcing fault is expected to consume the contents of the cabinet and burn for only a few minutes.
- Fire brigade intervention is not credited prior to 85-minutes. Fire Brigade drills indicated that typical manual suppression times can be expected to be much less (i.e., 20 minutes).

Based on the conservative values selected, providing adequate safety margin, for each of the parameters resulting in uncertainty associated with the detailed fire modeling tasks, Category I is acceptable for this Fire PRA application.

<u>Request</u>: - PRA RAI-02 Fire PRA F&Os (continued)

n. *<u>F&O 4-22 against HRA-A4</u>: The disposition appears to suggest that the focus of the interviews were on select dominant sequences rather than relevant actions identified in SR HRA-A1, HRA-A2, and HRA-A3. Please clarify how the interviews satisfy the requirements of HRA-A4 with regard to the cited SRs.*

<u>NPPD Response</u>:

Interviews are documented in NEDC 09-083, "*Task 7.12 Human Reliability Analysis,*" Attachment A. Two sets of operator interviews were performed. The second interview included talk-through with plant personnel on the procedures and sequence of events, as required by HRA-A4. During the second set of interviews responses from the first interview were reviewed for any possible changes. None were noted.

Safe Shutdown Analysis Report, Appendix M, "*Operator Manual Action Times,*" provides the fire specific timelines for fire response actions, shows that all actions in the fire procedures have been walked down, and been demonstrated to be feasible. This was reviewed during the operator interviews for currency and accessibility for performance during fires. No issues were noted. For those fire HFEs initiated by EOPs and other instructions, these were reviewed for currency and accessibility for performance during fires. No issues were noted. The use of the dominant scenarios was to select additional, focused interviewing to ensure that sequences of events that included several RAs did not introduce any problems.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

o. *F&O 2-15 against HR-G7: Please discuss how the peer review observation was addressed that "The current quantification method does not use higher HEP values in quantification and does not apply recovery file that includes HEP combination events."*

NPPD Response:

This was addressed by completing a formal dependency analysis using the HRA Calculator. This is detailed in NEDC 09-083, "*Task 7.12 Human Reliability Analysis*", Section 7.5 "*Subtask 5: Dependency*", as follows:

CNS HRA Dependency Process

Step 1: Set all HEPs to numerical 1.0 and generate single CDF equation for all scenarios.

The first step in the dependency analysis is to generate a single CDF equation which combines the results of all scenarios. The current Fire PRA is structured to quantify for individual scenarios. This single file was generated using the merge cutset file in CAFTA. However, there were challenges in this approach.

Running the Fire PRA model with all HFEs set to 0.98 created over 8 million cutsets which CAFTA cannot merge into a single cutset equation. Therefore to work within the limits of CAFTA, the top 1000 cutsets from each scenario which contained at least two operator actions were merged into a single equation. The dependency analysis is only concerned with combinations of operator actions so the cutsets with either one or no operator actions were not retained. The file generated is labeled "Merge.cut."

Because the Fire PRA applies different values to same basic event name in order to generate single equation each basic event can only have one value. Therefore, every variation of the HFE was given a unique name. This was the base HFE name with appendage such as C, M, A, and OMA. All basic events identified in HFE summary sheet were set to either logical true or 0.98. In the dependency analysis a logical true was used for HFEs that appear in the internal events model but are not used in the fire PRA.

There were two exceptions to the above. The fault tree logic contains a dependency of depressurization and injection. ADS-XHE-FO-COND "*Conditional Probability of Moderate Dependency between Injection Initiation and RPV Depressurization*" already represents the joint HFE, so it does not need additional consideration for the dependency analysis. ADS-XHE-FO-

COND was left at its pre-dependency value. In addition, DEP-XHE-FO-SPTDV, "*Operating Staff Fails to Initiate both SPC and Torus-DW Vent (HEP Floor)*", represents a floor dependency implemented in the fault tree. Because the internal events fault tree logic structure was not changed for fire, this event was left in place and the HEP value was increased to 5E-6.

Step 2: Import cutset equation into HRA Calculator and apply all default HRA Calculator dependency rules.

Prior to the import process within CAFTA, the "Merge.cut" file was sorted such that all HFEs in combination appear in alphabetical order. The "Merge.cut" file was imported into the HRA database.

Once imported, the HRA Calculator default dependency rules were applied. At this stage, no review of the combination was performed. All combination events were created and a lower bound of 1E-3 was applied to all joint HEPs.

Step 3: Generate Q recovery file with the minimum joint HEP set to 1E-3

A conservative lower bound of 1E-3 was initially applied to all joint HEPs. The merge cutset equation can only be used to identify combination of HFEs. Because of the logic trees used to create this file, along with logical fire failures, the cutsets in which the combinations occur are extremely difficult to review. In order to understand a combination, each combination must be reviewed in the fire scenario in which it occurs; but this information was not retained during the merging and cutset import process. The HRA Calculator dependency rules are known to be conservative and by applying a lower bound of 1E-3, the overall results of the HRA dependency analysis are known to be conservative. The results of the HRA Calculator were exported and a recovery rule file generated for use with Qrecover.

Step 4: Quantify all fire scenarios with the recovery rule file and rank order the scenarios by change in CDF between base case and case with dependencies

Each fire scenario was re-run using the recovery rule file. For each scenario the change in CDF was compared to the scenario run with no dependency rules applied.

Step 5: Starting with the scenario with largest change in CDF, review combinations and perform detailed dependency analysis on selected combinations.

On an as-needed basis, selected scenario cutset files were reviewed and HFE combinations were reviewed in detail. On a scenario-by-scenario basis, the reviewer can understand the context of the HFE combination. In many cases this detailed review showed that the joint HEP for the combination should be lower than the 1E-3 assumed lower bound. Because the combinations could be reviewed in the context of a specific fire scenario, the HRA analyst could be able to justify a lower level of dependency.

Each time a combination was reviewed in detail a "D" was appended to the end of the combination name. In some cases the HRA Calculator default results were not changed as part of this review. As an additional level of conservatism, a lower bound of 1E-6 was applied to combinations that were reviewed in detail.

Step 6: Generate updated recovery rule file and re-ran all scenarios. Repeat steps 4 through 6 until satisfied with results.

There are two dependency analyses, one with detailed review of selected combinations and one with very conservative results. Both results are exported to excel and two recovery rule files were generated and concatenated in an updated recovery file.

This updated file is then re-run for all scenarios and steps 4 and 5 are repeated until satisfied with the results. The dependence results are listed in NEDC 09-083 Attachment C.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

p. *F&O 7-8 against QU-D6: The disposition mentions that the CDF and LERF cutsets were not merged. Please discuss how reasonableness reviews were performed for CDF and LERF cutsets.*

NPPD Response:

As described in NEDC 09-085, "*Task 7.12 Fire Risk Quantification,*" Attachment D Section D.4.1, "*Review of Cutsets,*" scenario cutsets were examined to verify that individual cutsets would logically result in core damage. The converse was also looked for, i.e., "Were there cutsets missing from the results that should be present?" Each individual cut-set should result in core damage. The two main functions are RPV level control and decay heat removal. Methods of RPV level control and decay heat removal are:

- RPV Level Control (High Pressure)
  - High Pressure Coolant Injection (HPCI)
  - Reactor Core Isolation Cooling (RCIC)
  - No RPV Depressurization
- RPV Level Control (Low Pressure)
  - Core Spray A (CS A)
  - Core Spray B (CS B)
  - Low Pressure Coolant Injection A – RHR Pump A or Pump C (LPCI A)
  - Low Pressure Coolant Injection B – RHR Pump B or Pump D (LPCI B)
  - RPV Depressurization
- Decay Heat Removal
  - Suppression Pool Cooling A – RHR Pump A or Pump C (SPC A)
  - Suppression Pool Cooling B – RHR Pump B or Pump D (SPC B)
  - Shutdown Cooling A – RHR Pump A or Pump C (SDC A)

- Shutdown Cooling B – RHR Pump B or Pump D (SDC B)
- Hard Pipe Vent

Reasonableness reviews and assessment of significant contributors to risk were performed by examining the cutsets of those scenarios that contributed greater than 1 percent to core damage and large early release. In addition, cutsets of those scenarios with high conditional core damage probabilities and conditional large early release probabilities were reviewed.

The scenarios were discussed as a team that included PRA experts, safe shutdown experts, and fire modeling experts so that all aspects of the scenario could be evaluated including component failures, spurious operations, and human actions.

Numerous low contributors to risk were evaluated to ensure that they correctly represented appropriate risk contribution.

Sensitivity studies of human actions were also performed as part of the fire risk evaluation process.

Conclusions of results reviews are noted in the Fire PRA results in NEDC 09-085.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

q. *F&O 8-6 against LE-G3: It is not clear how the disposition addresses the peer review finding on documenting LERF contributions. Please clarify how the contributions to LERF were documented.*

NPPD Response:

Documentation of LERF contributions was performed in a similar manner for CDF. Risk contributions to LERF are mainly from loss of decay heat removal. Risk ranking of the fire scenarios by LERF and evaluation of the fire scenarios for contributors was performed. The fire-induced failures combined with equipment and human errors establish the plant damage states and these plant damage states are consistent with the Internal Events PRA. No new plant damage states were identified. The Task 14 calculation, NEDC 09-085, "*Task 7.14 Fire Risk quantification,*" documents LERF contributions. For each plant damage state the relative contribution of phenomena, containment challenges, and containment failure modes is already addressed in the Internal Events PRA and is available in the Fire PRA cut set results. Significant accident progression sequences were documented as discussed above. We did not rank order fire LERF contributors by plant damage state, phenomena, or containment challenges and failure modes, as this was deemed unnecessary, as no new plant damage states were identified.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

r. *F&O 7-8 against QU-D7: Please discuss what was reviewed, what results were reviewed, and the conclusions from the review.*

NPPD Response:

As described in NEDC 09-085, "*Task 7.12 Fire Risk Quantification,*" Attachment D Section D.4.1, "*Review of Cutsets,*" scenario cutsets were examined to verify that individual cutsets would logically result in core damage. The converse was also looked for, i.e., "Were there cutsets missing from the results that should be present?" Each individual cut-set should result in core damage. The two main functions are RPV level control and decay heat removal. Methods of RPV level control and decay heat removal are:

- RPV Level Control (High Pressure)
  - High Pressure Coolant Injection (HPCI)
  - Reactor Core Isolation Cooling (RCIC)
  - No RPV Depressurization
- RPV Level Control (Low Pressure)
  - Core Spray A (CS A)
  - Core Spray B (CS B)
  - Low Pressure Coolant Injection A – RHR Pump A or Pump C (LPCI A)
  - Low Pressure Coolant Injection B – RHR Pump B or Pump D (LPCI B)
  - RPV Depressurization
- Decay Heat Removal
  - Suppression Pool Cooling A – RHR Pump A or Pump C (SPC A)
  - Suppression Pool Cooling B – RHR Pump B or Pump D (SPC B)
  - Shutdown Cooling A – RHR Pump A or Pump C (SDC A)
  - Shutdown Cooling B – RHR Pump B or Pump D (SDC B)
  - Hard Pipe Vent

Reasonableness reviews and assessment of significant contributors to risk were performed by examining the cutsets of those scenarios that contributed greater than 1 percent to core damage and large early release. In addition, cutsets of those scenarios with high conditional core damage probabilities and conditional large early release probabilities were reviewed.

The scenarios were discussed as a team that included PRA experts, safe shutdown experts, and fire modeling experts so that all aspects of the scenario could be evaluated including component failures, spurious operations, and human actions.

Numerous low contributors to risk were evaluated to ensure that they correctly represented appropriate risk contribution.

Sensitivity studies of human actions were also performed as part of the fire risk evaluation process.

Conclusions of results reviews are noted in the Fire PRA results in NEDC 09-085.

Request: - PRA RAI-02 Fire PRA F&Os (continued)

s. *F&Os 7-8 and 8-2 against QU-F3: Please explain how it is known if the significant basic events are reasonable.*

NPPD Response:

The size and complexity of the Fire PRA lead to developing individual calculations for each fire damage state or scenario. This approach provides for additional information for each fire damage state. The significant basic events are known to be reasonable because they were reviewed in detail. The characteristics of fire damage states (equipment impacted by the fire damage state) drive the calculated conditional core damage probability (CCDP) and conditional large early release probability (CLERP) so both PRA expert review and team reviews with safe shutdown experts provide confidence in the results and insights.

For additional details for F&O 7-8 see responses to PRA RAI-02 p and r.

Request: - PRA RAI-03 PRA Modeling of VEWFDS

LAR Attachment V, first paragraph of Section V.2, states that the very early warning fire detection system (VEWFDS) was modeled using FAQ 08-0046, with the exception that "rather than modeling the increased potential for suppressing the fire, the analysis only modeled the early detection and then applied human reliability analyses to model operator response to the early detection." As indicated, the guidance in FAQ 08-0046 is meant for determining increased probability of fire suppression, not to determine the probability of shutdown from the MCR before forced abandonment. The discussion on page V-3 indicates that two operator actions are credited. A probability of 0.01 is assigned to the failure of operators to confirm the situation locally and report back to the MCR. A probability of 0.01 is also assigned to the failure of MCR operators to respond using procedures for these panels. Attachment S (see Item S-2.4) states that crediting these actions allows for shutdown from the CR with minimal field actions and a lower CCDP (i.e., 0.0127) than if the alternate shutdown room (ASD) is modeled (0.1). However, these operator actions are not the actions defined in the FAQ-08-0046 Event Tree. Accordingly, it is not clear a probability of 0.01 is an appropriate probability for these operator failures. No HRA is presented or referenced. In light of the significant risk reduction from VEWFDS (in combination with these HEPs), please provide the basis for these operator error probabilities. As part of this basis, please include a complete description of the required operator actions and the basis for the HEPs. In addition, please clarify if the two cabinets where the VEWFDS is being installed are "sealed" cabinets per NUREG/CR-6850 and FAQ 08-0042, "Fire Propagation from Electrical Cabinets" (ADAMS Accession No. ML092110537), and, if not, please justify why the fire is not postulated to propagate to adjacent cabinets.

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: - PRA RAI-04 Transient Fire Heat Release Rate

LAR Attachment V identifies that the Cable Spreading Room (CSR) and HRR have been designated enhanced transient and hot work controlled fire zones, and therefore a reduction (beyond NUREG/CR-6850 recommendations) from 317 kW to 69 kW is made for transient fires analyzed in these areas. Please provide additional justification for the use of 69 kW transient fires in these fire zones. Specifically, please address the specific attributes and considerations applicable to the location, plant administrative controls, the results of a review of records related to violations of the transient combustible controls, and any other key factors for this reduced fire size. If the HRR cannot be justified using the guidance criteria, please discuss the impact on the analysis.

NPPD Response:

In a letter dated September 27, 2011, from B. Bradley (NEI) to D. Harrison (NRC), "Recent Fire PRA Methods Review Panel Decisions: Clarifications for Transient Fires and Alignment for Pump Oil Fires," Attachment 1, "Description of Treatment for Transient Fires," and Attachment 3, "Panel Decision," allow the user to choose a lower screening heat release rate for transient fires in a fire compartment based on "the specific attributes and considerations applicable to that location." The guidance indicates that "plant administrative controls should be considered in the appropriate HRR for a postulated transient fire" and that "a lower screening HRR can be used for individual plant specific locations if the 317 kW value is judged to be unrealistic given the specific attributes and considerations applicable to that location."

At CNS, a 69 kW transient heat release rate is justified for the new enhanced combustible controlled areas in the Auxiliary Relay Room (Fire Zone 8A) and the Cable Spreading Room (Fire Zone 9A) based on several factors:

- Fire Zones 8A and 9A are subject to enhanced strict combustible controls (areas designated as "No Storage"), so paper, cardboard, scrap wood, rags and other trash shall not be allowed to accumulate in the area.
- Large combustible liquid fires are not expected in these areas since activities in the areas do not include maintenance of oil containing equipment.
- The transient fire history in the plant was reviewed and a transient fire has not occurred in these fire areas.
- A transient fire in an area of strict combustible controls, where only small amounts of contained trash are considered possible, is judged to be no larger than the 75^{th} percentile fire in an electrical cabinet with one bundle of qualified cable.
- The materials composing the fuel packages included in Table G-7 of NUREG/CR-6850 (e.g., eucalyptus duff, one quart of acetone, 5.9 kg of methyl alcohol, etc.) are not representative of the typical materials expected to be located in these areas.

- A review of the transient ignition source tests in Table G-7 of NUREG/CR-6850 indicates that the type of transient fires expected in these zones (i.e., polyethylene trash can or bucket containing rags and paper) were measured at peak heat release rates of 50 kW or below.

Since only small quantities of trash in temporary containers can be expected, a 69 kW peak heat release rate was determined to be appropriate to represent this quantity of combustibles. The 69kW heat release rate bounds the small trash can fires reported in NUREG/CR-6850 Appendix G.

Request: - PRA RAI-05 Flame and Radiant Heat Shields

Table 4-3 of the LAR identifies "flame impingement shields" and "radiant energy shields" as features of the Fire Protection Program (FPP). Although Table 4.3 indicates that these shields are credited as "Required for Risk Significance," it is not clear whether they are credited as part of the fire modeling supporting the FPRA. If they are credited, please define what is credited and provide justification of this credit. Include in the discussion identification of engineering evaluations used to support the assumptions made about the function of these shields.

NPPD Response:

These installed Promat-H boards and the "to be installed" shields are currently being credited in the fire modeling performed for the Fire PRA to prevent damage or delay damage to Fire PRA credited conduit and cable trays.

Promat-H board is provided in the Cable Spreading Room on the northwest side of the column at column line 14.6 and J.3 and along the south wall of the room. The conduit at these locations are encased with two (2) layers of Promat-H board up to an elevation at which congestion precludes further protection. The Promat-H board protects vertical runs of required Division II conduit. The Promat-H board ensures that damage due to radiant heat flux from a floor-based transient fire would be delayed to provide time for detection and suppression system actuation prior to cable damage.

Promat-H board is provided in the Cable Expansion Room under the Division II ductbank. The conduit bank is protected from a floor-based transient fire by two (2) layers of Promat-H board under the bottommost conduit in the bank. The Promat-H board ensures that the conduit above is not damaged by plume or flame impingement from a floor-based transient fire.

A fire rating cannot be assigned to the Promat-H board fire barriers in the Cable Spreading Room and the Cable Expansion Room as the configurations are not completely enclosed. However, the construction is the same as that of a 1-hour fire rated barrier per Modification DC 92-097, "Thermo-lag Barrier Replacement." The seam construction, barrier thickness, etc., are the same as that in an approved 1-hour rated barrier. The 1-hour fire rated resistance is adequate for these scenarios based on the fire duration of a transient fire being less than 1-hour with no additional secondary cable trays or other combustibles being involved in transient fire scenarios in these zones. Calculation NEDC 10-021 assesses the fire resistance rating of the installed Promat-H boards.

The planned installations in Fire Area CB-D (Modification S-2.7) are plume impingement shields above panels PMIS-MUX-LNK6 and PMIS-MUX-LNK7 to prevent damage to conduit and cable trays located directly above these panels. The planned installations in Fire Area RB-M (Modifications S-2.5 and S-2.6) are radiant energy shields along the east wall (outside of the Critical Switchgear Room) south of column line K-11.7 of Fire Zone 3C to protect vertical conduit along the wall from a floor-based transient fire and radiant energy shields west of the elevator in Fire Zone 3C, just north of column line J-10.5, to protect vertical cable trays through the floor from a floor-based transient fire.

These "to be installed" shields will be constructed to 1-hour fire rated resistance similar to the existing Promat-H board installations, based on the fire duration of these panels being less than 1-hour with no additional secondary cable trays being involved in the fire scenarios.

Request: - PRA RAI-06 Non-suppression Probability

The non-suppression probability (P_{ns}) results reported in NEDC-08-041, Rev. 3 (i.e., Tables 11, 12, 13, 21, 22, and 23) used non-suppression probability values less than 0.001, contrary to NUREG/CR-6850 Attachment P. Please provide the results of a sensitivity analysis (CDF, LERF, delta (Δ) CDF, ΔLERF) using P_{ns} no lower than 1E-03.

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: - PRA RAI-07 MCB Modeling

Attachment A of NEDC-10-001 shows a single fire scenario for MCB 9-4. Attachment D of NEDC-09-085 indicates that this scenario results in MCR abandonment. Please discuss the modeling of this panel and why there are no loss-of-control scenarios.

NPPD Response:

MCR abandonment due to habitability and MCR abandonment due to loss of control were both included in the Fire PRA model.

MCR abandonment due to loss of control from a significant loss of mitigation capability was included in the model for Fire Area CB-D. A significant loss of mitigation capability is defined as loss of multiple systems/trains. In examining those scenarios with multiple systems/trains failed, the resulting CCDP was generally 0.1 or greater. Therefore, a CCDP of 0.1 was assumed as the figure of merit for MCR abandonment due to loss of control. This value considers use of the alternate shutdown strategy when control from the MCR is less reliable/available.

Scenario 10B 9-4S01 is a full burn-up of Panel 9-4 of the MCB. Panel 9-4 contains controls for RCIC, RWCU, Radwaste containment isolation valves RW-AOV-AO82/AO83/ AO94/AO95, and the Reactor Recirculation System. Only one scenario was warranted when modeling this panel. This scenario results in fire-induced initiators: (1) General Transients, (2) Break-Outside-Containment from failure of the RWCU Containment isolation valve failure to close and resultant ISLOCA outside the Containment, and (3) a very small LOCA from Reactor Recirculation pump seal leakage. The mitigating system lost is RCIC.

The dominant contributors to risk are associated with spurious operations (spurious opening) of RWCU valves combined with failure to close of the RWCU containment isolation valves. Although the CDF is low because of the small scenario frequency, the CCDP is high and it was postulated for this scenario that the operators would abandon the MCR and use Alternate Shutdown. If it is assumed that the operators would not abandon the MCR, the resulting CDF would increase by only 0.03 percent and LERF by only 0.2 percent.

Request: - PRA RAI-08 Fixed Fire Ignition Frequencies

Attachment B of NEDC 08-032 identifies instances in which motors/pumps smaller than 5 horsepower (hp) are included in the count for Bins 21 and 26 (e.g., pages 44 and 45). There are also instances in which transformers rated less than 45 kilovolt-ampere (kVa) are included in the count for Bin 23b (e.g., page 55). Please clarify whether these components, and any other identified components, have been assessed appropriately and, if not, please provide an assessment of the impact on the PRA results (CDF, LERF, ΔCDF, ΔLERF) of not including these components in the ignition source weighting factors.

NPPD Response:

Although these components are less than the screening value (i.e., <5 hp and <45 kVA), these are Fire PRA credited components. These components were retained in the ignition frequency calculation in order to assign a fire frequency to the conditional core damage probability associated with the loss of the component. Fire scenarios were generated to account for failure of the equipment itself and all cables terminating at the component. In order to assess the risk associated with the loss of the equipment, an ignition frequency was necessary. Therefore, these components are considered to have been assessed appropriately.

The following identifies the Fire PRA components that were retained in NEDC 08-032 with attributes below the screening values:

- Bin 21 (Pumps) – 4 Fire PRA components < 5 hp retained in NEDC 08-032 with a total of 154 total components counted
- Bin 23b (Dry Transformer) – 3 Fire PRA components < 45 kVA retained in NEDC 08-032 with a total of 17 total components counted
- Bin 26 (Ventilation Subsystem) – 4 Fire PRA components < 5 hp retained in NEDC 08-032 with a total of 142 total components counted.

<u>Request</u>: - PRA RAI-09 Inclusion of Multiple Compartment Scenarios

LAR Attachment W, states that "The total calculated CDF and LERF (post NFPA 805), including multi-compartment scenarios, are 5.2E-5/yr and 1.2E-5/yr respectively." However, Table W-2 shows the fire CDF and LERF to be 5.07E-5/yr and 1.05E-5/yr, respectively. This suggests that Table W-2 does not include the contribution from the multi-compartment scenarios. Please clarify this discrepancy. If the ΔCDF and ΔLERF, and the additional risk of RAs shown in Table W-2 do not include the contribution of multi-compartment scenarios, then provide a recompilation of Table W-2 that includes risk from multi-compartment scenarios.

<u>NPPD Response</u>:

Multi-compartment scenarios are not included in Table W-2. The delta CDF and delta LERF were evaluated for potential impact of multi-compartment scenarios. The delta risk calculations were conducted on a fire area basis. To assure that multi-compartment considerations would not change the conclusions, multi-compartment analyses (MCA) were performed. Of the fire areas for which FREs were performed, only CB-A, RB-DI, RB-P, and TB-A had calculated risk contributions from MCA. The total contribution to risk from MCA for all areas is much less than the risk from intra-compartment scenarios (on the order of a factor of 40 less for CDF and greater than a factor of 20 less for LERF, based on the Pre-NFPA 805 plant model) and were screened from further consideration in the delta risk as the impact is in the second decimal place on CDF and LERF and would be even lower on delta CDF and delta LERF. However, for completeness, the MCA total risk contribution was included in the discussion regarding total calculated CDF and LERF contained in LAR Attachment W. This is documented in the Delta Risk calculation (NEDC 11-108, Rev 3).

<u>Request</u>: - PRA RAI-10 Spread of Fire to Other Combustibles

Please describe how your evaluation includes the possible increase in HRR caused by the spread of a fire from the ignition source to other combustibles. Summarize how suppression is included in your evaluation

<u>NPPD Response</u>:

Plant walkdowns were performed to identify secondary combustibles, typically cable trays, within the zone of influence of the fire source. The distance from the source to the cable tray was utilized to determine the heat release rate necessary to ignite the cable tray. The time at which this heat release rate was reached was utilized in the Fire Modeling Workbooks to generate a fire scenario including fire growth. Fire spread along the cable tray and propagation to additional cable trays was included in the fire growth and propagation analysis per Section R.4 of NUREG/CR-6850. The ignition source was utilized as the point of origin to determine distance to the nearest fixed suppression system and the distance from the fire elevation to the ceiling was determined and used as input in the NUREG-1805 FDT10 spreadsheet to calculate the sprinkler activation time. The heat release rate input in the spreadsheet was varied to determine the minimum heat release rate in which suppression will activate. Once this minimum heat release rate was determined, the fire growth and propagation analysis in the Fire Modeling Workbook was used to determine the time at which the minimum heat release rate is reached. This minimum heat release rate includes the initial fire source, propagation to adjacent vertical sections and spread to secondary cable trays.

Refer to the response to Fire Modeling RAI 01(a), which is a 90-day response, for further discussion of fire propagation to non-cable tray secondary combustibles, including combustible insulation.

Request: - PRA RAI-11 Transient Fire Modeling at Pinch Points

Per Section 11.1.5.6 of NUREG/CR-6850, transient fires should at a minimum be placed in locations within the plant physical access units (PAUs) where critical targets are located, such as where CCDPs are highest for that PAU (i.e., at "pinch points"). Pinch points include locations of redundant trains or the vicinity of other potentially risk-relevant equipment, including the cabling associated with each. Transient fires should be placed at all appropriate locations in a PAU where they can threaten pinch points. Hot work should be assumed to occur in locations where hot work is a possibility, even if improbable (but not impossible), keeping in mind the same philosophy.

a. *Please describe how transient and hot work fires are distributed within the PAUs. In particular, identify the criteria that determine where an ignition source is placed within the PAUs. Also, if there are areas within a PAU where no transient or hot work fires are located since those areas are considered inaccessible, please describe the criteria used to define "inaccessible." Note that an inaccessible area is not the same as a location where fire is simply unlikely, even if highly improbable.*

b. *Relative to the MCR, please provide an assessment of the impact on the PRA results (CDF, LERF, ΔCDF, ΔLERF) of placing transients behind the open-back MCBs and back panels.*

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: - PRA RAI-12 Defense in Depth and Safety Margins

Please describe the methodology that was used to evaluate DID and that was used to evaluate safety margins. The description should include what was evaluated, how the evaluations were performed, and what, if any, actions or changes to the plant or procedures were taken to maintain the philosophy of DID or sufficient safety margins.

NPPD Response:

The following discussion provides the methodology used to perform the defense-in-depth and safety margin evaluations:

DEFENSE-IN-DEPTH

The methodology that was used to evaluate defense-in-depth is documented in the "NFPA 805 Task Plan for Fire Risk Evaluations," Revision 1A, dated April 2011. The methodology is as follows, followed by a list of CNS defense-in-depth actions.

Defense-in-Depth Approach

A review of the impact of the VFDRs on defense-in-depth shall be performed, regardless of the risk evaluation method used. The review of defense-in-depth is typically qualitative and should address each of the elements with respect to the proposed change.

1) Evaluate the fire area for the impact of the VFDRs on fire protection defense-in-depth. Fire protection defense-in-depth is achieved when an adequate balance of each of the following elements is provided:
    a. preventing fires from starting;
    b. rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage; and
    c. providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.
2) In general, the defense-in-depth requirement is satisfied if the proposed change does not result in a substantial imbalance among these elements. Table PRA-12-1 contains additional defense-in-depth guidance.
3) In evaluating defense-in-depth, it may become necessary to consider the potential for risk significant fire scenarios to impact VFDRs. A fire scenario is defined as a unique quantification of a fire damage state (which may include severity factors and probability of non-suppression) multiplied by a CCDP or CLERP to arrive at a CDF or LERF. For purposes of defense-in-depth, "potentially risk significant" fire scenarios could be characterized as follows, for example:

    - A scenario in which the calculated risk is equal to or greater than 1E-6/year for CDF and/or 1E-7/year for LERF, could be characterized as "potentially risk significant."
    - A scenario in which the calculated risk falls between 1E-6/ year and 1E-8/year for CDF, or between 1E-7/year and 1E-9/year for LERF, and where defense-in-depth echelon 1 and 2 attributes are causing a significant reduction in risk, could be characterized as "potentially risk significant."
    - A scenario in which the calculated risk is less than 1E-8/year for CDF and/or 1E-09/year for LERF, regardless of reliance on defense-in-depth echelon 1 and 2 attributes, may be characterized as "potentially not risk significant." These values are

considered "potentially not risk significant" based on being two to three orders of magnitude below the acceptance criteria of RG 1.174 as referenced by RG 1.205, Revision 1.

- A scenario with a high consequence (i.e., CCDP>E-1) could be considered "potentially risk significant."

For an individual VFDR without a calculated CDF or LERF, the following additional guidance was used:

- Additional risk insights (Dominant scenarios and components, etc.),
- Fire Modeling insights (fire frequency, transient versus fixed source, etc.), and
- Operator insights (ease of accomplishment, dose, number of personnel, additional available means, etc.).

4) Fire protection features and systems relied upon to ensure defense-in-depth should be clearly identified in the assessment (e.g., detection, suppression system, etc.).
5) Verify that defense-in-depth is maintained by assessing and documenting that the balance is preserved among prevention of core damage, prevention of containment failure, and mitigation of consequences. RG 1.174 provides guidance on maintaining the philosophy of nuclear safety defense-in-depth that is acceptable for NFPA 805 Fire Risk Evaluations.
6) Each fire area shall be evaluated for the need to incorporate defense-in-depth enhancements to provide assurance that plant performance goals can be achieved and maintained. Documentation of these defense-in-depth enhancements can be on a fire area basis and/or tied directly to a VFDR disposition, as appropriate.
7) Provide the results of the defense-in-depth review in a tabular format, such as that shown in the example in Table PRA-12-2. Defense-in-depth attributes shall be evaluated for applicability to NFPA 805, Section 4.2.3 or 4.2.4 (Chapter 3, as required).

- If a defense-in-depth attribute is credited for NSCA deterministic criteria, licensing action or engineering equivalency evaluation then the system/feature should already be considered to form an integral part of defense-in-depth. The parent echelon of the system/feature should then be evaluated against the process and considerations presented in Table PRA-12-1, to determine if any improvements or changes are necessary, such as to offset a weakness in another echelon.
- If the Fire PRA credits any of the fire protection features or a recovery action to improve the risk profile then these attributes or features should already be considered to form an integral part of defense-in-depth. The parent echelon of the system/feature should then be evaluated against the process and considerations presented in Table PRA-12-1, to determine if any improvements or changes are necessary, such as to offset a weakness in another echelon.
- Defense-in-depth attributes that go above and beyond the existing requirement(s) with the purpose of bolstering derived weaknesses within the defense-in-depth elements to maintain an overall balance should be designated as a change or improvement necessary for defense-in-depth.

- Note – this may or may not involve a physical improvement to the element, but by virtue of including an attribute that was not required for deterministic or risk reasons, defense-in-depth is considered enhanced.

- Features or enhancements required for defense-in-depth warrant consideration for inclusion in the monitoring program.

Approach to Document Required Fire Protection Systems and Features

The methodology that was used to document required fire protection systems and features, for defense-in-depth, is documented in Section 5.8.2 of the EPM Procedure EPM-DP-FP-003 "Fire Area Review," Revision 1, dated March 2011. The methodology is as follows:

> If the fire protection system or feature is required to demonstrate the acceptability of risk or defense-in-depth, as determined in Step 5.6 [of Procedure EPM-DP-FP-003], then it is required by NFPA 805 Chapter 4 and is then subject to the applicable requirements of NFPA 805 Chapter 3.
>
> Note: The defense-in-depth review performed as part of Step 5.6 determines which systems and features require enhancement in order to demonstrate adequate balance of the three echelons of defense-in-depth. Only those fire protection systems and features that require enhancement are the ones considered "required" in the context of this review.

Table PRA-12-1 - Considerations for Defense-in-Depth Determination

Method of Providing Defense-in-Depth	Considerations
Echelon 1: Prevent fires from starting	
▪ Combustible Material Controls ▪ Hot Work Controls	Combustible and hot work controls are fundamental elements of defense–in-depth and as such are always in place. The issue to be considered during the fire risk evaluation is whether this element needs to be strengthened to offset a weakness in another echelon thereby providing a reasonable balance. Considerations include: ▪ Creating a new Transient Combustible Free Area ▪ Creating a new Hot Work Restriction Area ▪ Modifying an existing Transient Combustible Free Area or Hot Work Restriction Area The fire scenarios involved in the fire risk evaluation quantitative calculation should be reviewed to determine if additional controls should be added. Review the remaining elements of defense-in-depth to ensure an over-reliance is not placed on programmatic activities for weaknesses in plant design.
Echelon 2: Rapidly detect, control and extinguish promptly those fires that do occur thereby limiting fire damage	
▪ Detection system ▪ Automatic fire suppression ▪ Portable fire extinguishers provided for the area ▪ Hose stations and hydrants provided for the area	Automatic suppression and detection may or may not exist in the fire area of concern. The issue to be considered during the fire risk evaluation is whether installed suppression and or detection is required for defense-in-depth or whether suppression/detection needs to be strengthened to offset a weakness in another echelon thereby providing a reasonable balance. Considerations include:

Table PRA-12-1 - Considerations for Defense-in-Depth Determination	
Method of Providing Defense-in-Depth	**Considerations**
▪ Fire Pre-Fire Plan	Risk Insights: ▪ If the variance is never affected in a "potentially risk significant" fire scenario, manual suppression capability may be adequate and no additional systems required. Recovery Actions: ▪ If the fire area requires recovery actions, then as a minimum, detection and manual suppression capability are required, and suppression should be considered. ▪ If a fire area contains neither suppression nor detection and a recovery action is required, consider adding detection and/or suppression. Firefighting Activities: ▪ If firefighting activities in the fire area are expected to be challenging (either due to the nature of the fire scenario or accessibility to the fire location) then both suppression and detection may be required Fire Scenarios: ▪ If fire scenarios credit fire detection or fire suppression systems, then these should be considered to form an integral part of defense-in-depth
Echelon 3: Provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed	
▪ Walls, floors ceilings and structural elements are rated or have been evaluated as adequate for the hazard. ▪ Penetrations in the fire area barrier are rated or have been evaluated as adequate for the hazard. ▪ Supplemental barriers (e.g., ERFBS, cable tray covers, combustible liquid dikes/drains, etc.) ▪ Fire rated cable ▪ Guidance provided to operations personnel detailing the required success path(s) including recovery actions to achieve nuclear safety performance criteria.	If fires occur and they are not rapidly detected and promptly extinguished, then the third echelon of defense-in-depth would be relied upon. The issue to be considered during the fire risk evaluation is whether existing separation is adequate (or over relied on) and whether additional measures (e.g., supplemental barriers, fire rated cable, or recovery actions) are required to offset a weakness in another echelon thereby providing a reasonable balance. Considerations include: Risk Insights: ▪ If the variance is never affected in a "potentially risk significant" fire scenario, internal fire area separation may be adequate and no additional reliance on recovery actions necessary. ▪ If the variance is affected in a risk significant fire scenario, internal fire area separation may not be adequate and reliance on a recovery action, supplemental barrier, or other modification may be necessary. ▪ If the consequence associated with the variance is considered high (e.g., CCDP>1E-01 or by qualitative SSD assessment) regardless of whether it is in a risk significant fire scenario, a recovery action, supplemental barriers, or other modification should be considered. ▪ There are known modeling differences between the Fire PRA and nuclear safety capability assessment due to different success criteria, end states, etc. Although a variance may be associated with a function that is not considered a significant contribution to core damage frequency, the variance may be considered important enough to the NSCA to retain as a recovery action.[1]

Table PRA-12-1 - Considerations for Defense-in-Depth Determination

Method of Providing Defense-in-Depth	Considerations
	Operations Insights: ▪ If the sequence to perform a recovery action is particularly challenging then including the action for defense-in-depth may be considered.[2] The fire scenarios involved in the fire risk evaluation quantitative calculation should be reviewed to determine the fires evaluated and the consequence in the area to best determine options for this element of defense-in-depth. [1]An example would be components in the NSCA associated with maintaining natural circulation at a pressurized water reactor that are not modeled explicitly in the Fire PRA since they are not part of a core damage sequence. [2]An example would be a recovery action that is unique in nature, time critical and/or not included in emergency response procedures such that the MCR staff may not be able to quickly recognize and perform the required action.

Table PRA-12-2: Example Defense-in-Depth Impact Review for Fire Area

Method of Providing Defense-in-Depth	Required to Support Deterministic Analysis or Fire PRA?	Changes or Improvements Necessary for Defense-in-Depth?	Basis/Justification
Echelon 1: Prevent fires from starting			
Combustible Control is implemented in accordance with Procedure X, "Control of Combustible Materials".	Yes	No	• This element is adequate based on no perceived weakness of, or over-reliance on, another echelon of defense-in-depth.
Hot Work Control is implemented in accordance with Procedure X, "Welding, Burning, and Grinding Activities"	Yes	No	
Echelon 2: Rapidly detect, control and extinguish promptly those fires that do occur thereby limiting fire damage			
Fire Detection System	No	No	• Detection is not credited in the performance-based analysis, firefighting activities are not expected to be challenging, and no recovery actions are required; therefore, no change or improvement to the installed system is required to maintain defense-in-depth.
Automatic Fire Suppression	Yes	No	
Portable Fire Extinguishers	Yes	No	
Hose stations and hydrants located in the area(s)	Yes	No	• Automatic suppression is credited in the performance based analysis. No further change or improvement to the installed system is required to maintain defense-in-depth.
Fire Pre-Fire Plan	Yes	No	
Echelon 3: Provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed			

Table PRA-12-1 - Considerations for Defense-in-Depth Determination

Method of Providing Defense-in-Depth			Considerations
Walls, floors ceilings and structural elements are rated or have been evaluated as adequate for the hazard.	Yes	No	• Supplemental barriers are credited in the performance-based analysis, and therefore, form an integral part of defense-in-depth. • The variance is never affected in a risk significant fire scenario and internal fire area separation is adequate. No additional Echelon 3 attributes are necessary to maintain defense-in-depth for defense-in-depth. • There are no significant modeling differences between the Fire PRA and nuclear safety capability assessment (i.e., due to different success criteria, end states, etc.) that are contributing to reduce core damage frequency.
Openings in the fire area barrier are rated or have been evaluated as adequate for the hazard.	Yes	No	
Supplemental barriers (e.g., ERFBS, cable tray covers, etc.)	Yes	No	
Fire rated cable	No	No	
Guidance provided to operations personnel detailing the required success path(s) including recovery actions to achieve nuclear safety performance criteria.	No	No	

As a result of the defense-in-depth evaluations, the following recovery actions were added to maintain the philosophy of defense-in-depth.

Table PRA-12-3 – Defense-in-Depth Actions

Fire Area	Component	Component Description	Defense-in-Depth Action	VFDR
CB-A	EE-CB-4160G-SWP1B	BRKR F/ SWP B	Remove control power fuses and close the SWP1B breaker as required.	CBA-02
CB-A	SW-MOV-37MV	SW P CROSSTIE	Open breaker 7A at MCC-Y Close 37MV via handwheel.	CBA-02
CB-A	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	CBA-02
CB-A	SW-STNR-B	SW STNR B	Manually open SW-V-194.	CBA-05
CB-D	CRD-SOV-SO31A	SDV VENT & DR PILOT V SO-31A	Close IA-V-16. Remove pipe plug and open IA-V-26.	CBD-08
CB-D	CRD-SOV-SO31B	SDV VENT & DR PILOT V SO-31B	Close IA-V-16. Remove pipe plug and open IA-V-26.	CBD-08
RB-A	SW-AOV-TCV451B	REC HX B OUTLET	Open breaker 5 at the CCP1B Panel.	RBA-02
RB-A	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	RBA-03
RB-B	PC-AOV-245AV	SUPPRESSION CHAMBER EXH OUTBOARD ISO	Close IA-V-16. Remove pipe plug and open IA-V-26.	RBB-01
RB-CF	PC-MOV-231MV	DW EXH INBOARD ISO	Open breaker 2B at MCC-RA Close PC-V-510 and 231MV via handwheels.	RBCF-05
RB-CF	RHR-MOV-MO16B	RHR P B & D MIN FLOW	De-energize RHR train A logic circuit by opening breaker 6 at AA2. Operate switch from MCR as required.	RBCF-06
RB-CF	RW-AOV-AO82	DW FL DR SUMP DISCH	Lift leads at TB1207 to secure power to AO82.	RBCF-05
RB-CF	RW-AOV-AO94	DW EQUIP DR SUMP DISCH	Lift leads at TB1207 to secure power to AO94.	RBCF-05
RB-CF	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	RBCF-10

Table PRA-12-3 – Defense-in-Depth Actions				
Fire Area	**Component**	**Component Description**	**Defense-in-Depth Action**	**VFDR**
RB-DI	MS-SOV-SPV71A-PASSIVE	PILOT VALVE FOR MS-RV-71ARV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71B-PASSIVE	PILOT VALVE FOR MS-RV-71BRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71C-PASSIVE	PILOT VALVE FOR MS-RV-71CRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71D	PILOT V F/ MSRV-71DRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71E-PASSIVE	PILOT VALVE FOR MS-RV-71ERV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71F	PILOT V F/ MS-RV-71FRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71G-PASSIVE	PILOT VALVE FOR MS-RV-71GRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	MS-SOV-SPV71H-PASSIVE	PILOT VALVE FOR MS-RV-71HRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	RBDI-04
RB-DI	NBI-LT-52A	REACTOR LEVEL TO FW CONTR	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-LT-52C	REACTOR LEVEL TO FW CONTR	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-LT-59A	REACTOR WTR LEVEL WIDE RANGE T	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-LT-59C	REACTOR WTR LEVEL WIDE RANGE T	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-LT-91A	REACTOR SHROUD LEVEL T	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-LT-91C	REACTOR WTR LEVEL FUEL ZONE T	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-PT-53A	REACTOR PRESS T	Close valve NBI-V-620.	RBDI-05
RB-DI	NBI-PT-53C	REACTOR PRESS T	Close valve NBI-V-620.	RBDI-05
RB-E	SW-AOV-TCV451A	REC HX A OUTLET	Open breaker 5 at the CCP1A Panel.	RBE-03
RB-E	SW-MOV-MO89A	RHR HX A SW OUTLET	Remove control power fuses for position 8A at MCC-Q and operate MO89A using the starter.	RBE-03
RB-FN	EE-MCC-R-1A	MCC R XFER SW	At MCC-S, unlock and place breaker 7B, MCC-R EMER FEEDER to "ON". At MCC-R, press red EMERG button at compartment 1A, "MCC-R Fed from MCC-S".	RBFN-06
RB-FN	HPCI-ECCS	DUMMY COMPONENT FOR HPCI LOW RPV LEVEL/HIGH DRYWELL PRESSURE SPURIOUS INITIATION	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-FAN-GSE	HPCI GLAND SEAL EXH	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-FIC-108	P DISCH FLOW CONTR	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO14	ST SUPPLY TO TU	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO15	ST SUPPLY INBOARD ISO	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO15-Passive	ST SUPPLY INBOARD ISO	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO16-Passive	ST SUPPLY OUTBOARD ISO V	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO17	P SUCT FROM ECST	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO19	HPCI INJECT	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO20	HPCI P DISCH	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO21	HPCI-P-MP TEST BYPASS TO ECST	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO24	HPCI-P-MP TEST BYPASS REDUNDANT SHUTOFF	Operate HPCI from HPCI ASD panel.	RBFN-05

Table PRA-12-3 – Defense-in-Depth Actions				
Fire Area	**Component**	**Component Description**	**Defense-in-Depth Action**	**VFDR**
RB-FN	HPCI-MOV-MO25	HPCI-P-MP MIN FLOW BYPASS LINE ISO	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-MOV-MO58	HPCI P SUCT FROM SUPPRESSION POOL	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-P-ALOP	HPCI AUX LO P	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-P-CP	HPCI COND P	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-PI-109	P DISCH PRESS	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-PI-111	TU ST INLET PRESS	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-PI-112	TU ST EXH PRESS	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-PI-116	P SUCT PRESS	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-SI-2792	TU SI	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-FN	HPCI-TU-TURB	HPCI TU & CVL CHEST	Operate HPCI from HPCI ASD panel.	RBFN-05
RB-K	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	RBK-01
RB-K	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	RBK-01
RB-K	EE-CB-4160F-RSWP1A	BRKR F/ RHR SWBP A	Remove control power fuses and operate the RSWP1A breaker as required.	RBK-03
RB-K	SW-MOV-MO89A	RHR HX A SW OUTLET	Remove control power fuses for position 8A at MCC-Q and operate MO89A from the starter.	RBK-05
RB-M	MS-SOV-SPV71D	PILOT V F/ MSRV-71DRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2. Remove control power fuses for MS-SOV-SPV71D.	RBM-03
RB-M	MS-SOV-SPV71F	PILOT V F/ MS-RV-71FRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2. Remove control power fuses for MS-SOV-SPV71F.	RBM-03
RB-M	PC-MOV-231MV	DW EXH INBOARD ISO	Open breaker 2B at MCC-RA. Close PC-V-510 and 231MV via handwheels.	RBM-05
TB-A	EE-CB-4160DG1-EG1	BRKR F/ D GEN NU 1 OUTPUT	Remove control power fuses and close the EG1 breaker as required.	TBA-02
TB-A	EE-CB-4160F-1FA	BRKR F/ TIE TO 4160V BUS A	Remove control power fuses and open the 1FA breaker as required.	TBA-02
TB-A	EE-CB-4160F-1FS	FDR BRKR TO 4160V BUS F FROM EMERG XFMR	Remove control power fuses and operate the 1FS breaker as required.	TBA-02

Note: Refer to the response for SSD RAI 09 for discussion of the plant modification that will change existing recovery actions by eliminating the need to remove fuses and operation of MOVs using the motor starter.

SAFETY MARGIN

The methodology that was used to evaluate safety margins is described in the "NFPA 805 Task Plan for Fire Risk Evaluations," Revision 1A, dated April 2011. The methodology is summarized below.

Based on NEI 04-02, the requirements related to safety margins for the change analysis is described for each of the specific analysis types used in support of the fire risk assessment. The specific safety margin evaluation depended on the change set.

The evaluation addresses whether:

- Codes and Standards or their alternatives accepted for use by the NRC are met, and
- Safety analysis acceptance criteria in the licensing basis (e.g., FSAR, supporting analyses) are met, or provide sufficient margin to account for analysis and data uncertainty.

These evaluations can be grouped into categories. These categories are:

1. Fire Modeling
2. Plant System Performance
3. PRA Logic Model
4. Other

1. Fire Modeling

If a performance based approach is used, the margin between the parameters describing the Maximum Expected Fire Scenario (MEFS) and the Limiting Fire Scenario (LFS) and the process of judging the adequacy of that fire modeling margin is required for the overall safety margin consideration. The level of review to be performed as part of the safety margin treatment involves the integration of that margin with the potential consequences of the upset, or damage, that may occur given the LFS. The acceptability of the fire modeling margin between MEFS and LFS was judged in the context of the potential severity of the resulting plant system impact if an LFS were to occur. An LFS that causes an ISLOCA event would tend to demand a higher margin between MEFS and LFS as compared to an event that causes a degradation of long term decay heat removal.

2. Plant System Performance

The development of the fire risk assessment may involve the re-examination of plant system performance given the specific demands associated with the postulated fire event. The methods, input parameters, and acceptance criteria used in these analyses was reviewed against that used for the plant design basis events.

This subtask evaluates the plant system performance given the specific demands associated with the postulated fire event. The methods, input parameters, and acceptance criteria utilized in the risk-informed, performance-based analysis was reviewed against the plant design basis events. This evaluation determined if the safety margin established in the plant design basis events is preserved.

3. PRA Logic Model

This subtask evaluates results of the Fire PRA model to verify that the safety margins have not changed. The contribution to the CDF and LERF results of components in the cutset results was evaluated to verify that events with high contribution have reasonable failure probabilities for the scenarios of interest. This was particularly important for human error basic events. The results of each risk evaluation were evaluated against the base case fire results to determine that no single event has undue influence on the results of the change analysis. This evaluation demonstrated that the safety margin established in the PRA model is preserved and that the Fire PRA model is sufficient to treat the fire-induced core damage sequences.

4. Other (referred to as Miscellaneous in NEI 04-02)

This category addresses any other analyses not addressed above. The general requirements related to codes and standards, and acceptance criteria, provided above apply.

Example of a Typical Safety Margin Review as Contained in a Fire Safety Analysis Report and EPM Report R1906-008-001, "Defense-in-Depth and Safety Margin Review," for a Fire Area with One or More VFDRs

In accordance with NEI 04-02, Section 5.3.5.3 guidance, the maintenance of adequate safety margin is assessed by the consideration categories of analyses utilized by this FRE.

Safety margins are considered to be maintained if:

- Codes and Standards or their alternatives accepted for use by the NRC are met, and
- Safety analyses acceptance criteria in the licensing basis (e.g., USAR, supporting analyses) are met, or provides sufficient margin to account for analysis and data uncertainty.

The following summarizes the bases for ensuring the maintenance of safety margins:

- The risk-informed, performance-based processes utilized are based upon NFPA 805, 2001 edition, endorsed by the NRC in 10 CFR 50.48(c).
- The fire risk evaluation process is in accordance with NEI 04-02, Revision 2, which is endorsed by the NRC in Regulatory Guide 1.205, Revision 1.
- The Fire PRA is developed in accordance with NUREG/CR-6850, which was developed jointly between the NRC and EPRI.
- The Fire PRA has undergone an industry peer review to the quality standards of ASME/ANS RA-Sa-2009.
- The "combined analysis approach" is used during transition (NEI 04-02, Section 5.3.4.3); therefore, MEFS/LFS is not analyzed separately from the Fire PRA results.
- Fire Protection systems and features determined to be required by NFPA 805 Chapter 4 have been confirmed to meet the requirements of NFPA 805 Chapter 3, and their associated referenced codes and listings, or provided with acceptable alternatives using processes accepted for use by the NRC (i.e., FAQ 06-0008, FAQ 08-0054, and FAQ 07-0033).
- Fire modeling performed in support of the transition has been performed within the Fire PRA utilizing codes and standards developed by industry and NRC staff which have been verified and validated in authoritative publications, such as NUREG-1824, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications." In general, the fire modeling performed in support of the fire risk evaluations has been performed using

conservative methods and input parameters that are based upon NUREG/CR-6850 as documented in Section 7.2 of the detailed fire modeling calculations. While this is generally not ideal in the context of best estimate probabilistic risk analysis, it is a pragmatic approach given the current state of knowledge regarding the uncertainties related to the application of the fire modeling tools and associated input parameters for specific plant configurations.

Request: - PRA RAI-13 Fire Ignition Frequencies from Supplement 1

Section 10 of NUREG/CR-6850, Supplement 1, states that a sensitivity analysis should be performed when using the fire ignition frequencies in the Supplement as the base case instead of the fire ignition frequencies provided in Table 6-1 of NUREG/CR-6850. Please provide the results of a sensitivity analysis of the impact of using the Table 6-1 frequencies instead of the Supplement frequencies on CDF, LERF, ΔCDF, and ΔLERF for all of those bins that are characterized by an alpha that is less than or equal to one. If the sensitivity analysis indicates that the change in risk acceptance guidelines would be exceeded using the values in Table 6-1, please justify not meeting the guidelines.

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: - PRA RAI-14 Main Control Room Abandonment

Please describe how CDF and LERF are estimated in MCR abandonment scenarios. Please state if any fires outside of the MCR cause MCR abandonment because of loss of control and/or loss of control room habitability. State if "screening" values for post MCR abandonment are used (e.g., CCDP of failure to successfully switch control to the primary control station (PCS) and achieve safe shutdown of 0.1) or state if detailed human error analyses been completed for this activity. Also, please justify any screening value used. In the justification, please provide the results of the HFE quantification process, such as that described in Section 5 of NUREG-1921, "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines," which would include the following, or an analogous method:

a. *The results of the feasibility assessment of the operator action(s) associated with the HFEs, specifically addressing each of the criteria discussed in Section 4.3 of NUREG-1921.*

b. *The results of the process in Section 5.2.8 of NUREG-1921 for assigning scoping HEPs to actions associated with the use of alternate shutdown, specifically addressing the basis for the answers to each of the questions asked in the Figure 5-5 flowchart.*

c. *The results of a detailed HRA quantification, per Section 5.3 of NUREG-1921, if the screening CCDP is determined to not be bounding.*

NPPD Response:

Fires outside MCR causing MCR Abandonment

The fire response procedures are divided into two categories; (1) fire areas in which the primary control station may be moved from the MCR to Alternate Shutdown, i.e., MCR abandonment and (2) all other fire areas in which MCR remains the primary control station.

Fire Areas CB-D and RB-FN fall into the first category. Fire Area CB-D contains the MCR as well as the Computer Room, Cable Expansion Room, Cable Spreading Room, and Auxiliary Relay Room. Fires in Fire Area CB-D that occur outside of the MCR could lead to MCR abandonment from a loss of command and control. Loss of command and control for Fire Area CB-D is included in the Fire PRA and discussed in the response to PRA RAI-07.

Currently Fire Area RB-FN is an area where, given a fire, the operators may abandon the MCR. In the Fire PRA, however, no MCR abandonment was postulated for this area because no loss of command and control occurred for any of the Fire Area RB-FN fire scenarios. Note: Fire Area RB-FN will become a non-abandonment area in the post-NFPA-805 configuration, and was modeled in the Fire PRA accordingly.

All other fire areas fall into the second category and the MCR remains the primary control station. No MCR abandonment was postulated for these fire areas in the Fire PRA.

MCR Abandonment HRA

Section 5.1.3 of NUREG–1921, "*EPRI/NRC-RES, Fire Human Reliability Analysis Guidelines,*" (EPRI TR 1023001, July 2012) suggests the use of a single overall failure probability value to represent the failure of reaching safe shutdown using alternate means as described below:

> NUREG/CR-6850 suggests that the use of a single overall failure probability value to represent the failure of reaching safe shutdown using alternative means can be used if the probability value is evaluated conservatively and a proper basis is provided. It notes that this approach was used in several IPEEE submittals and that, in many cases, 0.1 was used as a point value estimate for the probability. Before crediting this approach, the analyst must have applied the criteria discussed in Section 4.3 for assessing the feasibility of the operator action(s) associated with that HFE.

Section 4.3 of NUREG-1921 describes the following feasibility assessment and considerations:

- Required actions are proceduralized or skill-of-the-craft
- Sufficient time is available to perform the required actions
- Sufficient manpower is available
- Operators are trained on the required actions
- Required tools and parts are available
- Areas where actions are required are accessible

- Necessary and sufficient cues and indications are available

These considerations have been addressed for CNS as follows.

Procedures: At CNS, control room evacuation and local safe shutdown actions are proceduralized in 5.4POST-FIRE, "*Post-Fire Operational Information,*" and 5.4FIRE-S/D, "*Fire Induced Shutdown from Outside Control Room.*"

Timing and Manpower: All actions associated with performing the relevant, required manual actions were timed during a feasibility demonstration to ensure the time available to perform the actions exceeds the time required. The feasibility evaluation consisted of a timed walk through for each action associated with the main control room evacuation procedure, and accounted for assignments to the different operators within the plant response team, and thus confirmed sufficient manpower. This feasibility validation assures that the actions can be performed by the minimum complement of plant response staffing, following the procedures and plant response strategy, within the time constraints of the fire-induced failures.

Training, Tools and Parts: Operator Continuing Training classroom courses and hands-on training (as Job Performance Measures) are conducted. Job Performance Measures are field demonstrations that walk-through the conduct of the action including any provisions needed for tools, parts, or personnel protective equipment. Job Performance Measures are trained on during initial operator licensing as well as during re-qualification training.

- Licensed operators receive training on post fire procedures and implementation of the associated recovery actions. The enabling objectives of the course are that operators can:
  - List the sections which makeup the emergency remote shutdown procedure and describe the purpose or function of each one.
  - Recognize conditions that require implementation of emergency remote shutdown and fire area response guidelines.
  - Differentiate between full alternate shutdown and partial implementation of remote shutdown procedures.
  - Identify actions necessary to stabilize plant conditions following control room evacuation.
  - Interpret the basis for steps identified in the emergency remote shutdown procedure
  - Identify the four time critical actions in the emergency remote shutdown procedure and their associated time limits
- Job Performance Measures include the tasks associated with control room Evacuation.

Tools and Keys: Emergency Procedure 5.4FIRE-S/D, "*Fire Induced Shutdown From Outside Control Room,*" divides and assigns the responsibilities of the operators through procedures. These procedures explicitly state all of the tools, including keys that will be needed in order to complete the required tasks.

Accessibility: As part of the timed walk through of the recovery actions required in the event of a control room evacuation, the accessibility of the control stations and the sites of the local actions were confirmed (including the transit paths).

Cues and Indications: As part of the recovery action feasibility assessment, all cues and indication needed to reach a safe and stable end state were verified to be available once the decision to abandon the control room has been made.

In summary, the CNS NSCA lists all of the recovery actions taken when implementing the Emergency Procedure 5.4FIRE-S/D, "*Fire Induced Shutdown From Outside Control Room.*" While there are many actions to be taken to ensure successful plant response, these local actions (defined as actions where the operators leave the main control room) are not intrinsically different from other local actions that may be performed following other accident initiators such as during a Station Blackout response. Detailed HEPs in Station Blackout scenarios are typically of the order 1E-02, and HEPs associated with a detailed evaluation of individual, local actions following control room evacuation would be of the same order. In addition to the local, manual portion of the HEP (estimated to be approximately 5E-2), the 0.1 control room evacuation HEP includes failure to diagnose the need for control room evacuation, and failure to conduct the evacuation in a timely manner. For scenarios that required control room evacuation, an HEP of 0.1 was assigned as the total probability representing failing to evacuate and establish local plant control. The 0.1 HEP was applied at CNS, and based on the information discussed above, is considered to be a reasonable estimate.

Request: - PRA RAI-15 Control Power Transformer Credit

It was recently stated at the industry fire forum that the Phenomena Identification and Ranking Table Panel (PIRT) being conducted for the circuit failure tests from the DESIREE-FIRE and CAROL-FIRE tests may be eliminating the credit for Control Power Transformers (CPTs) (about a factor 2 reduction) currently allowed by Tables 10-1 and 10-3 of NUREG/CR-6850, Vol. 2, as being invalid when estimating circuit failure probabilities. Please provide a sensitivity analysis that removes this CPT credit from the PRA and provide new results that show the impact of this potential change on CDF, LERF, ΔCDF, and ΔLERF. If the sensitivity analysis indicates that the change in risk acceptance guidelines would be exceeded after eliminating CPT credit, please justify not meeting the guidelines.

NPPD Response:

This RAI will be addressed in the 90-day response.

<u>Request</u>: - PRA RAI-16 Calculation of VFDR ΔCDF and ΔLERF

Attachment W of the LAR provides the ΔCDF and ΔLERF for the VFDRs for each of the fire areas, but the LAR does not describe either generically or specifically how ΔCDF and ΔLERF were calculated. Please describe the method(s) used to determine the changes in risk reported in the Tables in Appendix W. The description should include:

a. *A summary of PRA model additions or modifications needed to determine the reported changes in risk. If any of these model additions used data or methods not included in the fire PRA Peer Review, please describe the additions.*

b. *Identification of new operator actions (not including post MCR abandonment which are addressed elsewhere) that have been credited in the change in risk estimates. If such actions are credited, please explain how instrument failure is addressed in the HRA.*

c. *Please clarify why and how the VDFR risk estimates provided in the Fire Risk Evaluations (FRE) reports are different from the ΔCDF and ΔLERF values provided in Attachment W of the LAR for each Fire Area.*

d. *Please discuss how the FREs considered modifications, fire procedures, and RAs in the determination of risk evaluations.*

e. *LAR Table W-2 reports a negative delta risk for Fire Area RB-FN. During the audit, it was discussed that this reported Δ risk was likely in error. Please provide the revised Δ risk (CDF and LERF) for Fire Area RB-FN and any other identified corrections to Table W-2. Discuss the reason for the error in the results and whether the source of the error has potentially broader implications. If there is determined to be broader implications, please provide updated risk results where applicable.*

<u>NPPD Response</u>:

a. There were no model modifications made in determining the reported changes in risk.

b. There were no new operator actions credited in the change in risk estimates. The operator actions included were those in the post-transition Fire PRA. This is the case for both the post-transition and the compliant case.

c. There are differences, in some cases, between the FRE results and the results provided in Attachment W of the LAR.

As most of the FREs were completed before final decisions on modifications were made, some of the compliant case results and associated delta risk results vary, but overall the FRE results range from somewhat conservative to unchanged at the first decimal point, to possibly optimistic but again at the first decimal point. These impacts are insignificant given the uncertainty in results and the bias towards conservatism in the analyses. A comparison was made of the values from the final quantification against those in the FREs and the small differences noted validated the decisions made. Final risk values were used in Table 4 of the Delta Risk Calculation (NEDC 11-108, Rev. 3) to determine the risk offset and net delta CDF/LERF. As the results demonstrate, the reduction in risk as a result of modifications beyond those needed for compliance have both calculated risk benefit and engineering defense in depth benefit:

- Providing for offsite power in addition to an EDG improves defense in depth.
- Providing for incipient detection improves defense in depth.
- Providing for transient free zones improves defense in depth.
- Selective protection of equipment also provides for defense in depth.

d. Modifications, fire procedures, and RAs in the determination of risk evaluations were considered using the following methodology. The methodology for ΔCDF and ΔLERF for the VFDRs consists of the following steps:

Step 1a: The Fire PRA model was quantified for three cases; Pre-NFPA 805 Case (current as-built as-operated plant), Compliant Case, and Post-NFPA 805 Case. All cases used the same Fire PRA model. The only differences in quantification were the components and human action(s) that were considered to be failed, successful, or included an HEP.

The Pre-NFPA 805 Case quantification was based on the plant as it is designed and operated today. This included field actions in the current fire response procedures that were included in the Fire PRA model.

The Compliant Case quantification was also based on the current plant design and operation. The only differences between the pre-NFPA 805 Case and Compliant Case are that the VFDRs are set to 100 percent success for the Compliant Case (i.e., the VFRDs are eliminated).

The Post-NFPA 805 Case quantification models plant modifications (hardware and procedural) aimed at resolving selected VFDRs and models additional modifications beyond those addressing VFDRs, such as providing for the availability of offsite power in addition to the availability of an EDG, installation of incipient detection, establishing transient free zones, and other changes. The changes beyond those that are needed to address VFDRs (Changes beyond Compliance) can be applied as a "risk offset" for the remaining VFDRs that are not planned to be resolved by a modification.

The Post-NFPA 805 Case also reflects decisions made on carrying forward or eliminating RAs. Thus, Post-NFPA 805 can have fewer recovery actions than the Pre-NFPA 805 Case (current plant).

Step 1b: Using the results from the FREs for each fire area, the delta risk associated with each remaining VFDR is tabulated for delta CDF and delta LERF.

In modeling the compliant case, the VFDR was eliminated either by setting the recovery action to guaranteed success or eliminating the component failure (s) attributable to the VFDR. In addition, all VFDRs associated with a fire area were eliminated in the compliant case so as to address any potential interdependencies.

Step 2: The totals for CDF, LERF, delta CDF and delta LERF are calculated for comparison to acceptance criteria.

Step 3: The benefit of design and/or procedure changes beyond those required to resolve a VFDR are then included in the tabulation. These benefits can be used to offset the delta risk increase associated with remaining VFDRs.

Step 4: The totals for CDF, LERF, delta CDF and delta LERF considering the above beneficial changes are calculated for comparison to acceptance criteria.

Step 5: Multi-compartment scenarios are addressed so as to confirm the conclusions of the fire area specific evaluations.

The delta risk associated with the transition can be calculated as the risk calculated for the Post-NFPA 805 Case minus the risk calculated for a compliant plant (Compliant Case). This can be either a positive or negative value.

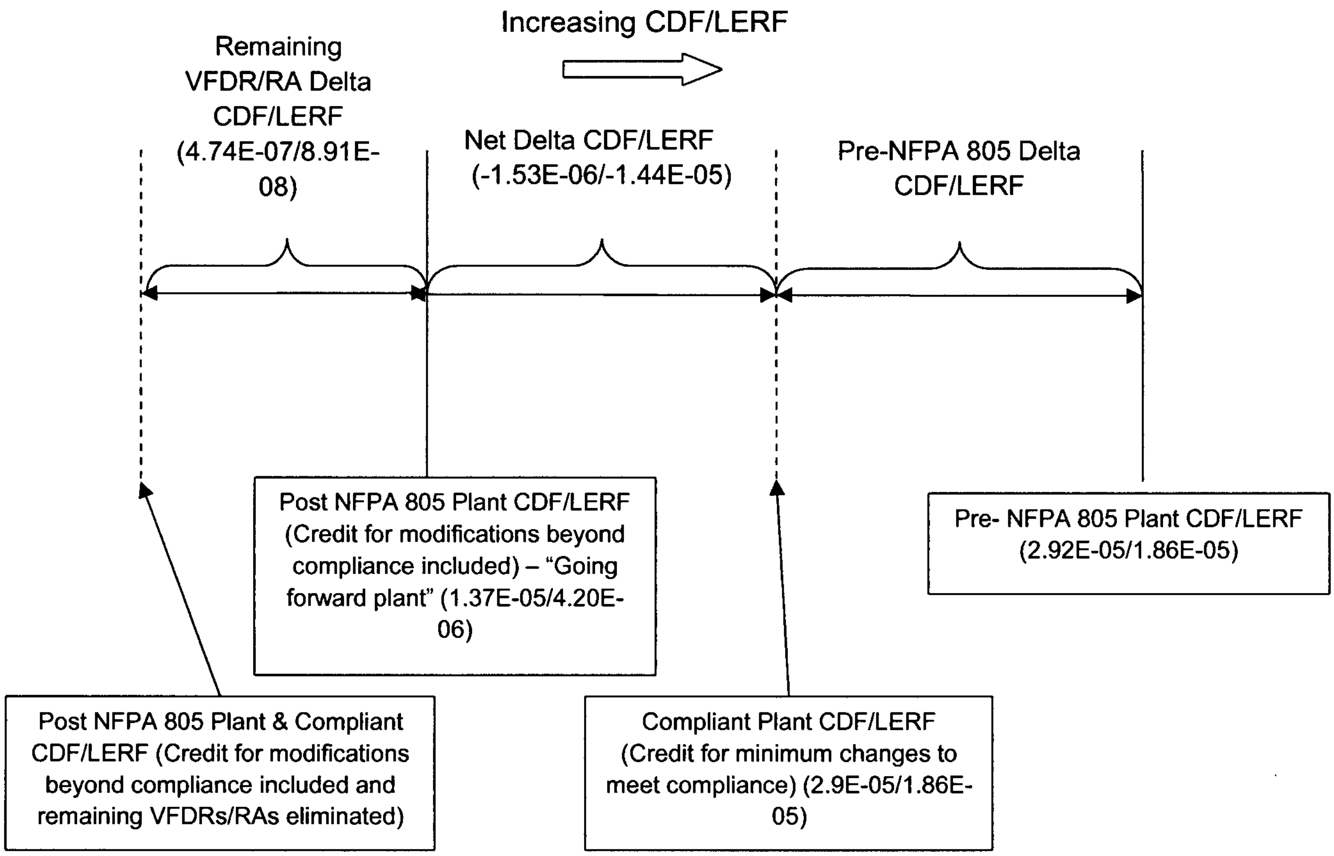
All needed information can be determined using Compliant Case results, Post-NFPA 805 Case results, and the delta risk associated with remaining VFDRs. Because the format of Table W-2 in the LAR includes the risk for remaining VFDRs, the development of the Risk Offset delta CDF/LERF and Net delta CDF/LERF are calculated as follows:

- "Net delta CDF/LERF" is "Post-NFPA 805 Case" MINUS "Compliant Case results."
- "Risk Offset delta CDF/LERF" is "Net delta CDF/LERF" MINUS "VFDR delta risk."

To ensure clarity, the following three examples show the how the Net Delta CDF/LERF values and Remaining VFDR/RA Delta CDF/LERF values are determined. Each of these examples refers to information contained in Table W-2 below.

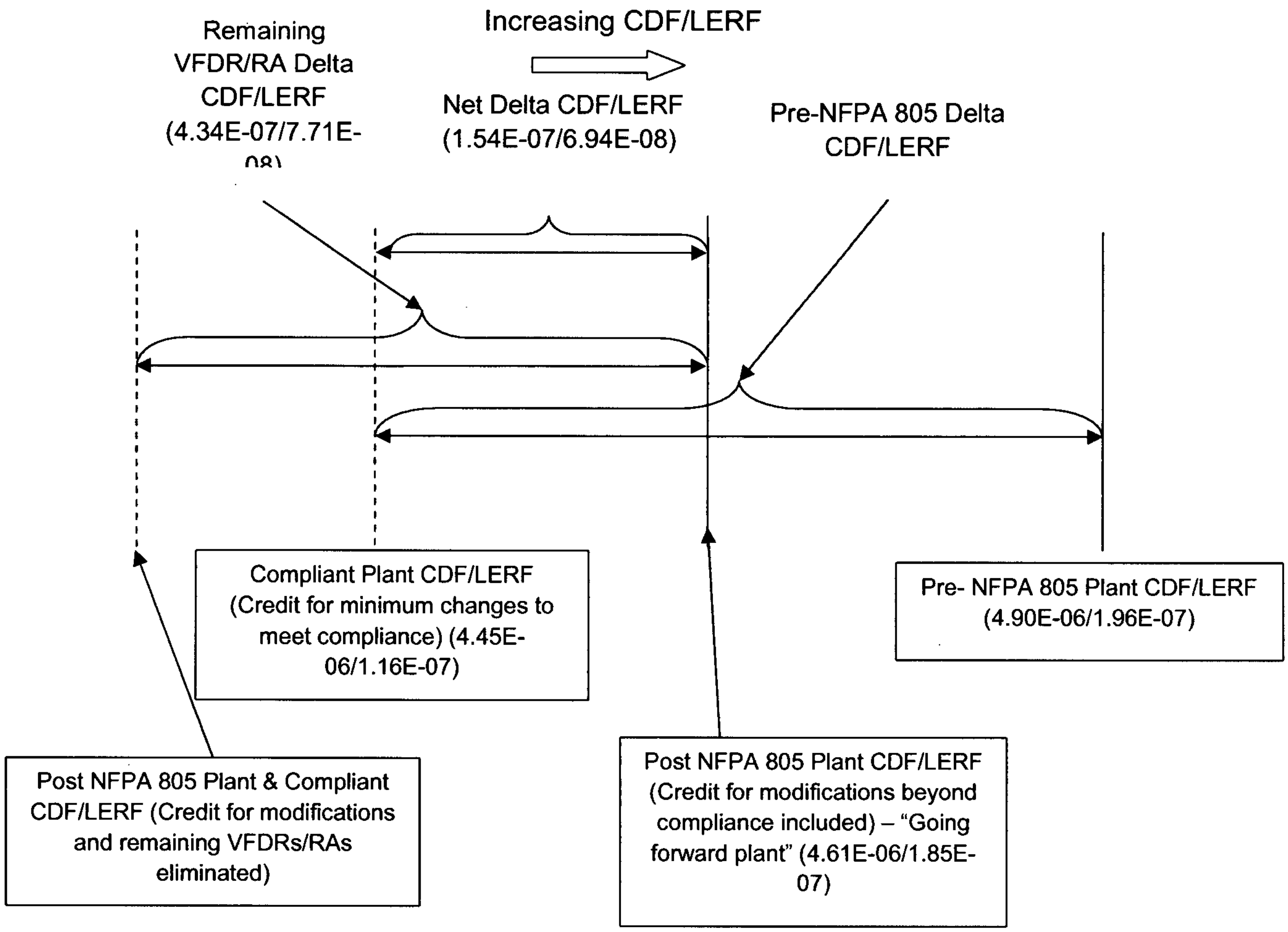
Example 1 – Risk of VFDRs/RAs completely off-set by modifications beyond compliance (Net Delta CDF/LERF are negative).

Fire Area CB-D



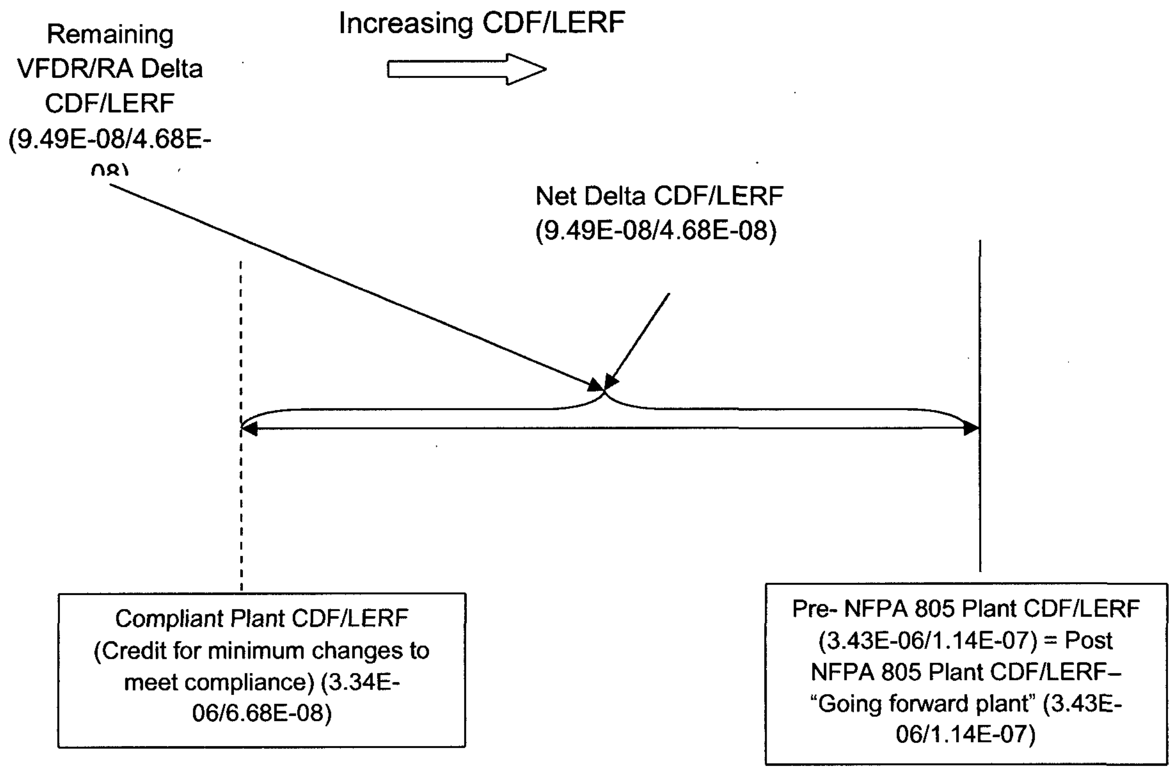
Example 2 – Risk of VFDRs/RAs partially off-set by modifications (Net Delta CDF/LERF are positive)

Fire Area CB-B



Example 3 – Risk of VFDRs/RAs not off-set by (Net Delta CDF/LERF are positive and equal the remaining VFDR/RA Delta CDF/LERF)

Fire Area CB-A-1



e. This RAI will be addressed in the 90-day response.

Request: - PRA RAI-17 RG 1.200 Rev 2 Clarifications

Please clarify if the peer reviews for both the IEPRA and FPRA considered the clarifications and qualifications from RG 1.200, Revision 2, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," March 2009 (ADAMS Accession No. ML090410014), to the ASME/ANS PRA Standard. If not, please provide a self-assessment of the PRA model for the RG 1.200 clarifications and qualifications and indicate how any identified gaps were dispositioned.

NPPD Response:

Fire PRA Peer Review

The April 2010 full scope peer review and the February 2011 follow-on focused-scope peer review of the CNS Fire PRA used the NEI 07-12 process and the ASME/ANS Combined PRA Standard (ASME/ANS RA-Sa-2009) along with the NRC clarifications provided in Regulatory Guide 1.200, Rev. 2. The Regulatory Guide 1.200, Rev. 2 considerations are documented in the peer review report associated with the CNS Fire PRA. The Fire PRA peer review is therefore consistent with the clarifications in RG 1.200, Rev 2.

Internal Event Peer Review

The Internal Events PRA peer review occurred in May 2008. The peer review used the NEI 05-04 process and the ASME PRA Standard (ASME-RA-Sc-2007) along with the NRC clarifications provided in Regulatory Guide 1.200, Rev. 1. As such, the Internal Events PRA was peer reviewed against the clarifications and qualifications presented in the latest revision of RG 1.200 available at the time of the review. In general, the changes to the internal events high level and supporting requirements from RG 1.200 revision 1 to revision 2 were minor, and included the following:

1. Incorporation into the standard NRC issues identified in RG 1.200 Revision 1.
2. Renumber of the Standard High Level Requirements (HLR) and SRs to remove deleted SRs and SRs ending with a letter (e.g., SR QU-A2a).
3. Changes in the cross-references updated to the new tables.
4. Corrections of Typos, grammar or wording.

As the Regulatory Guide 1.200, Rev. 2 clarifications and qualifications have minimal impact; a self-assessment of the Internal Events PRA against the RG 1.200, Rev 2 clarifications and qualifications has not been completed.

Request: - PRA RAI-18 Wrapped or Embedded Cables

Please identify if any VFDRs in the LAR involved performance-based evaluations of wrapped or embedded cables. If applicable, please describe how wrapped or embedded cables were modeled in the Fire PRA including assumptions and insights on how the PRA modeling of these cables contributes to the VFDR delta-risk evaluations.

NPPD Response:

None of the VFDRs in the LAR involved performance-based evaluations of wrapped or embedded cables.

Wrapped or embedded cables were credited in the Fire PRA to protect cables from fire damage, commensurate with the fire barrier rating (e.g., 1 hour, etc.) of the wrap or embedment. The wrapped or embedded cables were subsequently considered protected from fire damage and did not contribute to risk evaluations. Calculation NEDC 10-021 documents that justification of the fire resistance ratings provided by the embedded conduit, concrete cable enclosures, and Promat-H board.

Request: - PRA RAI-19 Implementation Item Impact on Risk Estimates

Please identify any plant modifications (implementation items) in Attachment S of the LAR that have not been completed but which have been credited directly or indirectly in the change-in-risk estimates provided in Attachment W. When the affects of a plant modification has been included in the PRA before the modification has been completed, the models and values used in the PRA are necessarily estimates based on current plans. The as-built facility after the modification is completed may be different than the plans. Please add an implementation item that, upon completion of all PRA credited implementation items, verifies the validity of the reported change-in-risk. This item should include a plan of action should the as-built change-in-risk exceed the estimates reported in the LAR.

NPPD Response:

The CNS NFPA 805 LAR, Table S-2, details the committed Plant Modifications that have not been completed, but have been credited in the change-in-risk estimates provided in Attachment W. An Implementation Item has been added (S-3.30) to verify the validity of the reported change-in-risk, and will include a plan of action should the as-built change-in-risk exceed the estimates reported in the LAR. (See Attachment 2, Change 9).

Request: - PRA RAI-20 Model Changes and Focused Scope Reviews Since Full Peer Review

Please identify any changes made to the IEPRA or FPRA since the last full-scope peer review of each of these PRA models that are consistent with the definition of a "PRA upgrade" in ASME/ANS-RA-Sa-2009, "Standard for Level 1/Large Early Release Frequency for Nuclear Power Plant Applications," as endorsed by RG 1.200. Also, please address the following:

a. *If any changes are characterized as a PRA upgrade, please indicate if a focused-scope peer review was performed for these changes consistent with the guidance in ASME/ANS-RA-Sa-2009, as endorsed by RG 1.200, and describe any findings from that focused-scope peer review and the resolution of these findings.*

b. *If a focused-scope peer review has not been performed for changes characterized as a PRA upgrade, please describe what actions will be implemented to address this review deficiency.*

NPPD Response:

The IEPRA model has undergone revision since the May 2008 peer review to address peer review comments and to reflect plant modifications such as portable diesel generator for powering DC chargers, procedure improvements, and supplemental diesel generator installation. All of the revisions were completed to reflect plant changes and did not involve new methods or modeling approaches, as defined in the ASME/ANS PRA Standard.

Fire PRA

The only changes made to the Fire PRA model since the peer review are those associated with F&Os generated during the peer review and further refinements. The changes made to the model, including both changes made to address F&Os and model refinements, used the same methodologies that were used for development of the Fire PRA prior to peer review. No additional components were added. Detailed human reliability analysis was performed for some human error probabilities that had been set to screening values. Some additional fire modeling was performed.

These changes to the Fire PRA model subsequent to the peer review do not constitute a PRA Upgrade as defined in the AMSE/ANS PRA Standard.

Request: - PRA RAI-21 Fire Barriers

A number of dampers are blocked open and non-rated fire barriers exist.

a. *Please state if these have been considered in the FPRA and FREs. In performing FREs, please state what assumptions are made for (1) non-rated fire barriers and (2) blocked open fire dampers.*

b. *Please state if all such dampers and fire barriers have been considered in the FPRA. Include a discussion on fire modeling and conclusions, as well as application of NUREG/CR-6850 guidance on multi-compartment analysis. Specifically, please discuss the following:*

    i. *Both RPS Rooms are connected by ventilation without fire-rated dampers and non-rated barriers according to EE 09-040. Please state if this is considered in the FPRA and FREs.*

    ii. *FA RB-J has non-rated fire barriers for critical switchgear rooms. Please state how this is considered in the FPRA and FREs.*

NPPD Response:

a. Fire compartment/fire zone boundaries and features, including non-rated features and blocked open dampers, have been assessed in the Plant Partitioning and Detailed Fire Modeling tasks to determine if the non-rated features are adequate to preclude fire spread to adjacent fire zones/compartments and impact to Fire PRA credited targets in the adjacent area. Non-rated elements were only credited as compartment boundaries provided that they have been included in the fire protection program and justified as acceptable in engineering equivalency evaluations. The Multi-Compartment Analysis assessed the potential failure of fire dampers and also the spread of fire/smoke between fire zones via interconnected ductwork.

b. Fire compartment barriers and features, including doors, dampers, and penetrations, have been assessed in the Plant Partitioning, Detailed Fire Modeling, and Multi-Compartment Analysis tasks. Non-rated barrier elements were only credited as compartment boundaries provided that they have been included in the fire protection program and justified as acceptable in engineering equivalency evaluations.

These boundaries were assessed during plant partitioning and detailed fire modeling walkdowns to confirm that the barriers are substantial enough to preclude fire spread to adjacent fire zones within the fire compartment. These plant walkdowns considered the construction of the barrier (i.e., concrete) any potential openings or unrated/unprotected features with respect to the fire hazards and combustibles in the fire zone. Based on the nature and configuration of the fire hazards and combustibles in the fire zone, the barriers were assessed qualitatively to determine if they were robust enough to prevent target damage on the other side of the barrier.

Engineering Evaluation EE 09-040 assessed non-rated fire barrier features of the RPS Rooms related to ventilation ductwork without fire dampers and minor door code deviations. The NFPA 80 deviations concern astragals cut for clearance and less than ¾" overlap, reduced latch throw engagement and lack of coordination device. These doors are 1½ hour fire rated doors and are adequate for the detailed fire scenarios postulated for the RPS Rooms to prevent failure of Fire PRA targets in the adjacent fire compartment. The ventilation ductwork is provided with fire rated seal material between the ductwork and the barrier. The NFPA recognizes that a metal duct does provide some degree of fire resistance. The NFPA states the following in the Fire Protection Handbook:

> In the gages commonly used, some sheet metal ducts may protect an opening in a building construction assembly for up to one hour, if properly hung and fire stopped. Therefore, ducts passing through fire barriers having a rating of up to one hour of fire resistance can possibly present no extra ordinary hazard.

This indicates that although a fire rated damper has not been provided in the openings, the mere presence of the ventilation ductwork can be credited in providing fire resistance capability. Based on the ignition sources modeled in the RPS Rooms and lack of significant secondary combustibles (i.e., no cable trays), the resistance provided by the ductwork is adequate to prevent failure of Fire PRA credited targets in the adjacent fire compartment.

Engineering Evaluation EE 09-031 assessed non-rated fire barrier features of the Critical Switchgear Rooms related to ventilation ductwork without fire dampers, unsealed penetrations, and minor door deviations. The ductwork within the Critical Switchgear

Rooms (FA RB-J and RB-K) is wrapped with a 1½ hour rated fire retardant material and the ductwork in the adjacent corridor is located above the ceiling tile with no ventilation openings. The exhaust duct contains a smoke detector which stops the supply fan. The supply and exhaust air registers within both Critical Switchgear Rooms are provided with 1½ hour fire rated dampers.

The NFPA 80 door deviations for the Critical Switchgear Rooms are related to a conduit penetration, excessive door to frame clearance, astragal modification, unlabeled glass window and non-UL listed gasket material. These doors are 1½ hour fire rated doors and are adequate for the detailed fire scenarios postulated for the Critical Switchgear Rooms to prevent failure of Fire PRA targets in the adjacent fire compartment. The unsealed conduit penetrations are wrapped in the fire retardant material protecting the ventilation ductwork.

The Multi-Compartment Analysis assessed the potential failure of fire dampers and also the spread of fire/smoke between fire zones via interconnected ductwork. Failure of fire doors and penetrations were also included in the Multi-Compartment Analysis.

Request: - PRA RAI-22 MSO Combinations

The LAR page F-4 states "For cases where the pre-transition MSO combinations did not meet the deterministic compliance, the MSO combinations were added to the scope of the RI-PB [risk-informed, performance-based] change evaluations." Please elaborate on this statement. Please discuss the risk significance of the MSOs identified, and the contributing reasons for the observed significance.

NPPD Response:

MSO combinations were added to the NSCA and FPRA models as applicable to CNS and are discussed in NEDC 09-080. MSO combinations were reviewed for their impact on deterministic compliance (i.e., fire area by fire area reviews to determine if the same fire could result in potential MSO combinations). As part of the process, VFDRs were created where the deterministic requirements of NFPA 805 Section 4.2.3 were not met. These VFDRs were addressed by demonstrating compliance with the performance-based approach of Section 4.2.4 of NFPA 805.

Spurious operations, both single and multiple, have an impact on the overall fire risk and are included in the NSCA and Fire PRA models. Fire-induced spurious operations can lead to initiating events and can also affect mitigation of initiating events. Given the potential significance of fire-induced MSOs, an expert panel was held at CNS to systematically search for and identify potential MSOs. Logic modifications were made in the Fire PRA and NSCA to incorporate potential fire-induced MSO-related failures not already included. While difficult to quantify the impact of MSOs (since the PRA results contain single spurious as well as multiple spurious events), the contribution of fire-induced MSOs is considered to be conservative in the CNS Fire PRA due to the industry's knowledge of the conditional probability and duration of fire-induced spurious operations. Nonetheless, fire-induced MSOs are included in the Fire PRA and NSCA models, and their associated risk is included in the quantification of fire scenarios, of total calculated plant fire risk, and evaluation of VFDRs. The VFDRs are identified in LAR Table B-3 in Attachment C and a summary of the Fire PRA results is provided in Attachment W.

Request: PRA RAI-23 SSC Modeling

Please describe any systems, structures, and components (SSC) boundaries, failure modes, or success criteria that have been changed from the IEPRA model for the FPRA model.

NPPD Response:

This RAI is similar to PRA RAI-02 j. Components added to the FPRA model are provided in the table below. Differences from the Internal Events PRA or if the component is instrumentation are given in the columns to the right in the table.

In general, there were three cases discussed in the table; (1) a new component was added, (2) a new failure mode for an existing component was added, and (3) a subcomponent was added that was included within the boundaries of an existing component.

An example of the first case, are valves RCIC-MOV-MO15 and MO16. These are the containment isolation valves for the steam lines going to the RCIC turbine. These valves are not included in the Internal Events PRA. Spurious closure of these valves due to a fire was added for the Fire PRA.

For the second case, consider flow diversion of RHR Train A to the Suppression Pool instead of injecting into the Reactor Pressure Vessel. There are two normally closed valves that can spuriously open. Valve RHR-MOV-MO38A is not included in the Internal Events PRA and is another example of the first case. Valve RHR-MOV-MO39A is, however, included in the internal events model, but with a fails-to-open failure mode. A spuriously opens due to fire was added for the Fire PRA and is an example of the second case.

A good example of the third case is the large pumps that receive power from 4160 VAC buses. The pump breakers are included within the pump boundary for the Internal Events PRA. For the Fire PRA, the breakers were modeled as separate subcomponents so that they could be recovered by manual actions at the bus.

The Internal Events PRA model success criteria was not changed for the Fire PRA model with the exception of RHR Service Water pump "windmilling," Windmilling is discussed in the response to PRA RAI-24.

The response to PRA RAI-02j provides a list of the criteria for adding basic events for components / failure modes not included in the Internal Events PRA.

Components Added to the Fire PRA Model

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
ADS-K11-SW-DIV1	CIRCUIT CONNECTION FOR THE ADS POWER CROSS TIE	FIRE-IE0605SPM				Y	Electric power distribution
ADS-K11-SW-DIV2	CIRCUIT CONNECTION FOR THE ADS POWER CROSS TIE	FIRE-IE0606SPM				Y	Electric power distribution
CM-AM-681	EMERGENCY CONDENSATE TANK HIGH LEVEL ALARM	FIRE-IE0601SPM	Y				
CM-ES-6	CONDENSATE MAKE-UP LOOPS 1 AND 2 POWER SUPPLY	FIRE-IE0602SPM		Y			
CM-LI-681A	EMERGENCY CONDENSATE STORAGE TANK 1A LEVEL INDICATOR	FIRE-IE0711GK	Y				
CM-LI-681B	EMERGENCY CONDENSATE STORAGE TANK 1B LEVEL INDICATOR	FIRE-IE0712GK	Y				
CM-LT-681A	EMERGENCY CONDENSATE STORAGE TANK 1A LEVEL	CM-LIT-FH-681A		Y			

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
CM-LT-681B	EMERGENCY CONDENSATE STORAGE TANK 1B LEVEL	CM-LIT-FH-681B		Y			
CRD-SOV-SO140A	TRIP SYS A BACKUP SCRAM VLV SO-140A	CRD-SOV-CC-SO140A		Y			
CRD-SOV-SO140B	TRIP SYS B BACKUP SCRAM VLV SO-140B	CRD-SOV-CC-SO140B		Y			
CRD-SOV-SO31A	SCRAM DISCH VOL VENT AND DRAIN PILOT VLV SO31A	CRD-SOV-FI-SO31A		Y			
CRD-SOV-SO31B	SCRAM DISCH VOL VENT AND DRAIN PILOT VLV SO31B	CRD-SOV-FI-SO31B		Y			
CS-CV-18CV	CSS A TESTABLE CHECK	LCS-CKV-LK-18CV			Y		
CS-CV-19CV	CSS B TESTABLE CHECK	LCS-CKV-LK-19CV			Y		
CS-ES-52A	POWER SUPPLY FOR CSP1A FLOW AND PRESS INSTRUMENTS	FIRE-IE0403SPM				Y	CS-MOV-MO5A
CS-ES-52B	POWER SUPPLY FOR CSP1B FLOW AND PRESS INSTRUMENTS	FIRE-IE0405SPM				Y	CS-MOV-MO5B
CS-FT-40A	PUMP A DISCHARGE FLOW	FIRE-IE0404SPM				Y	CS-MOV-MO5A

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
CS-FT-40B	PUMP B DISCHARGE FLOW	FIRE-IE0406SPM				Y	CS-MOV-MO5B
CS-MOV-MO11A	CORE SPRAY SYSTEM A INJECTION THROTTLE	LCS-MOV-SC-MO11A			Y		
CS-MOV-MO11B	CORE SPRAY SYSTEM B INJECTION OUTBOARD	LCS-MOV-SC-MO11B			Y		
CS-MOV-MO12A	CORE SPRAY SYSTEM A INJECTION BLOCK - PASSIVE	LCS-MOV-SO-MO12A			Y		
CS-MOV-MO12B	CORE SPRAY SYSTEM B INJECTION BLOCK - PASSIVE	LCS-MOV-SO-MO12B			Y		
CS-MOV-MO26A	CORE SPRAY PUMP A TEST LINE ISOLATION - PASSIVE	LCS-MOV-SO-MO26A			Y		
CS-MOV-MO26B	CORE SPRAY PUMP B TEST LINE ISOLATION	LCS-MOV-SO-MO26B			Y		
DGDO-LS-LCH1	DIESEL OIL DAY TANK NO 1 HIGH LEVEL PUMP STOP	EAC-LIS-FH-LCH1				Y	EDG 1

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
DGDO-LS-LCH2	DIESEL OIL DAY TANK NO 2 HIGH LEVEL PUMP STOP	EAC-LIS-FH-LCH2				Y	EDG 2
DGDO-LS-LCL1	DIESEL OIL DAY TANK NO 1 LOW LEVEL & PP START	FIRE-IE0370YV				Y	EDG 1
DGDO-LS-LCL2	DIESEL OIL DAY TANK NO 2 LOW LEVEL & PP START	FIRE-IE0371YV				Y	EDG 2
DGDO-P-DOTA	DIESEL FUEL OIL TRANSFER PUMP A	FIRE-IE0372YV				Y	EDG 1 and EDG 2
DGDO-P-DOTB	DIESEL FUEL OIL TRANSFER PUMP B	FIRE-IE0373YV				Y	EDG 1 and EDG 2
DGDO-P-FB1	DIESEL FUEL OIL BOOSTER PUMP 1	FIRE-IE0374YV				Y	EDG 1
DGDO-P-FB2	DIESEL FUEL OIL BOOSTER PUMP 2	FIRE-IE0375YV				Y	EDG 2
DGDO-SOV-SSV5028	DIESEL FUEL OIL DAY TANK SHUTOFF VALVE	EAC-SOV-SC-SSV5028				Y	EDG 1
DGDO-SOV-SSV5029	DIESEL FUEL OIL DAY TANK SHUTOFF VALVE	EAC-SOV-SC-SSV5029				Y	EDG 2
DG-GEN-DG1	DG1 GENERATOR	EAC-DGN-SS-DG1			Y		
DG-GEN-DG2	DG2 GENERATOR	EAC-DGN-SS-DG2			Y		
DGSA-SOV-SPV1	DG1 LEFT BANK AIR START PILOT VALVE	FIRE-IE0380YV				Y	EDG 1

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
DGSA-SOV-SPV2	DG2 LEFT BANK AIR START PILOT VALVE	FIRE-IE0381YV				Y	EDG 2
DGSA-SOV-SPV3	DG1 RIGHT BANK AIR START PILOT VALVE	FIRE-IE0382YV				Y	EDG 1
DGSA-SOV-SPV4	DG2 RIGHT BANK AIR START PILOT VALVE	FIRE-IE0383YV				Y	EDG 2
EE-CB-4160A-1AE	EE-CB-4160-1AE OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-1AE			Y		
EE-CB-4160A-1AF	EE-CB-4160A-1AF OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-1AF			Y		
EE-CB-4160A-CBP1A	EE-CB-4160A-CBP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-CBP1A				Y	4160 VAC Bus 1A
EE-CB-4160A-CP1A	EE-CB-4160A-CP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-CP1A				Y	4160 VAC Bus 1A
EE-CB-4160A-CWP1A	EE-CB-4160A-CWP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-CWP1A				Y	4160 VAC Bus 1A

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160A-CWP1B	EE-CB-4160A-CWP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-CWP1B				Y	4160 VAC Bus 1A
EE-CB-4160A-SS1A	EE-CB-4160A-SS1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-SS1A			Y		
EE-CB-4160A-SS1C	EE-CB-4160A-SS1C OVERCURRENT PROTECTION (TRIPS BUS 4160 1A)	EAC-CRB-FI-SS1C				Y	4160 VAC Bus 1A
EE-CB-4160B-1BE	EE-CB-4160B-1BE OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-1BE			Y		
EE-CB-4160B-1BG	EE-CB-4160B-1BG OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-1BG			Y		
EE-CB-4160B-CBP1B	EE-CB-4160B-CBP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-CBP1B				Y	4160 VAC Bus 1B
EE-CB-4160B-CP1B	EE-CB-4160B-CP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-CP1B				Y	4160 VAC Bus 1B

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160B-CWP1C	EE-CB-4160B-CWP1C OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-CWP1C				Y	4160 VAC Bus 1B
EE-CB-4160B-CWP1D	EE-CB-4160B-CWP1D OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-CWP1D				Y	4160 VAC Bus 1B
EE-CB-4160B-SS1B	EE-CB-4160B-SS1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-SS1B			Y		
EE-CB-4160B-SS1D	EE-CB-4160B-SS1D OVERCURRENT PROTECTION (TRIPS BUS 4160 1B)	EAC-CRB-FI-SS1D				Y	4160 VAC Bus 1B
EE-CB-4160C-1CS	4160V BUS C FDR BRKR FROM SU XFMR	EAC-CRB-SC-1CS			Y		
EE-CB-4160D-1DS	4160V BUS D FDR BRKR FROM SU XFMR	EAC-CRB-SC-1DS			Y		
EE-CB-4160DG1-EG1	BREAKER FOR DIESEL GENERATOR NU 1 OUTPUT	EAC-CRB-SC-EG1			Y		
EE-CB-4160DG2-EG2	BREAKER FOR DIESEL GENERATOR NU 2 OUTPUT	EAC-CRB-SC-EG2			Y		

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160F-1FS	FEEDER BREAKER TO 4160V BUS F FROM EMERGENCY TRANSFORMER	EAC-CRB-SC-1FS			Y		
EE-CB-4160F-CSP1A	BREAKER FOR CORE SPRAY PUMP A	EAC-CRB-SC-CSP1A				Y	CS-P-A
EE-CB-4160F-CSP1A	EE-CB-4160F-CSP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-CSP1A			Y		
EE-CB-4160F-RHRP1A	BREAKER FOR RESIDUAL HEAT REMOVAL PUMP A	EAC-CRB-SC-RHRP1A				Y	RHR-P-A
EE-CB-4160F-RHRP1A	EE-CB-4160F-RHRP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-RHRP1A			Y		
EE-CB-4160F-RHRP1B	BREAKER FOR RESIDUAL HEAT REMOVAL PUMP B	EAC-CRB-SC-RHRP1B					RHR-P-B
EE-CB-4160F-RHRP1B	EE-CB-4160F-RHRP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-RHRP1B			Y		
EE-CB-4160F-RSWP1A	BREAKER FOR RHR SERVICE WATER BOOSTER PUMP A	EAC-CRB-SC-RSWP1A				Y	SW-P-BPA

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160F-RSWP1A	EE-CB-4160F-RSWP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-RSWP1A			Y		
EE-CB-4160F-RSWP1C	BREAKER FOR RHR SERVICE WATER BOOSTER PUMP C	EAC-CRB-SC-RSWP1C				Y	SW-P-BPC
EE-CB-4160F-RSWP1C	EE-CB-4160F-RSWP1C OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-RSWP1C			Y		
EE-CB-4160F-SS1F	EE-CB-4160F-SS1F OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-SS1F			Y		
EE-CB-4160F-SWP1A	BREAKER FOR STATION SERVICE WATER PUMP A	EAC-CRB-SC-SWP1A				Y	SW-P-A
EE-CB-4160F-SWP1A	EE-CB-4160F-SWP1A OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-SWP1A			Y		
EE-CB-4160F-SWP1C	BREAKER FOR STATION SERVICE WATER PUMP C	EAC-CRB-SC-SWP1C				Y	SW-P-C

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160F-SWP1C	EE-CB-4160F-SWP1C OVERCURRENT PROTECTION (TRIPS BUS 4160 1F)	EAC-CRB-FI-SWP1C			Y		
EE-CB-4160G-1GS	4160V BUS G FEEDER BREAKER FROM EMERGENCY TRANSFORMER	EAC-CRB-SC-1GS			Y		
EE-CB-4160G-CSP1B	BREAKER FOR CORE SPRAY PUMP B	EAC-CRB-SC-CSP1B				Y	CS-P-B
EE-CB-4160G-CSP1B	EE-CB-4160G-CSP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-CSP1B			Y		
EE-CB-4160G-RHRP1C	BREAKER FOR RESIDUAL HEAT REMOVAL PUMP C	EAC-CRB-SC-RHRP1C				Y	RHR-P-C
EE-CB-4160G-RHRP1C	EE-CB-4160G-RHRP1C OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-RHRP1C			Y		
EE-CB-4160G-RHRP1D	BREAKER FOR RESIDUAL HEAT REMOVAL PUMP D	EAC-CRB-SC-RHRP1D				Y	RHR-P-D

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160G-RHRP1D	EE-CB-4160G-RHRP1D OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-RHRP1D			Y		
EE-CB-4160G-RSWP1B	BREAKER FOR RHR SERVICE WATER BOOSTER PUMP B	EAC-CRB-SC-RSWP1B				Y	SW-P-BPB
EE-CB-4160G-RSWP1B	EE-CB-4160G-RSWP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-RSWP1B			Y		
EE-CB-4160G-RSWP1D	BREAKER FOR RHR SERVICE WATER BOOSTER PUMP D	EAC-CRB-SC-RSWP1D				Y	SW-P-BPD
EE-CB-4160G-RSWP1D	EE-CB-4160G-RSWP1D OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-RSWP1D			Y		
EE-CB-4160G-SS1G	EE-CB-4160G-SS1G OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-SS1G			Y		
EE-CB-4160G-SWP1B	BREAKER FOR STATION SERVICE WATER PUMP B	EAC-CRB-SC-SWP1B				Y	SW-P-B

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-CB-4160G-SWP1B	EE-CB-4160G-SWP1B OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-SWP1B			Y		
EE-CB-4160G-SWP1D	BREAKER FOR STATION SERVICE WATER PUMP D	EAC-CRB-SC-SWP1D				Y	SW-P-D
EE-CB-4160G-SWP1D	EE-CB-4160G-SWP1D OVERCURRENT PROTECTION (TRIPS BUS 4160 1G)	EAC-CRB-FI-SWP1D			Y		
EE-CB-480A,(MCC-B)	BREAKER FOR FEEDER TO MCC-B	EAC-CRB-SO-480AMCCB		Y			
EE-MCC-B	MOTOR CONTROL CENTER MCC-B	FIRE-IE0474SPM		Y			
EE-MCC-CB	MOTOR CONTROL CENTER MCC-CB	FIRE-IE0514SPM		Y			
EE-CB-480B,(MCC-G)	BREAKER FOR FEEDER TO MCC-G	EAC-CRB-SO-480BMCCG		Y			
EE-MCC-G	MOTOR CONTROL CENTER MCC-G	FIRE-IE0475SPM		Y			
EE-MCC-R-1A	MCC-R TRANSFER SWITCH (FROM MCC K OR S TO MCC R)	FIRE-IE0663SPM				Y	MCC R (EE-MCC-R)
EE-MCC-R-1A-EMERGENCY	MCC-R TRANSFER SWITCH - EMERGEMCNY (MCC S TO MCC R)	FIRE-IE0664SPM				Y	MCC R (EE-MCC-R)

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-MCC-R-1A-NORMAL	MCC-R TRANSFER SWITCH - NORMAL (MCC K TO MCC R)	FIRE-IE0662SPM				Y	MCC R (EE-MCC-R)
EE-MCC-RA-1A	MCC-R TRANSFER SWITCH (FROM MCC K OR S TO MCC RA)	FIRE-IE0665SPM				Y	MCC RA (EE-MCC-RA)
EE-MCC-RA-1A-EMERGENCY	MCC-R TRANSFER SWITCH - EMERGENCY (MCC S TO MCC RA)	FIRE-IE0666SPM				Y	MCC RA (EE-MCC-RA)
EE-MCC-RA-1A-NORMAL	MCC-R TRANSFER SWITCH - NORMAL (MCC K TO MCC RA)	FIRE-IE0667SPM				Y	MCC RA (EE-MCC-RA)
EE-PNL-CPCADB	CRITICAL CONTROL PANEL CP-CAD-1B	FIRE-IE0533SPM		Y			
EE-PNL-RPSPP1A-ALT	ALTERNATE POWER SUPPLY FROM DIST PNL CDP1B TO RX PROT SYSTEM POWER PANEL RPSPP1A	EAC-DPL-LP-RPS1A-A-FIRE				Y	Panel RPSPP1A (EE-PNL-RPSPP1A)
EE-PNL-RPSPP1A-NORM	NORMAL POWER SUPPLY FROM MG SET 1A TO RX PROT SYSTEM POWER PANEL RPSPP1A	EAC-DPL-LP-RPS1A-N-FIRE				Y	Panel RPSPP1A (EE-PNL-RPSPP1A)

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-PNL-RPSPP1B-ALT	ALTERNATE POWER SUPPLY FROM DIST PNL CDP1A TO RX PROT SYSTEM POWER PANEL RPSPP1B	EAC-DPL-LP-RPS1B-A-FIRE				Y	Panel RPSPP1B (EE-PNL-RPSPP1B)
EE-PNL-RPSPP1B-NORM	NORMAL POWER SUPPLY FROM MG SET 1B TO RX PROT SYSTEM POWER PANEL RPSPP1B	EAC-DPL-LP-RPS1B-N-FIRE				Y	Panel RPSPP1B (EE-PNL-RPSPP1B)
EE-SW-125HPCI	TRANSFER SWITCH FOR 125VDC HPCI STARTER RACK	FIRE-IE0552SPM				Y	Starter Rack 125HPCI (EE-STRR-125HPCI)
EE-SW-125HPCI-EMERGENCY	TRANSFER SWITCH FOR 125VDC HPCI STARTER RACK - ALTERNATE POWER (DIV I)	FIRE-IE0636SPM				Y	Starter Rack 125HPCI (EE-STRR-125HPCI)
EE-SW-125HPCI-NORMAL	TRANSFER SWITCH FOR 125VDC HPCI STARTER RACK - NORMAL POWER (DIV II)	FIRE-IE0637SPM				Y	Starter Rack 125HPCI (EE-STRR-125HPCI)
EE-SW-125RCIC	TRANSFER SWITCH FOR 125VDC RCIC STARTER	FIRE-IE0553SPM				Y	Starter Rack 125HPCI (EE-STRR-125RCIC)

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-SW-125RCIC-EMERGENCY	TRANSFER SWITCH FOR 125VDC RCIC STARTER RACK - ALTERNATE POWER (DIV II)	FIRE-IE0546SPM				Y	Starter Rack 125HPCI (EE-STRR-125RCIC)
EE-SW-125RCIC-NORMAL	TRANSFER SWITCH FOR 125VDC RCIC STARTER RACK - NORMAL POWER (DIV I)	FIRE-IE0545SPM				Y	Starter Rack 125HPCI (EE-STRR-125RCIC)
EE-SW-125RX	TRANSFER SWITCH FOR 125VDC REACTOR BLDG STARTER RACK	FIRE-IE0554SPM				Y	MCC RX (EE-MCC-RX)
EE-SW-125RX-EMERGENCY	TRANSFER SWITCH FOR 125VDC REACTOR BUILDING STARTER RACK - ALTERNATE POWER (DIV I)	FIRE-IE0692SPM				Y	MCC RX (EE-MCC-RX)
EE-SW-125RX-NORMAL	TRANSFER SWITCH FOR 125VDC REACTOR BUILDING STARTER RACK - NORMAL POWER (DIV II)	FIRE-IE0693SPM				Y	MCC RX (EE-MCC-RX)

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-SW-A	TRANSFER SWITCH FOR 125VDC DISTRIBUTION PANEL A	FIRE-IE0555SPM				Y	Distribution Panel A (EE-PNL-A)
EE-SW-A-EMERGENCY	TRANSFER SWITCH FOR 125VDC DISTRIBUTION PANEL A - ALTERNATE POWER (DIV II)	FIRE-IE0687SPM				Y	Distribution Panel A (EE-PNL-A)
EE-SW-A-NORMAL	TRANSFER SWITCH FOR 125VDC DISTRIBUTION PANEL - NORMAL POWER (DIV I)	FIRE-IE0686SPM				Y	Distribution Panel A (EE-PNL-A)
EE-SW-B	TRANSFER SWITCH FOR 125VDC DISTRIBUTION PANEL B	FIRE-IE0556SPM				Y	Distribution Panel B (EE-PNL-B)
EE-SW-B	TRANSFER SWITCH FOR 125VDC DISTRIBUTION PANEL B - ALTERNATE POWER (DIV I)	FIRE-IE0689SPM				Y	Distribution Panel B (EE-PNL-B)

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-SW-B	TRANSFER SWITCH FOR 125VDC DISTRIBUTION PANEL B - NORMAL POWER (DIV II)	FIRE-IE0688SPM				Y	Distribution Panel B (EE-PNL-B)
EE-SWGR-2000-AMP-BUS-DUCT	2000 AMP BUS DUCT TO CRITICAL SWITCHGEAR	FIRE-IE0624SPM				Y	Electric power distribution
EE-SWGRA-2000A-BUS-DUCT	SWITCHGEAR A 2000A BUS DUCT	FIRE-IE0562SPM				Y	Electric power distribution
EE-SWGRB-2000A-BUS-DUCT	SWITCHGEAR B 2000A BUS DUCT	FIRE-IE0563SPM				Y	Electric power distribution
EE-SWGRC-1200A-BUS-DUCT	SWITCHGEAR C 1200A BUS DUCT	FIRE-IE0703SPM				Y	Electric power distribution
EE-SWGRD-1200A-BUS-DUCT	SWITCHGEAR D 1200A BUS DUCT	FIRE-IE0704SPM				Y	Electric power distribution
EE-TRN-SU-TRIP	STARTUP TRANSFORMER TRIP CIRCUITRY	EAC-TRN-SU-FI				Y	EE-XFMR-SU
EE-XFMR-RPS1A	SOLATRON/ACUVOLT LINE CONDITIONER 25KVA 120VAC SINGLE PHASE	FIRE-IE0105YV		Y			

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
EE-XFMR-RPS1B	SOLATRON/ACUVOLT LINE CONDITIONER 25KVA 120VAC SINGLE PHASE	FIRE-IE0106YV		Y			
EE-XFMR-SU-3000A-BUS-DUCT	EE-XFMR-SU-3000A-BUS-DUCT	FIRE-IE0564SPM				Y	Electric power distribution
FP-PS-737	FIRE P D LO PRESS AUTO STRT	FPS-PIS-HW-737				Y	FP-P-D
HPCI-ES-110	TRANSMITTER POWER SUPPLY	FIRE-IE0199GK				Y	HPCI control logic
HPCI-FIC-108	PUMP DISCHARGE FLOW CONTROL	FIRE-IE0200GK				Y	HPCI control logic
HPCI-FT-82	PUMP DISCHARGE FLOW	FIRE-IE0203GK				Y	HPCI control logic
HPCI-IVTR-119	115VAC INSTRUMENTATION POWER SUPPLY	FIRE-IE0222GK				Y	HPCI control logic
HPCI-MOV-MO14	STEAM SUPPLY TO TURBINE - PASSIVE	HCI-MOV-SO-MO14			Y		Spurious opening not included in IEPRA
HPCI-MOV-MO15	STEAM SUPPLY INBOARD ISOLATION VALVE - PASSIVE	HCI-MOV-SC-MO15		Y			Spurious closure not included in IEPRA
HPCI-MOV-MO16	STEAM SUPPLY OUTBOARD ISOLATION VALVE	HCI-MOV-OO-MO16-F		Y			Spurious closure not included in IEPRA

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
HPCI-MOV-MO16	STEAM SUPPLY OUTBOARD ISOLATION VALVE - PASSIVE	HCI-MOV-SC-MO16		Y			Spurious closure not included in IEPRA
HPCI-MOV-MO17	PUMP SUCTION FROM EMERGENCY CONDENSATE STORAGE TANK	HCI-MOV-SC-MO17			Y		Spurious closure not included in IEPRA
HPCI-MOV-MO20	HPCI PUMP DISCHARGE	HCI-MOV-SC-MO20		Y			Spurious closure not included in IEPRA
HPCI-MOV-MO21	HPCI PUMP TEST BYPASS TO EMERGENCY CONDENSATE STORAGE TANK	HCI-MOV-SO-MO21		Y			Spurious opening not included in IEPRA
HPCI-MOV-MO24	HPCI PUMP TEST BYPASS REDUNDANT SHUTOFF	HCI-MOV-SO-MO24		Y			Spurious opening not included in IEPRA
HPCI-P-ALOP	HPCI AUX. LUBE OIL PUMP (SUPER COMPONENT 2)	FIRE-IE0638SPM				Y	HPCI-TU-TURB
HPCI-PS-2787	AUXILIARY OIL PUMP START/STOP PRESSURE SWITCH	FIRE-IE0218GK				Y	HPCI-TU-TURB
HPCI-SI-2792	TURBINE SPEED INDICATOR	FIRE-IE0212GK				Y	HPCI control logic

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
HPCI-SOV-SSV2795	HPCI TURBINE TRIP	HCI-SYS-25T-SS				Y	HPCI control logic
HPCI-SQRT-118	PUMP DISCHARGE FLOW	FIRE-IE0213GK				Y	HPCI control logic
HV-AD-AD1417	FIRE DAMPER - DC SWGR 1A EXHAUST	FIRE-IE0566SPM		Y			
HV-AD-AD1418	FIRE DAMPER - DC SWGR 1A SUPPLY	FIRE-IE0567SPM		Y			
HV-AD-AD1419	FIRE DAMPER - MAIN SUPPLY - BETWEEN BATTERY ROOM 1A AND CABLE SPREAD ROOM	FIRE-IE0568SPM		Y			
HV-AD-AD1420	FIRE DAMPER - MAIN EXHAUST - BETWEEN BATTERY ROOM 1A AND CABLE SPREAD ROOM	FIRE-IE0569SPM		Y			
HV-FAN-FC-R-1J	NW QUAD RECIRC FAN	FIRE-IE0426YV		Y			
HV-TS-1035C	TEMPERATURE SWITCH, INTERLOCK FOR SPV-1035C	FIRE-IE0427YV				Y	EDG 1 Room Air Cooling Unit
HV-TS-1035D	TEMPERATURE SWITCH, INTERLOCK FOR SPV-1035D	FIRE-IE0428YV				Y	EDG 2 Room Air Cooling Unit

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
HV-TS-872	TEMPERATURE SENSOR DC CRITICAL SWITCHGEAR ROOM 1A (HIGH)	HVC-TIS-SL-872				Y	Essential Control Building Supply Fans
HV-TS-873	TEMPERATURE SENSOR DC CRITICAL SWITCHGEAR ROOM 1B (HIGH)	HVC-TIS-SL-873				Y	Essential Control Building Supply Fans
HV-TS-874	TEMPERATURE SENSOR ESSENTIAL CONTROL BUILDING EXHAUST DIV I (LOW)	HVC-TIS-SL-874				Y	Essential Control Building Exhaust Fan 1F
HV-TS-875	TEMPERATURE SENSOR ESSENTIAL CONTROL BUILDING EXHAUST DIV I (LOW)	HVC-TIS-SL-875				Y	Essential Control Building Exhaust Fan 1F
HV-TS-889	TEMPERATURE SENSOR CONTROL BUILDING DIV II ESSENTIAL EXHAUST (LOW)	HVC-TIS-SL-889				Y	Essential Control Building Exhaust Fan 1G
HV-TS-890	TEMPERATURE SENSOR CONTROL BUILDING DIV II ESSENTIAL EXHAUST (LOW)	HVC-TIS-SL-890				Y	Essential Control Building Exhaust Fan 1G

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
MS-RV-71ARV	SAFETY RELIEF VALVE RV-71ARV - MAIN STEAM LINE A - VALVE GROUP III - PASSIVE	ADS-SRV-SO-ADSARV			Y		Spurious opening not included in IEPRA
MS-RV-71BRV	SAFETY RELIEF VALVE RV-71BRV - MAIN STEAM LINE A - VALVE GROUP III - PASSIVE	ADS-SRV-SO-ADSBRV			Y		Spurious opening not included in IEPRA
MS-RV-71CRV	SAFETY RELIEF VALVE RV-71CRV - MAIN STEAM LINE B - VALVE GROUP II - PASSIVE	ADS-SRV-SO-ADSCRV			Y		Spurious opening not included in IEPRA
MS-RV-71DRV	SAFETY RELIEF VALVE RV-71DRV - MAIN STEAM LINE B - LOW-LOW SET VALVE - PASSIVE	ADS-SRV-SO-ADSDRV			Y		Spurious opening not included in IEPRA
MS-RV-71ERV	SAFETY RELIEF VALVE RV-71ERV - MAIN STEAM LINE C - VALVE GROUP II - PASSIVE	ADS-SRV-SO-ADSERV			Y		Spurious opening not included in IEPRA

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
MS-RV-71FRV	SAFETY RELIEF VALVE RV-71FRV - MAIN STEAM LINE C - LOW-LOW SET VALVE - VALVE GROUP II - PASSIVE	ADS-SRV-SO-ADSFRV			Y		Spurious opening not included in IEPRA
MS-RV-71GRV	SAFETY RELIEF VALVE RV-71GRV - MAIN STEAM LINE C - VALVE GROUP III - PASSIVE	ADS-SRV-SO-ADSGRV			Y		Spurious opening not included in IEPRA
MS-RV-71HRV	SAFETY RELIEF VALVE RV-71HRV - MAIN STEAM LINE D - PASSIVE	ADS-SRV-SO-ADSHRV			Y		Spurious opening not included in IEPRA
NBI-LT-59D	REACTOR WATER LEVEL	NBI-LIT-HW-59D		Y			Supports Feedwater control
NBI-PS-52A1	REACTOR PRESSURE REACTOR RECIRCULATION DISCHARGE VALVE INTERLOCK	FIRE-IE0574SPM		Y			Supports Rx Recirc Pump isolation valves.
NBI-PS-52C1	REACTOR PRESSURE REACTOR RECIRCULATION DISCHARGE VALVE INTERLOCK	FIRE-IE0575SPM		Y			Supports Rx Recirc Pump isolation valves.

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
PC-AOV-235AV	SUPPRESSION CHAMBER INLET PURGE SHUTOFF	PCI-AOV-SO-AO235		Y			Spurious opening not included in IEPRA
PC-AOV-237AV	SUPPRESSION CHAMBER INLET OUTBOARD ISOLATION	PCI-AOV-SO-AO237			Y		Spurious opening not included in IEPRA
PC-AOV-239AV	N2 PURGE SUPPLY VALVE	PCI-AOV-SO-AO239		Y			Spurious opening not included in IEPRA
PC-AOV-246AV	DRYWELL EXHAUST OUTBOARD ISOLATION VALVE	PCI-AOV-SO-246AV			Y		Spurious opening not included in IEPRA
PC-MOV-231MV	DRYWELL EXHAUST INBOARD ISOLATION VALVE	PCI-MOV-SO-231MV			Y		Spurious opening not included in IEPRA
PC-MOV-233MV	SUPPRESSION CHAMBER, INLET INBOARD ISOLATION	PCI-MOV-SO-MO233			Y		Spurious opening not included in IEPRA
RCIC-CBX-3067	RCIC EGM CONTROL BOX	FIRE-IE0203YV				Y	RCIC-TU-TURB
RCIC-CHA-3067	RCIC TURBINE CONTROL HYDRAULIC ACTUATOR	FIRE-IE0204YV				Y	RCIC-TU-TURB
RCIC-CV-18CV	CONDENSATE SUPPLY TO RCIC SYSTEM - PRESSURE MAINTENANCE	RCI-CKV-LK-18CV		Y			

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RCIC-CV-19CV	CONDENSATE SUPPLY TO RCIC SYSTEM - PRESSURE MAINTENANCE	RCI-CKV-LK-19CV		Y			
RCIC-FIC-91	PUMP DISCHARGE FLOW CONTROL	FIRE-IE0207YV				Y	RCIC-TU-TURB
RCIC-FT-58	PUMP DISCHARGE FLOW	FIRE-IE0211YV				Y	RCIC-TU-TURB
RCIC-IVTR-1A	RCIC, INVERTER	FIRE-IE0212YV				Y	RCIC-TU-TURB
RCIC-SW-S17	RCIC TURBINE TRIP	RCI-SWS-SS-S17				Y	RCIC-TU-TURB
RCIC-LS-99	BARO COND HIGH LEVEL ALARM & COND PUMP START	FIRE-IE0219YV				Y	RCIC-TU-TURB
RCIC-MOV-MO15	RCIC STEAM INBOARD ISOLATION - PASSIVE	RCI-MOV-SC-MO15		Y			Spurious closure not included in IEPRA
RCIC-MOV-MO16	RCIC STEAM OUTBOARD ISOLATION - PASSIVE	RCI-MOV-SC-MO16		Y			Spurious closure not included in IEPRA
RCIC-MOV-MO18	RCIC SUPPLY FROM EMERGENCY CONDENSATE STORAGE TANKS - PASSIVE	RCI-MOV-SC-MO18			Y		Spurious closure not included in IEPRA
RCIC-MOV-MO20	RCIC PUMP DISCHARGE	RCI-MOV-SC-MO20		Y			Spurious closure not included in IEPRA

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RCIC-MOV-MO30	TEST BYPASS TO EMERGENCY CONDENSATE STORAGE TANK VALVE.	RCI-MOV-SO-MO30		Y			Spurious opening not included in IEPRA
RCIC-MOV-MO33	ECST TEST LINE SHUTOFF VALVE	RCI-MOV-SO-MO33		Y			Spurious opening not included in IEPRA
RCIC-PS-67-1	PUMP SUCTION LOW PRESSURE TURBINE TRIP	RCI-PIS-SS-PS671				Y	RCIC Control Logic
RCIC-PS-72A	TURBINE STEAM EXHAUST HIGH PRESSURE ALARM & TRIP	RCI-PIS-SS-PS72A				Y	RCIC Control Logic
RCIC-PS-72B	TURBINE STEAM EXHAUST HIGH PRESSURE ALARM & TRIP	RCI-PIS-SS-PS72B				Y	RCIC Control Logic
RCIC-PS-87A	STEAM LINE LOW PRESSURE - AUTO ISOLATION	RCI-PIS-SS-PS87A				Y	RCIC Control Logic
RCIC-PS-87B	STEAM LINE LOW PRESSURE - AUTO ISOLATION	RCI-PIS-SS-PS87B				Y	RCIC Control Logic
RCIC-PS-87C	STEAM LINE LOW PRESSURE - AUTO ISOLATION	RCI-PIS-SS-PS87C				Y	RCIC Control Logic

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RCIC-PS-87D	STEAM LINE LOW PRESSURE - AUTO ISOLATION	RCI-PIS-SS-PS87D				Y	RCIC Control Logic
RCIC-SC-3067	TURBINE SIGNAL CONVERTER	FIRE-IE0238YV				Y	RCIC Control Logic
RCIC-SE-3067	TURBINE SPEED MAGNETIC PICKUP	FIRE-IE0239YV				Y	RCIC Control Logic
RCIC-SOV-SV	RCIC TURBINE OVERSPEED TRIP SOLENOID VALVE	RCI-SOV-FI-SV				Y	RCIC Control Logic
RCIC-SQRT-99	PUMP DISCHARGE FLOW	FIRE-IE0242YV				Y	RCIC Control Logic
RCIC-TS-79A	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-79A				Y	RCIC Control Logic
RCIC-TS-79B	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-79B				Y	RCIC Control Logic
RCIC-TS-79C	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-79C				Y	RCIC Control Logic
RCIC-TS-79D	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-79D				Y	RCIC Control Logic
RCIC-TS-80A	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-80A				Y	RCIC Control Logic

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RCIC-TS-80B	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-80B				Y	RCIC Control Logic
RCIC-TS-80C	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-80C				Y	RCIC Control Logic
RCIC-TS-80D	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-80D				Y	RCIC Control Logic
RCIC-TS-81A	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-81A				Y	RCIC Control Logic
RCIC-TS-81B	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-81B				Y	RCIC Control Logic
RCIC-TS-81C	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-81C				Y	RCIC Control Logic
RCIC-TS-81D	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-81D				Y	RCIC Control Logic
RCIC-TS-82A	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-82A				Y	RCIC Control Logic
RCIC-TS-82B	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-82B				Y	RCIC Control Logic

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RCIC-TS-82C	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-82C				Y	RCIC Control Logic
RCIC-TS-82D	STEAM LEAK DETECTION - TEMP SWITCH	RCI-TIS-FI-TS-82D				Y	RCIC Control Logic
REC-AOV-902AV	AIR COMPRESSOR B RBCCS SUPPLY ISOLATION VALVE	REC-AOV-SO-AV902		Y			Spurious opening not included in IEPRA
REC-AOV-904AV	AIR COMPRESSOR C RBCCS SUPPLY ISOLATION VALVE	REC-AOV-SO-AV904		Y			Spurious opening not included in IEPRA
REC-MOV-712MV	REC HX A OUTLET TO NON-CRITICAL SUPPLY	FIRE-IE0713SPM			Y		
REC-MOV-712MV	REC HX A OUTLET TO NON-CRITICAL SUPPLY - PASSIVE	REC-MOV-SO-712MV			Y		Spurious opening not included in IEPRA
REC-MOV-713MV	REC HX B OUTLET TO NON-CRITICAL SUPPLY - PASSIVE	REC-MOV-SO-713MV			Y		Spurious opening not included in IEPRA
REC-TE-451A	REC HX A OUTLET TEMP ELEMENT	FIRE-IE6263YV				Y	SW-AOV-TCV451A
REC-TE-451B	REC HX B OUTLET TEMP ELEMENT	FIRE-IE0266YV				Y	SW-AOV-TCV451B
REC-TIC-451A	SW TO REC HX A	FIRE-IE6263YV				Y	SW-AOV-TCV451A
REC-TIC-451B	SW TO REC HX B	FIRE-IE0266YV				Y	SW-AOV-TCV451B

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RFC-PLC-RXVL	TRICONIX FEEDWATER LEVEL CONTROLLER	NBI-PCS-TRICONIX		Y			
RHR-DPIS-125A	A RHR HX DISCH MIN FLOW CONTROL	RHR-PIS-FH-DPIS125A				Y	RHR-MOV-MO16A
RHR-DPIS-125A	A RHR HX DISCH MIN FLOW CONTROL	RHR-PIS-FL-DPIS125A				Y	RHR-MOV-MO16A
RHR-DPIS-125B	B RHR HX DISCH MIN FLOW CONTROL	RHR-PIS-FH-DPIS125B				Y	RHR-MOV-MO16B
RHR-DPIS-125B	B RHR HX DISCH MIN FLOW CONTROL	RHR-PIS-FL-DPIS125B				Y	RHR-MOV-MO16B
RHR-MOV-MO15A	RHR PUMP A SHUTDOWN COOLING SUCTION - PASSIVE	LCI-MOV-SO-MO15A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO15B	RHR PUMP B SHUTDOWN COOLING SUCTION - PASSIVE	LCI-MOV-SO-MO15B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO15C	RHR PUMP C SHUTDOWN COOLING SUCTION - PASSIVE	LCI-MOV-SO-MO15C			Y		Spurious opening not included in IEPRA
RHR-MOV-MO15D	RHR PUMP D SHUTDOWN COOLING SUCTION - PASSIVE	LCI-MOV-SO-MO15D			Y		Spurious opening not included in IEPRA

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RHR-MOV-MO20	RHR CROSSHEADER SHUTOFF - PASSIVE	RHR-MOV-SO-MO20			Y		Spurious opening not included in IEPRA
RHR-MOV-MO20	RHR CROSSHEADER SHUTOFF - PASSIVE	RHR-MOV-SO-MO20			Y		Spurious opening not included in IEPRA
RHR-MOV-MO20	RHR CROSSHEADER SHUTOFF - PASSIVE	RHR-MOV-SO-MO20			Y		Spurious opening not included in IEPRA
RHR-MOV-MO20	RHR CROSSHEADER SHUTOFF - PASSIVE	RHR-MOV-SO-MO20			Y		Spurious opening not included in IEPRA
RHR-MOV-MO20	RHR CROSSHEADER SHUTOFF - PASSIVE	RHR-MOV-SO-MO20			Y		Spurious opening not included in IEPRA
RHR-MOV-MO25A	RHR LOOP A INJECTION INBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO25A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO25B	RHR LOOP B INJECTION INBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO25B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO26A	DRYWELL SPRAY LOOP A OUTBOARD ISOLATION	RHR-MOV-SO-MO26A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO26B	DRYWELL SPRAY LOOP B OUTBOARD ISOLATION	RHR-MOV-SO-MO26B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO27A	RHR LOOP A INJECTION OUTBOARD THROTTLE - PRA	RHR-MOV-OO-MO27A-F			Y		

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RHR-MOV-MO27B	RHR LOOP B INJECTION OUTBOARD THROTTLE - PRA	RHR-MOV-OO-MO27B-F			Y		
RHR-MOV-MO31A	DRYWELL SPRAY LOOP A INBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO31A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO31A	DRYWELL SPRAY LOOP A INBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO31A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO31B	DRYWELL SPRAY LOOP B INBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO31B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO31B	DRYWELL SPRAY LOOP B INBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO31B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO34A	SUPPRESSION CHAMBER COOLING LOOP A INBOARD THROTTLE - PASSIVE	RHR-MOV-SO-MO34A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO34B	SUPPRESSION CHAMBER COOLING LOOP B INBOARD THROTTLE - PASSIVE	RHR-MOV-SO-MO34B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO38A	SUPPRESSION CHAMBER SPRAY LOOP A INBOARD THROTTLE - PASSIVE	RHR-MOV-SO-MO38A		Y			Spurious opening not included in IEPRA

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
RHR-MOV-MO38B	SUPPRESSION CHAMBER SPRAY LOOP B INBOARD THROTTLE	RHR-MOV-SO-MO38B		Y			
RHR-MOV-MO39A	SUPPRESSION CHAMBER COOLING LOOP A OUTBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO39A			Y		Spurious opening not included in IEPRA
RHR-MOV-MO39B	SUPPRESSION CHAMBER COOLING LOOP B OUTBOARD ISOLATION - PASSIVE	RHR-MOV-SO-MO39B			Y		Spurious opening not included in IEPRA
RHR-MOV-MO57	RHR DISCHARGE TO RADWASTE OUTBOARD THROTTLE - PASSIVE	RHR-MOV-SO-MO57		Y			Spurious opening not included in IEPRA
RHR-MOV-MO67	RHR DISCHARGE TO RADWASTE INBOARD SHUTOFF - PASSIVE	RHR-MOV-SO-MO67		Y			Spurious opening not included in IEPRA
RPS-CC-RPSA	RPS MG SET A CONTROL CUBICLE	EAC-MGS-FI-RPSACC-FIRE				Y	RPS-MG-RPSA
RPS-CC-RPSB	RPS MG SET B CONTROL CUBICLE	EAC-MGS-FI-RPSBCC-FIRE				Y	RPS-MG-RPSB
RR-MOV-MO43A	RR PUMP A SUCTION	FIRE-IE0340YV		Y			
RR-MOV-MO53A	RR PUMP A DISCHARGE	FIRE-IE0341YV		Y			

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
SW-AOV-TCV451B	REC HX B OUTLET-ASD	SWS-AOV-SC-TCV451B			Y		Spurious closure not included in IEPRA
SW-MOV-886MV	EMERG SUPPLY TO REC NORTH CRITICAL LOOP - PASSIVE	SWS-MOV-SO-886MV			Y		Spurious opening not included in IEPRA
SW-MOV-887MV	EMERG SUPPLY TO REC SOUTH CRITICAL LOOP - PASSIVE	SWS-MOV-SO-887MV			Y		Spurious opening not included in IEPRA
SW-MOV-888MV	EMERG RETURN FROM REC NORTH CRITICAL LOOP - PASSIVE	SWS-MOV-SO-888MV			Y		Spurious opening not included in IEPRA
SW-MOV-889MV	EMERG RETURN FROM REC SOUTH CRITICAL LOOP - PASSIVE	SWS-MOV-SO-889MV			Y		Spurious opening not included in IEPRA
SW-PS-364A	SW PPS A&C DISCH PRESS LOW	FIRE-IE0287YV				Y	SW-MOV-36MV
SW-PS-364B	SW PPS B&D DISCH PRESS LOW	FIRE-IE0288YV				Y	SW-MOV-37MV
SW-PS-365A	SW PPS A&C DISCH PRESS LO ALARM & PP AUTO START	FIRE-IE0289YV				Y	SW-P-A
SW-PS-365B	SW PPS B&D DISCH PRESS LO ALARM & PP AUTO START	FIRE-IE0290YV				Y	SW-P-C

Component ID	Equipment Description	Fire PRA Basic Event Added	Instrument	Component Not Included in IEPRA	Existing IEPRA Component with New Failure Mode	Subcomponent of Existing Component	Notes
SW-STNR-A	SERVICE WATER STRAINER A	SWS-STR-FR-STRA-FIRE		Y			Service Water supply flow path
SW-STNR-B	SERVICE WATER STRAINER B	SWS-STR-FR-STRB-FIRE		Y			Service Water supply flow path
TEC-AOV-21AV	AIR COMPRESSOR A TBCCW RETURN ISOLATION VALVE	TEC-AOV-SO-AV21		Y			Spurious opening not included in IEPRA
		Total Number	**3**	**50**	**87**	**142**	

Request: PRA RAI-24 Success Criteria

Please discuss if "windmilling" the residual heat removal system (RHR) service water (SW) pumps from the SW booster pumps is a new success criteria. If so, please provide the technical basis including this success criteria in the FPRA.

NPPD Response:

"Windmilling" the RHR SW pumps is included in the IEPRA model, but with a failure probability of 1.0 due to procedure restrictions of only allowing windmilling during Mode 4 (cold shutdown) or Mode 5 (refueling) operation. The Fire PRA recognizes the risk benefit of utilizing SW to supply the RHR heat-exchangers if all RHR SW pumps are rendered unavailable due to a fire. This does represent new success criteria for the Fire PRA. This success criterion was established based upon demonstrated use of "windmilling" during Mode 4/5 operation and reviewed against previous test data.

Because there are risk benefits associated with allowing "windmilling" in Mode 3 (hot shutdown), Implementation Item S-3.11 identifies that the emergency procedures will be updated to allow use of SW pumps alone to provide cooling to RHR heat exchangers in the event RHR SW booster pumps are rendered unavailable.

The new success criteria is crediting SW flow through the RHR SW pump impellers as being able to successfully provide sufficient water to the RHR heat exchangers for decay heat removal.

Request: PRA RAI-25 Drywell De-inertion

Please discuss the risk significance of potential drywell de-inertion pathways for this application, and insights which are important to its significance.

NPPD Response:

Potential fires for the de-inerted state of the drywell were included in the FPRA. The percent of time that the drywell is de-inerted during power operation was taken from the IEPRA.

The level 2 IEPRA modeling also includes recognition of the de-inerted state for containment response. LERF sequences are developed as a result of modeling the de-inerted states. The FPRA uses the same modeling.

De-inertion was bounded by modeling those fire-induced failures that lead directly to de-inertion pathways and a loss of containment integrity as being large early release plant damage states. These failures are not risk significant as determined in the delta risk calculations.

Request: PRA RAI-26 Containment Bypass

Please discuss how containment bypass pathways have been considered and which ones are modeled in the FPRA.

NPPD Response:

Containment bypass pathways were considered consistent with the internal events modeling supplemented by potential fire-induced failures, including spurious operations. Consistent with the modeling of other potential fire-induced failures or spurious operation; the associated fault trees were modified to include the appropriate logic (gates and flags). Fire-induced BOC and ISLOCA were explicitly included in the Fire PRA model as containment bypass pathways from the following systems:

- Scram Discharge Volume - BOC
- Reactor Water Clean-Up - BOC
- Core Spray - ISLOCA
- Residual Heat Removal - ISLOCA

In addition to the BOC and ISLOCA modes of Containment bypass, fire-induced failure of the Containment isolation system was modeled through the following pathways:

- Drywell Floor Drain Sump
- Drywell Equipment Drain Sump
- Torus Purge Line
- Drywell Purge Line
- Torus Vent Line
- Drywell Vent Line

Request: PRA RAI-27 Hardened Vent

Please discuss how the hardened wetwell vent is credited in the FPRA and how the potential fire impact on vent cables has been considered for the FPRA. Also, please discuss if fire areas with potential impact on hardened wetwell venting have been walked down.

NPPD Response:

The hard pipe vent (HPV) system components are explicitly included in the Fire PRA model. These components include valves PC-MOV-233MV, PC-AOV-237AV, and PC-AOV-AO32. AOVs 237AV and AO32 have associated air accumulators backing up the instrument air (IA) system (IA is assumed to be failed for fires).

The human error probability for the manual action to align the hard pipe vent was assessed for fires using the HRA Calculator and the guidance in NUREG-1921.

The components that are part of the HPV were cable traced and the cables identified are part of the Fire PRA model. The cables were walked down in all fire zones where they could be impacted by a fire with the exception of Zone 1D "RHR Pump Room 1B and 1D" (only valve AO32 can be affected in this zone), Zone 1F "Suppression Pool Area" (all 3 HPV valves can be affected in this zone), and Zone 10B "Main Control Room" (all 3 HPV valves can be affected in this zone). In these zones, the cables associated with hard pipe vent components were considered impacted by a fire and the components were modeled as being failed.

Request: PRA RAI-28 VFDR

VFDR ISA-03 is not specified as a separation issue. Please state what type of issue VFDR ISA-03 is.

NPPD Response:

VFDR ISA-03 is a separation issue for Inventory Control, Vital Auxiliaries, and Decay Heat Removal.

Request: PRA RAI-29 Human Reliability Analysis

a. *According to the peer review report, for the HRA analysis many of the actions are based on timing from the internal events HRA (e.g., HR-G4, HR-G5). Please state if this applies to OMAs and, if so, discuss why the timing applies.*

NPPD Response:

OMAs consist of fire response operator actions added during the development of the fire-induced risk model (NUREG/CR-6850 Task 5). NEDC 09-083 "*Task 7.12 Human Reliability Analysis,*" Table 2 lists the fire response HFEs that are credited in the Fire PRA. In order for an action to be credited in the Fire PRA it must be feasible in that there is enough time to diagnose and execute the action, there is enough crew to perform the action, and there must be cues and indications.

The *Safe Shutdown Analysis Report*, Appendix M, "*Operator Manual Action Times,*" provides the fire specific timelines for these actions, shows that all actions in the fire procedures have been walked down, and have been demonstrated to be feasible. Manual action timelines were created and identify the functional requirement milestones for each individual fire area. The time to perform actions was derived from walk downs performed by operations. The time lines have a summary of the manual actions that are part of the procedures and taken from Appendix A (a summary analysis report for each individual fire area). Milestones were created on the timelines to show when a time requirement existed for a prescribed set of actions.

Times are provided in NEDC 09-083, Table 13, which lists the fire zone where the action is credited, where the execution is taking place, and associated time. No action was credited where the environment would be affecting operator performance.

For EOP actions carried over into the Fire PRA from the IEPRA, the timeline was initially assumed to be the same as for internal events HRA. If it was necessary to account for fire impacts such as procedure delays due to the fire procedure implementation the timelines were re-evaluated and revised as appropriate for fires.

Request: PRA RAI-29 Human Reliability Analysis (continued)

b. *PCV-XHE-FO-AOV is a containment venting basic event. NEDC 09-083 does not contain an HRA worksheet for this basic event. Provide the worksheet or clarify. PC-XHE-FO-AOV is also an OMA in Fire Areas RB-J (3A), RB-K (3B), DGA (14A), DGB (14B), and DGA (14C). Please discuss why this basic event is associated with these fire areas.*

NPPD Response:

PCV-XHE-FO-AOV is a local action to open air operated valves PC-AOV-237AV and PC-AOV-32AV that are part of the hard pipe vent system. The HEP used in the Fire PRA and the HEP used in the Internal Events PRA are identical (0.1). PCV-XHE-FO-AOV is not documented in NEDC 09-083, "*Task 7.12 Human Reliability Analysis.*" It is a long term EOP action and is used in the Fire PRA with the Internal Events PRA value.

Discussion of PCV-XHE-FO-AOV is located in CNS-PSA-004, the internal events HRA notebook, and states:

> There are a number of associated HEPs for containment venting that deal with local actions outside the control room. These additional local HEPs are set to a failure probability of 0.1 for the current version of the PRA. Because they are a last resort action, they may not be directed until the pressure is near PCPL. At that time, it is judged the local actions could be too late to accomplish the action before exceeding PCPL. Therefore, a high failure probability of 0.1 is chosen for the model.

PCV-XHE-FO-AOV is one of the actions listed in the IEPRA HRA notebook under the above paragraph.

Field actions from the EOPs were generally set to fail in the Fire PRA model. For those fire scenarios where the field actions had a high Fussell-Vesely value, the actions were evaluated and credited as appropriate. This is the case for action PCV-XHE-FO-AOV and is the reason why it was credited with these fire areas. PCV-XHE-FO-AOV was set to the IEPRA HEP where it was credited.

Request: PRA RAI-29 Human Reliability Analysis (continued)

c. *PCV-XHE-FO-HPV is the basic event for when operators fail to operate the primary containment hard pipe vent system. Please discuss what the operator actions are and how fire impact was considered for these actions.*

NPPD Response:

This post accident human action models the alignment of the hard pipe vent path from the MCR to provide decay heat removal and preserve Primary Containment integrity. This action includes tracking containment pressure with the Primary Containment Pressure Limit Graph (EOP Graph 11), isolating equipment to prevent over-pressurization damage, and opening valves in the hard pipe vent flow path from the MCR. Failure to vent Primary Containment could lead to loss of containment heat removal.

The HEPs for PCV-XHE-FO-HPV "Operator Fails to Operate Primary Containment Hard Pipe Vent System" are documented in NEDC 09-083 "*Task 7.12 Human Reliability Analysis*," Attachment B, "*Detailed HFE Analysis*," with all instrumentation available and with minimum instrumentation available. A discussion of the HEP categories "All Instrumentation Available" and "Minimum Instrumentation Available" is provided in the response to PRA RAI-02c. The operator actions are the same for either all or minimum instrumentation available and are:

1. Place PC-MO-233 Isolation override keylock switch to OVERRIDE
2. Place PC-AO-237 Isolation override keylock switch to OVERRIDE
3. Open PC-AO-237AV, Torus Inlet Outboard Isolation Valve
4. Open PC-MO-233MV, Torus Inlet Inboard Isolation Valve
5. Open PC-AO-32, Torus HPV valve

Because of the fire, execution stress is considered high when determining the human error probabilities. For some fire areas, some Control Room indications are affected by the fire and are considered inaccurate, the EOP procedure provides no alternate instrumentation or a warning that instrumentation may be inaccurate during a fire. However, operators have been trained on how to detect failed instrumentation and the need to use alternate instrumentation when indications are suspect. Additionally, operator workload is considered high during a fire event since the EOPs are implemented in parallel with fire procedures and although venting containment with the hard pipe vent is a long term action, fire performance shaping factors were used in determining the HEPs.

Request: PRA RAI-29 Human Reliability Analysis (continued)

d. *HEPs considered fire with minimal instrumentation as noted in NEDC 09-83. Please discuss what is meant by minimal instrumentation and clarify if required instrumentation is verified to be available where it is credited in the FPRA sequences. If less than minimal instrumentation is available, please discuss how HEPs are quantified.*

NPPD Response:

This is documented in NEDC 09-083, "*Task 7.12 Human Reliability Analysis.*"

For each of the existing operator actions, the instrumentation required for cognition was identified. If the instrumentation cable routings were not known, the HEP was set to 1.0. It was assumed that these instruments would be unavailable for every fire, and with no instrumentation available for diagnosis the HEP is 1.0. The one exception to setting the HEP to 1.0 for no instrumentation available as discussed in the response to PRA RAI-02 c. Table 12 shows the HFEs retained in the Fire PRA and the instrumentation required for diagnosis for each HFE.

The EPRI HRA Calculator was used to document the definition and determine the HEPs of the existing EOP HFEs. Two cases were quantified in the HRA Calculator as follows:

- All Instrumentation Available: No instrumentation is made unavailable by the fire. For this case the fire will have minimal impact on operator performance. Fire performance shaping factors are applied. In the HRA Calculator database the HFE has the same basic event name as the internal events HFE name but "ALL" is appended to the basic event name.
- Minimum Instrumentation Available: Some instrumentation is made unavailable by the fire. For this case, some but not all instrumentation is failed and cognition will be more difficult but not a guaranteed failure. In the HRA Calculator database the HFE has the same basic event name as the internal events HFE name but "MIN" is appended to the basic event name.

For cases with All Instrumentation Available, the following fire-related adjustments were made when determining the HEP:

- Stress was increased to high, if not high already in the internal events HRA (see Note 1 below.
- For local actions, Tm was increased by 10 minutes to account for detours or delays in getting to the local area.
- If the time available to perform the action was insufficient due to the increase in Tm, the HEP is set to 1.0.
- If Tm was increased, the dependency levels for cognitive recovery were checked to ensure that dependency levels were equal to or higher than the minimal recommende,d levels.
- Pcb – Because the fire procedures are implemented in parallel to the EOPs, high workload is assumed.
- Pce – Because the fire procedures are implemented in parallel to the EOPs, multiple procedures are used.
- For the Human Cognitive Reliability (HCR)/Operator Reliability Experiments (ORE) method the sigma values were increased to the upper bound.

For cases with only a minimal set of instrumentation available in addition to those noted above for "ALL Instrumentation Available," the following fire related adjustments were made when determining the HEP:

- Pca – MCR indication is not considered accurate because of loss of some instrumentation due to fire. There are no warnings in the EOPs, and it is assumed that the operators will be trained on performing the fire procedures in conjunction with the EOPs [branch E].

- Pcd – The cues are not as stated due to loss of some instrumentation. There are no warnings in the EOPs, no specific training for such fire scenarios, but general training on the fire procedures is credited [branch D].

For the few existing EOP HFEs that either (1) use screening HEPs or (2) override values applied in the internal events analysis, NUREG/CR-6850 screening HEPs are applied. If the HEP was quantified using NUREG/CR-6850 then it is noted in comments field in Table 1. All HEPs (IEPRA and fire) are shown in Table 1. The detailed HFE analyses are provided in NEDC 09-083, Attachment B.

Note 1: For screening quantification of internal events HFEs, the stress was considered to be high. If a detailed analysis was performed following risk model development, the stress level was re-evaluated and possibly lowered, if it was determined that the fire was extinguished before the operator received the cue.

Request: PRA RAI-29 Human Reliability Analysis (continued)

e. *Please identify which RAs involve operator actions at the ASD panel while maintaining an operator presence in the MCR. Provide justification for their HEPs, and discuss their significance for the application.*

NPPD Response:

There are some Fire PRA scenarios where operators remain in the MCR but use ASD for some actions. Only three actions fell into this category (see table below). A detailed analysis was performed for these actions using the guidance from NUREG-1921 and the HRA Calculator. These analyses are provided in NEDC 09-083 "*Task 7.12 Human Reliability Analysis,*" Attachment B. The nominal human error probabilities used in the Fire PRA as well as the value used for performing these specific actions from ASD are provided below.

Human Actions Taken at ASD that are Credited in the Fire PRA

Human Failure Event	HFE Description	Nominal Human Error Probability (FPRA)	ASD Human Error Probability
ADS-XHE-FO-TRANS-ASD	Initiate ADS for RPV Depressurization - Transient (NON-ATWS) from ASD	1.2E-03	3.0E-02
ECS-XHE-FO-TRANS-ASD	Manual ECCS Initiation – Transient from ASD	1.1E-03	2.4E-02

Human Failure Event	**HFE Description**	**Nominal Human Error Probability (FPRA)**	**ASD Human Error Probability**
HCI-XHE-FO-LVL8-ASD	Control HPCI to Prevent Reaching High Level Trip from ASD	5.7E-03	1.6E-01

Action ADS-XHE-FO-TRANS-ASD is manual RPV depressurization and action ECS-XHE-FO-TRANS-ASD is manual initiation of ECCS. These actions are not risk significant with respect to the application as they do not address VFDRs. HCI-XHE-FO-LVL8-ASD is not a significant action with respect to risk as determined in the delta risk evaluation.

Request: PRA RAI-29 Human Reliability Analysis (continued)

f. *The detailed HEP worksheets show that for the case of minimal instrumentation available, the HEPs are insensitive to the parameter T_{sw}. For example, short times generally have HEPs of 0.15, while long times can be slightly greater. Please describe why the HEP does not increase for shorter T_{sw} times. Include a discussion on why the HEPs do not appear to vary between times when the fire impacts could be significant and when fire impacts would not be expected to be significant.*

NPPD Response:

For short Tsw times (typically less than 30 minutes), the HCR/ORE method can become dominant over the CBDTM/THERP method in evaluating HEPs. Also, Tdelay can also have a strong effect when it is a substantial fraction of Tsw, and may be affecting these times. For all HEPs with minimal instrumentation available, they were consistently evaluated as shown below.

From NEDC 09-083, "*Task 7.12 Human Reliability Analysis,*" for cases with only a minimal set of instrumentation available the following adjustments were made:

- Stress was increased to high, if not high already in the internal events HRA.
- For local actions, Tm was increased by 10 minutes to account for detours or delays in getting to the local area.
- If the time available to perform the action was insufficient due to the increase in Tm, the HEP is set to 1.0.
- If Tm was increased, the dependency levels for cognitive recovery were checked to ensure that dependency levels were equal to or higher than the minimum recommended levels.
- Pca - MCR indication is not considered accurate because of loss of some instrumentation due to fire. There are no warnings in the EOPs, and it is assumed that the operators will be trained on performing the fire procedures in conjunction with the EOPs [branch E].

- Pcb - Because the fire procedures are implemented in parallel to EOPs, high workload is assumed.
- Pcd - The cues are not as stated due to loss of some instrumentation. There are no warnings in the EOPs, no specific training for such fire scenarios, but general training on the fire procedures is credited [branch D].
- Pce - Because the fire procedures are implemented in parallel to EOPs, multiple procedures are used.
- For the HCR/ORE method the sigma values were increased to the upper bound.

For the few existing EOP HFEs that either (1) use screening HEPs or (2) override values applied in the internal events analysis, NUREG/CR-6850 screening HEPs are applied. If the HEP was quantified using NUREG/CR-6850 then it is noted in comments field in NEDC 09-083, Table 1.

Notes: Tsw is the total time available from the initiating event until the action is no longer beneficial. Tm is the time for execution of the action. Tdelay is time from start to cue received.

Request: PRA RAI-29 Human Reliability Analysis (continued)

g. *Please discuss what time line is assumed for which the fire is assumed not to affect operator actions. Also, please discuss how this is worked into the fire HEPs.*

NPPD Response:

NUREG-1921, "Fire Human Reliability Analysis Guidelines," was used in the development of the Fire HRA and has the following guidance:

> **Timing of cues for the action relative to expected fire suppression time.** An assumption of the scoping flowcharts is that actions that have to be performed during an ongoing fire (whether the action is inside or outside the MCR) will be more susceptible to both the direct and indirect effects of the fire. Therefore, two of the flowcharts (regarding MCR actions and ex-CR actions; Figures 5-3 and 5-4) explicitly ask whether the cue(s) for an action will occur while the fire is ongoing. Based on the information in the original NUREG/CR-6850 [1] which was further developed as FAQ-08-0050 [8] and then published as NUREG/CR-6850 Supplement 1 [1], for the application of the scoping flowcharts it is assumed that most fires (with exceptions noted next) will be extinguished or contained within 70 minutes of the start of the fire. As such, upon initiating the actions listed in Figures 5-3 and 5-4, the time from the beginning of the fire to the presentation of the cue for an action needs to be determined. For the scoping analysis, the start of the fire is considered concurrent with the initiating event (e.g., reactor trip). Although this is rarely the case in actuality, estimating the times this way allows a conservative estimate of the effect of the fire on the diagnosis and execution of the action.

Conservatively, 90 minutes was used in the Fire HRA as the expected time for an ongoing fire and the imposition of fire performance shaping factors on the HFEs. For operator actions occurring 90 minutes or greater than the fire cue, fire performance shaping factors are not imposed.

Request: PRA RAI-29 Human Reliability Analysis (continued)

h. Please discuss any floors used in the HEP and dependency analyses.

NPPD Response:

The philosophy and methods for floors used in the Internal Events PRA for HRA are described below.

The assessment of HEPs and dependent HEPs is a methodology that can have a number of variations in implementation by analysts. In an attempt to make the implementation consistent within NPPD and with industry evaluations, an approach has been established which does the following:

- Establishes a floor of 1E-6 for individual HEPs and combinations of HEPs that are required within 24 hours of an event. This is consistent with previous Probabilistic Safety Assessments (PSA) and HRA documentation.
- Establishes a floor of 5E-7 for combinations of HEPs that specify alternative cues and symptoms AND allow more than 24 hours for effective implementation.

This approach was chosen rather than the Swain approach of neglecting such HEPs by considering them of negligible probability and not including them in the PSA.

This was carried forward in the HFEs from the Internal PRA that were modified for use in the Fire PRA. In no instance was the value decreased from the Internal Event value. Also, none of the HFEs created for the Fire PRA required the use of the 1E-6 floor.

In the dependency analysis, a conservative lower bound of 1E-3 was initially applied to all joint HEPs. The merge cutset equation can only be used to identify combination of HFEs. The HRA Calculator dependency rules are known to be conservative and by applying a lower bound of 1E-3, the overall results of the HRA dependency analysis are known to be conservative.

On an as-needed basis, selected scenario cutset files were reviewed and HFE combinations were reviewed in detail. On a scenario-by-scenario basis, the reviewer can understand the context of the HFE combination. In many cases this detailed review showed that the joint HEP for the combination should be lower than the 1E-3 assumed lower bound. Because the combinations could be reviewed in the context of a specific fire scenario, the HRA analyst could justify a lower level of dependency.

Each time a combination was reviewed in detail a "D" was appended to the end of the combination name. In some cases the HRA Calculator default results were not changed as part of this review. As an additional level of conservatism, a lower bound of 1E-6 was applied to combinations that were reviewed in detail.

Request: PRA RAI 30 Risk Importance

LAR Section 4.6 (Risk Monitoring) indicates that risk significance criteria such as specific Risk Achievement Worth (RAW) values will be used. Use of RAW values would require initiating and failure event-related information. Since risk significance based on the FPRA will be used in the Monitoring Program, please confirm that this information can and will be developed using the FPRA.

NPPD Response:

RAW will be used in the monitoring process as discussed in the LAR. The Fire PRA results used to support the NFPA transition did not require use of RAW values and focus on establishing the RAW values was not a required task. The support of development of the monitoring process including the phases discussed in the LAR will require derivation of RAW values from the Fire PRA. The Fire PRA developed for the NFPA 805 transition evaluation has the capability to provide these RAW values. Therefore, RAW values will be derived as the monitoring process is fully developed.

Request: PRA RAI 31 Exclusion Analysis

NEDC 09-089 explains that the Feedwater and Condensate System (F&C) was significantly enhanced for support the FPRA and discusses an exclusionary analysis that was performed to credit the F&C in the FPRA for certain fire scenarios. Please discuss how this system and its supporting systems were modeled in the FPRA, including how random failures of components added to the enhanced model were treated. Furthermore, please discuss the results of the exclusionary analysis and how the results were used in the FPRA. Specifically, discuss additional circuit analysis performed to determine the location of both control and instrumentation and diagnostic cabling. In addition, please discuss how fire-induced impact to instrument air lines were modeled in the PRA, including how brazed instrument lines were modeled.

NPPD Response:

Condensate/Feedwater Modeling in Fire PRA and Quantification

NEDC 09-085, "*Task 7.14 Fire Risk Quantification,*" calculation states that Condensate, Feedwater, Instrument Air, and their support systems were treated as failed for all fire scenarios, with the exception where an exclusion analysis was performed to show that the fire scenario did not cause a failure of these systems. If an exclusion analysis showed that a fire would not impact any of these systems, then fire-induced failures for the components of these systems were not assumed. Non-fire-induced failures, i.e., random failures, of these systems were retained during quantification.

IEPRA modeling for Condensate, Feedwater, Instrument Air, and their support systems was retained and used in the Fire PRA. Only one change was made to the IEPRA logic structure for the Fire PRA. CNS had recently installed a new feedwater control system. The IEPRA model was based on the former system. The new system design was implemented in the Fire PRA for the purpose of RPV overfill by feedwater. Two components were added to the model for incorporating the new Feedwater control design; Triconix Feedwater Level Controller (Component ID: RFC-PLC-RXVL) and RPV level transmitter (Component ID: NBI-LT-59D); listed in PRA RAI-23 table. Both of these components were modeled using fire-induced failures. The branch of the fault tree where these components are modeled is dominated by a human failure event to control feedwater to prevent reaching the RPV high level trip. The human error probability is approximately three orders of magnitude greater than the component random failures and the random failures of the added components were not modeled. No other components were added and existing random failures were retained.

Condensate/Feedwater Exclusion Analysis

NEDC 09-089, "*Exclusionary Analysi,s*" provides the details and results of the condensate/feedwater exclusion analysis, which are summarized below.

The exclusion analysis determined that the Condensate, Feedwater, Turbine Equipment Cooling, Service Air, Service Water, and Circulating Water system components, control, and cables are predominately located in the Turbine building and Control Building. Equipment that has the potential to affect the operability of the Feedwater/Condensate that is located in the reactor building was identified and traced as documented in NEDC 09-089.

Initial Fire PRA Quantification results showed 26 specific fire scenarios in the Reactor Building where an exclusion analysis for condensate/feedwater was desirable.

Power cables were selected for condensate/feedwater components that were not already part of SAFE (Software for data and logic of deterministic aspects of fire protection). Additional components were located along with their power supplies in appropriate fire areas but cable routes were not determined unless one of the components was located within the Reactor Building. This assumption is valid because where component and power supplies are both located outside the Reactor Building power cables would not be routed into the Reactor Building and back out again. There would be a means of operating the component as long as power is available to the associated bus.

A base line of information on the Feedwater and Condensate system was gathered using existing information from CNS databases that include Edison/SAFE, SAP database, and CNS PRA system analysis. Edison/SAFE database contained the existing Appendix R and FPRA components, cables and raceway information, including their interactions through existing logics and locations within the plant. This information did not include all Feedwater and Condensate systems components or their logic ties necessary to perform this analysis. The SAP database was useful in providing a complete listing of all the components within each systems, including locations within the plant, it did not provide the necessary system interrelations. Logic ties were determined and entered into SAFE. When assigning system logics some systems were identified as having multiple functions.

A review of general design and plant layout of the Feedwater and Condensate System and associated support systems was conducted.

Additional detail and information was gathered for PRA systems using drawings and other design basis documentation to assess all possible components for system operation. This review focused on identifying those equipment and cables important to the primary and support systems and identifying those that had the potential to be located in or pass through the Reactor Building. From this review additional control cables, beyond those already identified in SAFE were deemed not required based on equipment and power supply locations.

The system design basis review was then used in conjunction with equipment failure reports to project system operation capability in the event of a specific fire at a specific location within the Reactor Building.

Instrument Air

CNS conducted a thorough review and plant walk down to identify that solder joints are not used in the Service Air/Instrument Air systems. Socket welds, butt welds or screw type joints are employed instead. Therefore loss of Instrument air due to solder joint failure is not credible.

Request: PRA RAI 32 Fire Area DW

NEDC 09-085 reports risk results (CDF/LERF) for Fire Area DW/Fire Zone Drywell. However, LAR Table W-2 does not have an entry for this fire area. Please explain this discrepancy. If the risk results for the drywell fire zone are not included in Table W-2, provide an updated table with the risk results for this fire zone/area. Please discuss whether there are any other missing fire zones/areas and, if so, provide the risk results for these areas.

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: PRA RAI 33 Torus Monitoring FRE

For the FRE performed for VFDR RBDI-05, please discuss the risk calculation. The variant case involves loss of all indication and operator actions at the ASD panel. The operator actions appear to apply only to scenarios when minimal instrumentation is available. If these actions are credited in the variant case, provide justification for their application. Also, if this scenario is a MCR abandonment scenario with control switched to the ASD panel, please provide justification for their application since such scenarios have been modeled differently in the MCR abandonment risk analysis. Further a FRE will typically model the impact of a fire. For this *scenario, it appears that the impact is not directly modeled. Please explain how the impact is modeled for the variant case.*

NPPD Response:

The strategy for Fire Area RB-DI is not control room abandonment but rather shutdown from the main control room using ADS with Train A of core spray for RPV level control and Train A of RHR in Suppression Pool Cooling mode for decay heat removal.

VFDR RBDI-5 does not involve indication at the ASD panel or using the ASD panel for shutdown, but instead involves loss of some indication in the MCR.

The applicable operator actions for RBDI-5 are manually initiating RPV depressurization and manually initiating ECCS. These actions apply to all fire scenarios within Fire Area RB-DI. The HEP used for the scenarios in RB-DI differ depending on what instrumentation is impacted by the fires. For some scenarios, all instrumentation is available and the HEP has a lower value than for other scenarios with only a minimum set of instrumentation available. The response to PRA RAI-02c provides a discussion of HEPs based on instrumentation being impacted by a fire.

In the base case for the scenarios in which some instrumentation was impacted by a fire, the actions to manually depressurize the RPV and manually initiate ECCS was set to an HEP based on minimum instrumentation being available. For the compliant case for RBDI-5, the actions were set to 100 percent success for those fire scenarios in which instrumentation was impacted by a fire. Setting the actions to 100 percent success maximizes the increase in risk for the compliant case with respect to the base case for RBDI-5.

Request: PRA RAI 34 Recovery Actions

Please explain which of the RAs in Attachment G of the LAR are included in the FPRA model. Include the basic event description and probability, and note if it is a dependent probability. In addition, please clarify which RAs are new and which are previously approved.

NPPD Response:

The table below lists the RAs from Attachment G of the LAR. These are mapped to the Fire PRA human actions credited in the Fire PRA. Not all Attachment G RAs were credited in the Fire PRA.

Included in the table is a description of the action and the human error probability used. None of the probabilities listed are dependent probabilities.

None of the RAs listed in LAR Attachment G are considered previously approved. Each RA identified in Attachment G and listed in the table below was the result of a VFDR separation issue and evaluated for acceptability through the Fire Risk Evaluation process.

LAR Attachment G Recovery Actions Mapped to Fire PRA Human Failure Events

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-A	EE-CB-4160G-1GE	BRKR F/ TIE TO D GEN NU 2	Remove control power fuses and operate the 1GE breaker as required.	YES	EAC-XHE-FI-BUS1G	OPERATOR FAILS TO ALIGN BUS 1G TO AVAILABLE POWER SOURCE	4.3E-02	Multiple Bus 1G breakers may be locally operated at Bus 1G to align Bus 1G with available power source with FPRA HFE.
CB-A	EE-CB-4160G-CSP1B	BRKR F/ CSP B	Remove control power fuses and operate the CSP1B breaker as required.	YES	ESC-XHE-FI-CSPBOMA	OPERATORS FAIL TO CLOSE EE-CB-4160G-CPPBD (CS PUMP B BREAKER) AT BUS 1G	5.2E-02	
CB-A	EE-CB-4160G-RHRP1D	BRKR F/ RHR P D	Remove control power fuses and operate the RHRP1D breaker as required.	YES	RHR-XHE-FI-RHRP1D	OPERATORS FAIL TO CLOSE EE-CB-4160G-RHRP1D (RHR PUMP D BREAKER) AT BUS 1G	2.0E-02	
CB-A	EE-CB-4160G-SWP1B	BRKR F/ SWP B	Remove control power fuses and close the SWP1B breaker as required.	YES	SWS-XHE-FI-SWPBDOMA	OPERATORS FAIL TO CLOSE EE-CB-4160G-SWP1B OR -SWP1D (SW PUMP B OR D BREAKERS) AT BUS 1G	4.2E-02	
CB-A	SW-MOV-37MV	SW P CROSSTIE	Open breaker 7A at MCC-Y. Close 37MV via handwheel.	YES	SWS-XHE-FI-37MVHDWL	OPERATOR FAILURE TO CLOSE SW-MOV-37MV USING HANDWHEEL	1.2E-02	Action is only credited in Fire Zone 7A in FPRA. Action is not credited in Fire Zones 7B, 8C, or 8D in Area CB-A in FPRA.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-A	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	YES	SWS-XHE-FI-MO89BOMA	OPERATOR FAILURE TO OPEN SW-MOV-MO89B FROM MCC Y	1.8E-02	
CB-A	SW-STNR-B	SW STNR B	Manually open SW-V-194.	NO				SWS-XHE-FI-STRBBYPS "OPERATOR FAILS TO OPEN BYPASS VALVE SW-V-194 AROUND SW-STNR-B" has HEP of 1.0 field action. Therefore never credited and always set to fail.
CB-A-1	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker as required.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
CB-B	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker as required.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	CRD-SOV-SO31A	SDV VENT & DR PILOT V SO-31A	Close IA-V-16. Remove pipe plug and open IA-V-26.	YES	RPS-XHE-FI-AIRHEADER	MANUAL ACTION TO EXHAUST SCRAM AIR HEADER FAILS	1.4E-02	Modeled for Area CB-D as follows: • Explicitly credited if command and control remains in the MCR • For MCR abandonment scenarios, included in the total CCDP and CLERP screening values of 0.1
CB-D	CRD-SOV-SO31B	SDV VENT & DR PILOT V SO-31B	Close IA-V-16. Remove pipe plug and open IA-V-26.	YES	RPS-XHE-FI-AIRHEADER	MANUAL ACTION TO EXHAUST SCRAM AIR HEADER FAILS	1.4E-02	See note for Area CB-D, Component CRD-SOV-SO31A
CB-D	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	See note for Area CB-D, Component CRD-SOV-SO31A
CB-D	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	See note for Area CB-D, Component CRD-SOV-SO31A

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	EE-CB-4160F-1FS	FDR BRKR TO 4160V BUS F FROM EMERG XFMR	Remove control power fuses and open the 1FS breaker as required.	YES	NA	NA	NA	Not explicitly modeled for CB-D as follows: • Not credited if command and control remains in the MCR • For MCR abandonment scenarios, included in the total CCDP and CLERP screening values of 0.1
CB-D	EE-CB-4160G-1GB	BRKR F/ TIE TO 4160V BUS B	Remove control power fuses and operate the 1GB breaker as required.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-CB-4160G-1GE	BRKR F/ TIE TO D GEN NU 2	Remove control power fuses and operate the 1GE breaker as required.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-CB-4160G-1GS	4160V BUS G FDR BRKR FROM EMERG XFMR	Remove control power fuses and operate the 1GS breaker as required.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-CB-4160G-RHRP1D	BRKR F/ RHR P D	Remove control power fuses and operate the RHRP1D breaker as required.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	EE-CB-4160G-SS1G	BRKR F/ 480V SUB G	Remove control power fuses and operate the SS1G breaker as required.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-CB-4160G-SWP1B	BRKR F/ SWP B	Remove control power fuses and operate the SWP1B breaker as required.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-CHG-125-1B	125VDC STA SERV BAT CHGR 1B	Repair cable.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-CHG-250-1B	250VDC STA SERV BAT CHGR 1B	Repair cable.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	EE-MCC-R-1A	MCC R XFER SW	At MCC-S, unlock and place breaker 7B, MCC-R EMER FEEDER to "ON". At MCC-R, press red EMERG button at compartment 1A, "MCC-R Fed from MCC-S".	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71A-PASSIVE	PILOT VALVE FOR MS-RV-71ARV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	MS-SOV-SPV71B-PASSIVE	PILOT VALVE FOR MS-RV-71BRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71C-PASSIVE	PILOT VALVE FOR MS-RV-71CRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71D	PILOT V F/ MSRV-71DRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71E-PASSIVE	PILOT VALVE FOR MS-RV-71ERV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71F	PILOT V F/ MS-RV-71FRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71G-PASSIVE	PILOT VALVE FOR MS-RV-71GRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	MS-SOV-SPV71H-PASSIVE	PILOT VALVE FOR MS-RV-71HRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	PC-AOV-245AV	SUPPRESSION CHAMBER EXH OUTBOARD ISO	Close IA-V-16. Remove pipe plug and open IA-V-26.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	PC-AOV-246AV	DW EXH OUTBOARD ISO	Close IA-V-16. Remove pipe plug and open IA-V-26. Close PC-V-410.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	REC-FIS-24-ASD	FC-R-1G COOLING WATER OUTLET	Monitor flow at HPCI Room inside panel TB221.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	REC-MOV-695MV-ASD	CRITICAL LOOP SUPPLY CROSSTIE	Remove control power fuses for position 8B at MCC-R and close 695MV using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	REC-MOV-712MV	REC HX A OUTLET	Open breaker 4C at MCC-Y. Close 712MV via handwheel.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	REC-MOV-713MV	REC HX B OUTLET	Open breaker 4B at MCC-RB. Close 713MV via handwheel.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	REC-MOV-714MV-ASD	SOUTH CRITICAL LOOP SUPPLY	Remove control power fuses for position 7C at MCC-Y and close 714MV using starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	RHR-MOV-MO20-ASD	RHR CROSSHEADER SHUTOFF	Remove control power fuses for position 3A at MCC-R and operate MO20 using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	RHR-MOV-MO26B-ASD	DRYWELL SPRAY LOOP B OUTBOARD ISOLATION	Remove control power fuses for position 3C at MCC-Y and operate MO26B using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	RHR-MOV-MO57-ASD	RHR DISCHARGE TO RADWASTE INBOARD THROTTLE	Remove control power fuses for position 3B at MCC-R and operate MO57 using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	RW-AOV-AO82	DW FL DR SUMP DISCH	Lift leads at TB1207 to secure power to AO82.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	RW-AOV-AO94	DW EQUIP DR SUMP DISCH	Lift leads at TB1207 to secure power to AO94.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	RWCU-MOV-MO15	SUPPLY INBOARD ISO	Remove control power fuses for position 5C at MCC-R and operate MO15 using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	SW-AOV-TCV451B-ASD	REC HX B OUTLET	Close IA-V-16. Remove pipe plug and open IA-V-26.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	SW-MOV-37MV-ASD	SW PUMPS CROSSTIE	Remove control power fuses for position 7A and operate 37MV using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	SW-MOV-651MV-ASD	REC HX B SW OUTLET	Remove control power fuses for position 6B at MCC-Y and operate 651MV using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	SW-MOV-887MV-ASD	EMERGENCY SUPPLY TO REC SOUTH CRITICAL LOOP	Remove control power fuses for position 4D at MCC-RB and operate 887MV using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	SW-MOV-889MV-ASD	EMERG RETURN FROM REC SOUTH CRITICAL LOOP	Remove control power fuses for position 5D at MCC-RB and operate 889MV using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
CB-D	SW-MOV-MO89B-ASD	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
CB-D	SW-STNR-B	SW STNR B	Manually open SW-V-194.	YES	NA	NA	NA	See note for Area CB-D, Component EE-CB-4160F-1FS
RB-A	SW-AOV-TCV451B	REC HX B OUTLET	Open breaker 5 at the CCP1B Panel.	YES	SWS-XHE-FI-TCV451B	OPERATOR FAILURE TO OPEN SW-AOV-TC451B DUE TO FIRE	1.0E-01	
RB-A	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	NO				Action was not credited in fire PRA for Area RB-A. Delta risk for this action was low.
RB-B	PC-AOV-245AV	SUPPRESSION CHAMBER EXH OUTBOARD ISO	Close IA-V-16. Remove pipe plug and open IA-V-26.	NO				PC-AOV-245AV is in the same flow path as PC-MOV-230MV. PCV-XHE-FI-230MV "OPERATOR FAILS TO ISOLATE PC-MOV-230MV AND PC-V-511" is the action that isolates this line and has HEP of 1.0 for field action. Therefore never credited and always set to fail.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-CF	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-CF	PC-MOV-231MV	DW EXH INBOARD ISO	Open breaker 2B at MCC-RA. Close PC-V-510 via handwheel. Close 231MV via handwheel.	NO				PCV-XHE-FI-231MV "OPERATOR FAILS TO ISOLATE PC-MOV-231MV AND PC-V-510" has HEP of 1.0 for field action. Therefore never credited and always set to fail.
RB-CF	RHR-MOV-MO16B	RHR P B & D MIN FLOW	De-energize RHR train A logic circuit by opening breaker 6 at AA2. Operate switch from MCR as required.	YES	RHR-XHE-FI-MO16BMCRO	OPERATOR FAILS TO OPEN RHR-MO16B FROM MCR	8.9E-02	Includes a field action before operating from MCR.
RB-CF	RW-AOV-AO82	DW FL DR SUMP DISCH	Lift leads at TB1207 to secure power to AO82.	YES	RW-XHE-FI-AO82AO83	OPERATOR FAILS TO ISOLATE DW FLOOR DRAIN SUMP LINE (RW-AO82 AND AO83)	1.0E-01	Credited in FPRA in Zones 1C and 2A-2 of Area RB-CF. Not credited in Zones 2A-3 and 2B.
RB-CF	RW-AOV-AO94	DW EQUIP DR SUMP DISCH	Lift leads at TB1207 to secure power to AO94.	YES	RW-XHE-FI-AO94AO95	OPERATOR FAILS TO ISOLATE DW EQUIP DRAIN SUMP LINE (RW-AO94 AND AO95)	1.0E-01	Credited in FPRA in Zones 1C and 2A-2 of Area RB-CF. Not credited in Zones 2A-3 and 2B.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-CF	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	NO				SWS-XHE-FI-MO89BOMA "Operator Fails to Open SW-MOV-MO89B from MCC Y" has HEP of 1.0 for field action in Area RB-CF. Therefore never credited and always set to fail in Area RB-CF.
RB-DI	CRD-SOV-SO31A	SDV VENT & DR PILOT V SO-31A	Close IA-V-16. Remove pipe plug and open IA-V-26.	YES	RPS-XHE-FI-AIRHEADER	MANUAL ACTION TO EXHAUST SCRAM AIR HEADER FAILS	1.4E-02	Credited in FPRA in Zone 2C of Area RB-DI. Not credited in Zones 1D, 1E, 2A-3, or 2D of Area RB-DI.
RB-DI	CRD-SOV-SO31B	SDV VENT & DR PILOT V SO-31B	Close IA-V-16. Remove pipe plug and open IA-V-26.	YES	RPS-XHE-FI-AIRHEADER	MANUAL ACTION TO EXHAUST SCRAM AIR HEADER FAILS	1.4E-02	Credited in FPRA in Zone 2C of Area RB-DI. Not credited in Zones 1D, 1E, 2A-3, or 2D of Area RB-DI.
RB-DI	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-DI	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-DI	MS-SOV-SPV71A-PASSIVE	PILOT VALVE FOR MS-RV-71ARV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				ADS-XHE-FO-ADSINOMA "Operators Fail to Prevent Spurious Opening of SRVs" has HEP of 1.0 for field action in Area RB-DI. Therefore never credited and always set to fail in Area RB-DI.
RB-DI	MS-SOV-SPV71B-PASSIVE	PILOT VALVE FOR MS-RV-71BRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.
RB-DI	MS-SOV-SPV71C-PASSIVE	PILOT VALVE FOR MS-RV-71CRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.
RB-DI	MS-SOV-SPV71D	PILOT V F/ MSRV-71DRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.
RB-DI	MS-SOV-SPV71E-PASSIVE	PILOT VALVE FOR MS-RV-71ERV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.
RB-DI	MS-SOV-SPV71F	PILOT V F/ MS-RV-71FRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-DI	MS-SOV-SPV71G-PASSIVE	PILOT VALVE FOR MS-RV-71GRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.
RB-DI	MS-SOV-SPV71H-PASSIVE	PILOT VALVE FOR MS-RV-71HRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	NO				See note for Area RB-DI, Component MS-SOV-SPV71A-PASSIVE.
RB-DI	NBI-LT-52A	REACTOR LEVEL TO FW CONTR	Close valve NBI-V-620.	NO				NBI-LT-52A is an input into automatic control of feedwater. Action to recover NBI-LT-52A is not included in FPRA.
RB-DI	NBI-LT-52C	REACTOR LEVEL TO FW CONTR	Close valve NBI-V-620.	NO				NBI-LT-52C is an input into automatic control of feedwater. Action to recover NBI-LT-52C is not included in FPRA.
RB-DI	NBI-LT-59A	REACTOR WTR LEVEL WIDE RANGE T	Close valve NBI-V-620.	NO				NBI-LT-59A supports RPV level indication in MCR. Operator uses all available RPV level indication for cues in fire response action and EOP actions. Recovery of NBI-LT-59A is not included in model.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-DI	NBI-LT-59C	REACTOR WTR LEVEL WIDE RANGE T	Close valve NBI-V-620.	NO				NBI-LT-59C supports RPV level indication in MCR. Operator uses all available RPV level indication for cues in fire response action and EOP actions. Recovery of NBI-LT-59C is not included in model.
RB-DI	NBI-LT-91A	REACTOR SHROUD LEVEL T	Close valve NBI-V-620.	NO				NBI-LT-91A supports RPV level indication in MCR. Operator uses all available RPV level indication for cues in fire response action and EOP actions. Recovery of NBI-LT-91A is not included in model.
RB-DI	NBI-LT-91C	REACTOR WTR LEVEL FUEL ZONE T	Close valve NBI-V-620.	NO				NBI-LT-91C supports RPV level indication in MCR. Operator uses all available RPV level indication for cues in fire response action and EOP actions. Recovery of NBI-LT-91C is not included in model.
RB-DI	NBI-PT-53A	REACTOR PRESS T	Close valve NBI-V-620.	NO				NBI-LT-53A supports RPV level indication in MCR. Operator uses all available RPV level indication for cues in fire response action and EOP actions. Recovery of NBI-LT-53A is not included in model.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-DI	NBI-PT-53C	REACTOR PRESS T	Close valve NBI-V-620.	NO				NBI-LT-53C supports RPV level indication in MCR. Operator uses all available RPV level indication for cues in fire response action and EOP actions. Recovery of NBI-LT-53C is not included in model.
RB-E	SW-AOV-TCV451A	REC HX A OUTLET	Open breaker 5 at the CCP1A Panel.	YES	SWS-XHE-FI-TCV451A	OPERATOR FAILURE TO OPEN SW-AOV-TC451A DUE TO FIRE	1.0E-01	
RB-E	SW-MOV-MO89A	RHR HX A SW OUTLET	Remove control power fuses for position 8A at MCC-Q and operate MO89A using the starter.	YES	SWS-XHE-FI-MO89AOMA	OPERATOR FAILURE TO OPEN SW-MOV-MO89A FROM MCC Q	1.8E-02	
RB-FN	EE-MCC-R-1A	MCC R XFER SW	At MCC-S, unlock and place breaker 7B, MCC-R EMER FEEDER to "ON". At MCC-R, press red EMERG button at compartment 1A, "MCC-R Fed from MCC-S".	NO				The relative importance of the action was low so was not credited in Area RB-FN for the fire PRA.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-FN	HPCI-ECCS	DUMMY COMPONENT FOR HPCI LOW RPV LEVEL/HIGH DRYWELL PRESSURE SPURIOUS INITIATION	Isolate and operate HPCI from HPCI ASD Panel.	NO				Most fire scenarios in Area RB-FN did not impact HPCI. Of those that did impact HPCI, RCIC was available as well as RPV depressurization and low pressure injection. The impact of losing HPCI for Area RB-FN was, therefore, low and recovery of HPCI was not credited for the area.
RB-FN	HPCI-FAN-GSE	HPCI GLAND SEAL EXH	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-FIC-108	P DISCH FLOW CONTR	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO14	ST SUPPLY TO TU	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO15	ST SUPPLY INBOARD ISO	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO16-PASSIVE	STEAM SUPPLY OUTBOARD ISOLATION VALVE	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO17	P SUCT FROM ECST	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-FN	HPCI-MOV-MO19	HPCI INJECT	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO20	HPCI P DISCH	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO21	HPCI-P-MP TEST BYPASS TO ECST	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO24	HPCI-P-MP TEST BYPASS TO ECST REDUNDANT SHUTOFF	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO25	HPCI-P-MP MIN FLOW BYPASS LINE ISO	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-MOV-MO58	HPCI P SUCT FROM SUPPRESSION POOL	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-P-ALOP	HPCI AUX LO P	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-P-CP	HPCI COND P	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-PI-109	P DISCH PRESS	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-FN	HPCI-PI-111	TU ST INLET PRESS	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-PI-112	TU ST EXH PRESS	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-PI-116	P SUCT PRESS	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-SI-2792	TU SI	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-FN	HPCI-TU-TURB	HPCI TU & CVL CHEST	Isolate and operate HPCI from HPCI ASD Panel.	NO				See notes for HPCI-ECCS.
RB-J	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-J	SW-MOV-MO89B	RHR HX B SW OUTLET	Remove control power fuses for position 6C at MCC-Y and operate MO89B using the starter.	YES	SWS-XHE-FI-MO89BOMA	OPERATOR FAILURE TO OPEN SW-MOV-MO89B FROM MCC Y	1.8E-02	
RB-K	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-K	EE-CB-4160C-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-K	EE-CB-4160F-RSWP1A	BRKR F/ RHR SWBP A	Remove control power fuses and operate the RSWP1A breaker as required.	NO				Recoveries of the RHR Service Water pumps are not included in the FPRA. Instead an action to allow "windmilling" of the RHRSW pumps is modeled. This allows the Service Water pumps to pump water through the RHRSW pumps to the RHR heat exchangers.
RB-K	SW-MOV-MO89A	RHR HX A SW OUTLET	Remove control power fuses for position 8A at MCC-Q and operate MO89A using the starter.	YES	SWS-XHE-FI-MO89AOMA	OPERATOR FAILURE TO OPEN SW-MOV-MO89A FROM MCC Q	1.8E-02	
RB-M	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-M	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-M	EE-CB-4160F-1FS	FDR BRKR TO 4160V BUS F FROM EMERG XFMR	Remove control power fuses and close the 1FS breaker as required.	YES	EAC-XHE-FI-BUS1F1G	OPERATOR FAILS TO ALIGN BOTH BUS 1F AND BUS 1G TO AVAIL POWER SOURCES	8.4E-02	The action EAC-XHE-FI-BUS1F1G is the alignment of both Bus 1F and Bus 1G to any available power sources, e.g., Emergency XFMR, Div 1 EDG (for Bus 1F), and Div 2 EDG (for Bus 1G). Multiple Bus 1F and Bus 1G breakers may need to be locally operated at Bus 1F and Bus 1G. In the Post NFPA 805 FPRA model, Bus 1F is not credited as being recovered for Zone 2B in Area RB-M. Both Bus 1F and 1G are credited as being recovered for Zones 3C, 3D, and 3E-2 in Area RB-M.
RB-M	EE-CB-4160F-RHRP1B	BRKR F/ RHR P B	Remove control power fuses and operate the RHRP1B breaker as required.	YES	RHR-XHE-FI-RHRP1B	OPERATORS FAIL TO CLOSE RHR PUMP B BRKR EE-CB-4160F-RHRP1B AT BUS 1F	2.0E-02	Credited in FPRA in Zones 3C, 3D, and 3E-2 of Area RB-M. Not credited in Zone 2B.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-M	EE-CB-4160F-SS1F	BRKR F/ 480V SUB F	Remove control power fuses and operate the SS1F breaker as required.	YES	EAC-XHE-FI-SS1F	OPERATOR FAILS TO ALIGN EE-CB-4160F-SS1F AT BUS 1F	2.8E-02	Credited in FPRA in Zones 3C and 3D of Area RB-M. Not credited in Zones 2B or 3E-2.
RB-M	EE-CB-4160G-1GS	4160V BUS G FDR BRKR FROM EMERG XFMR	Remove control power fuses and operate the 1GS breaker as required.	YES	EAC-XHE-FI-BUS1F1G	OPERATOR FAILS TO ALIGN BOTH BUS 1F AND BUS 1G TO AVAIL POWER SOURCES	8.4E-02	The action EAC-XHE-FI-BUS1F1G is the alignment of both Bus 1F and Bus 1G to any available power sources, e.g., Emergency XFMR, Div 1 EDG (for Bus 1F), and Div 2 EDG (for Bus 1G). Multiple Bus 1F and Bus 1G breakers may need to be locally operated at Bus 1F and Bus 1G. In the Post NFPA 805 FPRA model, Bus 1F is not credited as being recovered for Zone 2B in Area RB-M. Both Bus 1F and 1G are credited as being recovered for Zones 3C, 3D, and 3E-2 in Area RB-M.
RB-M	EE-CB-4160G-SS1G	BRKR F/ 480V SUB G	Remove control power fuses and operate the SS1G breaker as required.	YES	EAC-XHE-FI-SS1G	OPERATOR FAILS TO ALIGN EE-CB-4160G-SS1G AT BUS 1G	2.8E-02	Credited in FPRA in Zones 3C and 3D of Area RB-M. Not credited in Zones 2B or 3E-2.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-M	MS-SOV-SPV71D	PILOT V F/ MSRV-71DRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	ADS-XHE-FO-ADSINOMA	OPERATORS FAIL TO PREVENT SPURIOUS OPENING OF SRVS	3.5E-02	Credited for Zones 3C, 3D, and 3E-2 in FPRA. Not credited for Zone 2B in FPRA.
RB-M	MS-SOV-SPV71F	PILOT V F/ MS-RV-71FRV	Open breaker 15 at Panel AA2. Open breaker 8 at Panel BB2.	YES	ADS-XHE-FO-ADSINOMA	OPERATORS FAIL TO PREVENT SPURIOUS OPENING OF SRVS	3.5E-02	Credited for Zones 3C, 3D, and 3E-2 in FPRA. Not credited for Zone 2B in FPRA.
RB-M	PC-MOV-231MV	DW EXH INBOARD ISO	Open breaker 2B at MCC-RA. Close PC-V-510 via handwheel. Close 231MV via handwheel.	NO				PCV-XHE-FI-231MV "OPERATPOR FAILS TO ISOLATE PC-MOV-231MV AND PC-V-510" has HEP of 1.0 for field action. Therefore never credited and always set to fail.
RB-M	RCIC-ECCS	DUMMY COMPONENT FOR RCIC LOW RPV LEVEL SPURIOUS INITIATION	Place switch IS/RCIC in the Aux Relay Room to "ISOLATE".	NO				Scenario 7l in the MSO Expert Panel Report assessed the potential for spurious operation of RCIC. This was determined to have no impact on accident progression and deemed not applicable to Cooper Nuclear Station.
RB-M	RCIC-MOV-MO131	RCIC ST SUPPLY TO RCIC TU	Place IS/RCIC switch in the Aux Relay room to "ISOLATE".	YES	ESC-XHE-FI-RCICOMA	OPERATOR FAILS TO ISOLATE RCIC IN AUX RLY ROOM & OPERATE FROM MCR	8.0E-02	Credited for Zones 3C, 3D, and 3E-2 in FPRA. Not credited for Zone 2B in FPRA.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
RB-M	RCIC-MOV-MO18	RCIC SUPPLY FROM COND STORAGE	Place IS/RCIC switch in the Aux Relay room to "ISOLATE".	YES	ESC-XHE-FI-RCICOMA	OPERATOR FAILS TO ISOLATE RCIC IN AUX RLY ROOM & OPERATE FROM MCR	8.0E-02	Credited for Zones 3C, 3D, and 3E-2 in FPRA. Not credited for Zone 2B in FPRA.
RB-P	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-P	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-V	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
RB-V	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
TB-A	EE-CB-4160C-1CS	BRKR F/ FDR TO 4160V BUS C FROM SU XFMR	Remove control power fuses and open the 1CS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
TB-A	EE-CB-4160D-1DS	BRKR F/ FDR TO 4160V BUS D FROM SU XFMR	Remove control power fuses and open the 1DS breaker.	YES	RRS-XHE-FI-RRTRIPOMA	OPERATOR FAILS TO TRIP RX RECIRC PUMPS FROM BUSES 1C & 1D ON LOSS OF RX BLDG EQUIP CLNG WATER (REC)	4.7E-03	
TB-A	EE-CB-4160DG1-EG1	BRKR F/ D GEN NU 1 OUTPUT	Remove control power fuses and close the EG1 breaker as required.	YES	EAC-XHE-FI-BUS1F1G	OPERATOR FAILS TO ALIGN BOTH BUS 1F AND BUS 1G TO AVAIL POWER SOURCES	8.4E-02	The action EAC-XHE-FI-BUS1F1G is the alignment of both Bus 1F and Bus 1G to any available power sources, e.g., Emergency XFMR, Div 1 EDG (for Bus 1F), and Div 2 EDG (for Bus 1G). Multiple Bus 1F and Bus 1G breakers may need to be locally operated at Bus 1F and Bus 1G.
TB-A	EE-CB-4160F-1FA	BRKR F/ TIE TO 4160V BUS A	Remove control power fuses and open the 1FA breaker as required.	YES	EAC-XHE-FI-BUS1F1G	OPERATOR FAILS TO ALIGN BOTH BUS 1F AND BUS 1G TO AVAIL POWER SOURCES	8.4E-02	The action EAC-XHE-FI-BUS1F1G is the alignment of both Bus 1F and Bus 1G to any available power sources, e.g., Emergency XFMR, Div 1 EDG (for Bus 1F), and Div 2 EDG (for Bus 1G). Multiple Bus 1F and Bus 1G breakers may need to be locally operated at Bus 1F and Bus 1G.

Fire Area	Component	Component Description	Recovery Actions	Credited in Fire PRA	Human Failure Event in Fire PRA	HFE Description	Human Error Probability	Notes for Modeling in FPRA
TB-A	EE-CB-4160F-1FS	FDR BRKR TO 4160V BUS F FROM EMERG XFMR	Remove control power fuses and open the 1FS breaker as required.	YES	EAC-XHE-FI-BUS1F1G	OPERATOR FAILS TO ALIGN BOTH BUS 1F AND BUS 1G TO AVAIL POWER SOURCES	8.4E-02	The action EAC-XHE-FI-BUS1F1G is the alignment of both Bus 1F and Bus 1G to any available power sources, e.g., Emergency XFMR, Div 1 EDG (for Bus 1F), and Div 2 EDG (for Bus 1G). Multiple Bus 1F and Bus 1G breakers may need to be locally operated at Bus 1F and Bus 1G.

Radioactive Release (RR)

Request: RR RAI 01

Please provide information on the availability and use of spill control kits, temporary dikes, storm drain covers, retention ponds, settling ponds, etc. for containment of liquid effluents in areas where permanent engineering controls are not in place (e.g., tanks, sumps, concrete containment, etc.).

NPPD Response:

In the unlikely event that external containment is determined to be necessary, depending on the amount of contaminated liquid to be contained, containment can vary from the use of HAZMAT containment materials (pads and pigs) located in the Fire House and Fire Locker "D" (as identified in Procedure 15.FP.650) to the installation of flooding material (i.e. sandbags, construction material, etc.) located in a sea-van on the Low Level Radwaste Pad (as identified in Procedure 7.0.11).

Request: RR RAI 02

In areas where containment of gaseous and liquid effluents is not achieved and radiation monitoring is credited as a mitigating measure:

a. *Please describe the actions to be taken or methods to be used to minimize radioactive effluent (e.g., closing of doors, shutting off smoke educators).*

b. *For these areas, please provide a qualitative or quantitative bounding analysis to ensure that the 10 CFR 20 annual dose limits for members of the public will be met.*

NPPD Response:

Radiation monitoring has not been credited as a mitigating measure but rather as a Radiation Protection means to determine the radiological extent of the event. For gaseous effluent, Calculation NEDC 11-148 was developed as a quantitative bounding analysis to preclude any required actions such as closing of doors or shutting off smoke ejectors by demonstrating dose acceptability even if 100% of the activity of a Sea-Land is released instantaneously without any containment. For liquid effluent, NEDC 11-148 Revision 1, Attachment S, provides an evaluation to demonstrate that drainage systems are more than adequate to contain fire fighting water in the Multi-Purpose Facility such that any liquid effluent escape from the building is minimal and therefore dose limit criteria is not a concern. In addition, the response to RR RAI-01 applies based on the extent of the release of any fire fighting water that may escape a building.

Request: RR RAI 03

Please explain the potential discrepancy between statements in the LAR, Section 4.4, Radioactive Release Performance Criteria, that the methodology used was based on guidance in NFPA 805 Task Force FAQ 09-0056 (related to meeting limitations for instantaneous release of radioactive effluents in a licensee's Technical Specifications) and the analyses and conclusions in calculation NEDC 10-062 and NEDC 11-148 which conclude that the offsite radioactive effluent releases will be limited to less than the annual dose limits of 10 CFR 20.

NPPD Response:

This RAI will be addressed in the 90-day response.

Monitoring Program

Request: Monitoring Program RAI 01

Please describe the process that will be used to identify SSCs for inclusion in the NFPA 805 monitoring program. Include an explanation of how SSCs that are already within the scope of the Maintenance Rule program will be addressed with respect to the NFPA 805 monitoring program.

NPPD Response:

The process outlined in LAR Transition Report Section 4.6.2 aligns with the approved FAQ 10-0059 and its related closure memo. Section 4.6.2 describes the process by which SSCs will be identified for inclusion in the NFPA 805 monitoring program, including the approach to be applied to any fire protection and nuclear safety capability SSCs that are already included within the scope of the Maintenance Rule program.

Request: Monitoring Program RAI 02

Please describe the process that will be used to assign availability, reliability, and performance goals to SSCs within the scope of the NFPA 805 monitoring program including the approach to be applied to SSCs for which availability, reliability, and performance goals are not readily quantified. Please describe how SSCs that fail to meet assigned availability, reliability, or performance goals will be addressed.

NPPD Response:

The process outlined in LAR Transition Report Section 4.6.2 aligns with the approved FAQ 10-0059 and its related closure memo. Section 4.6.2 provides a description of the process that will be used to assign availability, reliability, and performance goals to High Safety Significant (HSS) SSCs within the scope of the monitoring program. Low Safety Significant (LSS) SSCs do not specifically require assignment of availability, reliability, and performance goals. Programmatic elements such as fire brigade performance, fire watches, combustible controls, etc., will be evaluated using the existing program health process. It is not practical to assign target values of reliability and availability to these attributes so their effectiveness is based on objective and anecdotal evidence evaluated by plant personnel in charge of the fire protection programs as is currently practiced. It is the intent to revise existing CNS procedures currently in place (e.g. corrective action process) to address SSCs that fail to meet availability, reliability, or performance goals.

Request: Monitoring Program RAI 03

Please describe how the NFPA 805 monitoring program addresses programmatic elements that fail to meet performance goals (examples include discrepancies in programmatic areas such as combustible controls programs).

NPPD Response:

The process outlined in LAR Transition Report Section 4.6.2 aligns with the approved FAQ 10-0059 and its related closure memo. Section 4.6.2 provides a description of how the monitoring program will address response to programmatic elements that fail to meet performance goals. Training is implicitly included within the performance regarding programmatic elements. Programmatic elements that fail to meet their performance goals will be entered into the Corrective Action Program (CAP). Corrective action plans will be developed using appropriate CNS Processes to address the performance deficiencies.

Request: Monitoring Program RAI 04

Please describe how the NFPA 805 monitoring program addresses fundamental fire protection program elements.

NPPD Response:

The process outlined in LAR Transition Report Section 4.6.2 aligns with the approved FAQ 10-0059 and its related closure memo. Section 4.6.2 provides a description of how the monitoring program addresses fire protection systems and features and programmatic elements. Fire protection program elements will consist of Transient Combustible Control, Hot Work Control, Control of Ignition Sources, Impairment and Compensatory Measures and Industrial Fire Brigade. These elements will be monitored through the CAP process, permits, health reports, self-assessments and drill performance critiques and compared to established performance criteria.

Request: Monitoring Program RAI 05

Please describe how periodic assessments of the monitoring program will be performed taking into account, where practical, industry wide operating experience, including whether this process will include both internal and external assessments and the frequency at which these assessments will be performed.

NPPD Response:

The process outlined in LAR Transition Report Section 4.6.2 aligns with the approved FAQ 10-0059 and its related closure memo. Section 4.6.2 provides a description of how periodic assessments of the monitoring program will be performed. Guidance for performing assessments is provided in Procedure EN-LI-104, Self-Assessment and Benchmark Process. Periodic assessments will be performed every two to three operating cycles and will taking into account internal and external operating experience.

Programmatic

Request: Programmatic RAI 01

Please describe the specific documents that will comprise the post transition design basis document in accordance with NFPA 805 Section 2.7.1.2.

NPPD Response:

The post-transition NFPA 805 fire protection program design basis for specific fire areas will be documented calculations designated as Fire Safety Analyses. For generic design basis, it will be documented in calculations developed for the B-1 table (Attachment A) and Radiation Release (Attachment E).

Request: Programmatic RAI 02

Please describe the changes that are anticipated to the configuration control program to incorporate the requirements of the NFPA 805 Section 2.7.2.

NPPD Response:

NPPD anticipates incorporating the process described in FAQ 12-061 that is currently being vetted through the FAQ process into existing CNS procedures.

Request: Programmatic RAI 03

Please describe the changes that are anticipated to the fire protection program manual as a part of the NFPA 805 transition process, including associated training and identification of the recipients of any such training necessary to support the program changes.

NPPD Response:

NPPD anticipates updating Procedure 0.23, CNS Fire Protection Plan, to reflect changes noted in the LAR and final Safety Evaluation. A Training Needs Analysis will be completed to determine additional training that will need be conducted to support to support the implementation to NFPA 805 based Fire Protection Program. This will include the determining the various levels of training that will be conducted and the recipient of such training.

Request: Programmatic RAI 04

Please describe where the requirements for periodic assessments (audits) of the fire protection program will reside in the NFPA 805 program documentation and how these requirements are anticipated to differ from the current requirements.

NPPD Response:

CNS Procedure 0.23, CNS Fire Protection Plan, will be updated to address requirements for periodic assessments (audits) of the fire protection program.

Request: Programmatic RAI 05

Please describe how the NFPA 805 plant change evaluation process will be implemented post-transition. Include identification of specific documents that need to be developed or changed to support the process, a description of how these documents will implement the process presented in Section 4.7.2 of the LAR, and a description of the training program that will support the change evaluation process to include who will be trained and how the training will be implemented (e.g., classroom, computer-based, reading program).

NPPD Response:

NPPD anticipates incorporating the process described in FAQ 12-061 that is currently being vetted through the FAQ process into existing CNS procedures.

Request: Programmatic RAI 06

Please describe how the combustible loading program will be administered to ensure that FPRA assumptions regarding combustible loading are met.

NPPD Response:

CNS Procedure 0.23, CNS Fire Protection Plan, will be updated to document the combustible loading program controls. Procedure 0.7.1, "Control of Combustibles," will be revised and will provide administrative controls of combustibles in the plant. Combustible loading that impact the FPRA are documented in Fire Modeling calculations. These calculations are controlled by Procedure 3.4.7, "Design Calculations," and will be used to maintain FPRA assumptions.

Request: Programmatic RAI 07

Please describe your commitment to conduct future NFPA 805 analyses in accordance with the requirements of NFPA 805 Section 2.7.3, Compliance with Quality Requirements.

NPPD Response:

As stated in LAR Section 4.7.3, NPPD will maintain the existing Fire Protection Quality Assurance program as outlined in the CNS Quality Assurance Program for Operation - Policy Document, as implemented by CNS Quality Assurance procedures. The Fire Protection Program procedures will be revised to specify application of the NFPA 805 Section 2.7.3 quality requirements (see Implementation Item S-3.8 of Attachment S, Table S-3).

LAR Section 4.7.3 documented compliance to NFPA 805 Section 2.7.3 in regards to the quality requirement for documents that were completed or revised to support the NFPA 805 LAR submittal. To clarify, all future documents prepared or revised to support the NFPA 805 based Fire Protection Program will meet the requirements of NFPA 805 Section 2.7.3.

Fire Modeling

Request: Fire Modeling RAI 01

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

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

a. *It appears that non-cable intervening combustibles were missed in some areas of the plant. An example is the combustible insulation of the heat exchangers in fire area RB-M. Please explain how non-cable secondary combustibles were accounted for in the fire modeling analyses. In addition, please describe the criteria that were used to determine when a secondary combustible could be ignored in the zone-of-influence (ZOI) calculations. Please identify where secondary combustibles were not and should have been considered, and assess the impact on the risk of including scenarios involving the intervening combustibles in the fire modeling analyses.*

b. *Please explain why the effect of the size of the ventilation opening was not evaluated in the temperature sensitive equipment hot gas layer (HGL) study, or revise the analysis to include the ventilation opening size.*

NPPD Response:

This will be addressed in the 90-day response.

Request: Fire Modeling RAI 01 (continued)

c. *In the structural steel analysis for beams in areas 13A and 20B, the flame height exceeds the elevation of the beams. Please explain why the gas temperature around the beams used in the analysis is lower than the flame temperature, or revise the analysis to reflect the flame temperature.*

d. *The fire resistance of the columns in area 13A is determined from an empirical method that is based on test data from American Society of Testing Materials (ASTM) Standard E119, "Standard Test Methods for Fire Tests of Building Construction and Materials," exposure. In the pool fire scenario that is considered in the structural steel analysis, the lower part of the columns are exposed to a more severe hydrocarbon fire. Please provide justification for using an empirical method that is based on ASTM E119 test data, or revise the analysis to reflect the more severe hydrocarbon fire.*

e. *Please explain how it is ensured that the model assumptions in terms of transient combustibles in a fire area or zone will not be violated during and post-transition.*

NPPD Response:

c. For Fire Zone 13A, the results of NUREG-1805 FDT 09, "*Estimating Centerline Plume Temperature of a Buoyant Fire Plume*," calculate a flame height of 78.1 feet, therefore, there is the potential for the steel beams to be exposed to direct flame impingement and temperatures in excess of those within the plume. Per NUREG-1805, most open flames of any fuel type produce flame temperatures in the region of 2000°F. Specifically for large pool fires, flame temperatures can rise up to 2192°F (NUREG-1805). Conservatively assuming an exposure flame temperature of 2200°F, the results of the lumped capacitance calculation determine that when the beam is exposed to direct flame impingement for 54 seconds, the final temperature of the beam is 215°F, which is well below the failure threshold of 1100°F.

Fire Zone 13A 21WF62 Beam Flame Exposure		
Beam Dimension	in	ft
Depth	20.99	1.75
Width	8.24	0.69
Web Thickness	0.40	0.03
	in²	ft²
Cross Sectional Area	18.30	0.13
Spill Characteristics	in²	ft²
Spill Area	348624.00	2421.00
	in	ft
Radius of Spill	333.21	27.77
Diameter of Spill	666.41	55.53
Length (Distance of Exposure, Distance of Exposure = Diameter of Spill)	666.41	55.53
Properties of Steel		
h	28.20	W/m²*K
ρ	7800.00	kg/m³
C	579.00	J/kg*K
Exposure Time	0.90	minutes
	54.00	seconds
Initial Temp	313.00	K
Exposure Temp	1478.00	K

Prepared by:	TMG
Reviewed by:	JEB

	in²	m²
As	49742.79	32.09
V	12195.37	0.20

Beam Temperature	
374.40	Kelvin
101.40	°C
214.53	°F

Programmed equations:

$$\frac{\theta}{\theta_i} = \frac{T - T_\infty}{T_i - T_\infty} = exp\left[-t\left(\frac{hA_s}{\rho Vc}\right)\right]$$

$$A_s = [4(width) + 2(depth) - 2(web\ thickness)]length + [cross\ sectional\ area]^2$$

The impact on the structural steel for the worst-case fire scenario for Fire Zone 20B is bound by the calculations performed for Fire Zone 13A and an unconfined oil spill will not adversely impact the exposed structural steel members located in Fire Zone 20B. The spill area required to produce the minimum fire size is large enough such that the 53 gallons of oil would be consumed prior to failure of the exposed structural steel.

NEDC 09-090, "*Exposed Structural Steel Impact*," will be revised to document this updated analysis.

d. ASTM E119 test data is based on specimen response during exposure to a furnace. The steel columns in Fire Zone 13A could be exposed to more severe fire conditions due to the hydrocarbon pool fire. The empirical method based on the ASTM E119 has been removed from the analysis. Instead, the lumped capacitance method was utilized to determine the impact of direct flame impingement on the unprotected columns.

There is the potential for the steel columns in Fire Zone 13A to be exposed to direct flame impingement. Per NUREG-1805, most open flames of any fuel type produce flame temperatures in the region of 2000°F. Specifically for large pool fires, flame temperatures can rise up to 2192°F (NUREG-1805). Conservatively assuming an exposure flame temperature of 2200°F, the results of the lumped capacitance calculation determine that when the entire length of the column is exposed to direct flame impingement for 54 seconds, the final temperature of the beam is 131°F, which is well below the failure threshold of 1100°F.

Fire Zone 13A 14WF398 Column Flame Exposure		
Column Dimension	in	ft
Depth	18.29	1.52
Width	16.59	1.38
Web Thickness	1.77	0.15
	in²	ft²
Cross Sectional Area	117.00	0.81
Spill Characteristics	in²	ft²
Spill Area	348624.00	2421.00
	in	ft
Radius of Spill	333.21	27.77
Diameter of Spill	666.41	55.53
Length (Distance of Exposure, Assumed entire column exposed to flame)	876.00	73.00
Properties of Steel		
h	28.20	W/m²*K
p	7800.00	kg/m³
C	579.00	J/kg*K
Exposure Time	0.90	minutes
	54.00	seconds
Initial Temp	313.00	K
Exposure Temp	1478.00	K

Prepared by:	TMG
Reviewed by:	JEB

	in²	m²
As	100763.40	65.01
V	102492.00	1.68

Beam Temperature	
328.11	Kelvin
55.11	°C
131.19	°F

Programmed equations:

$$\frac{\theta}{\theta_i} = \frac{T - T_\infty}{T_i - T_\infty} = exp\left[-t\left(\frac{hA_s}{\rho V c}\right)\right]$$

$$A_s = [4(width) + 2(depth) - 2(web\ thickness)]length + [cross\ sectional\ area]^2$$

The impact on the structural steel for the worst-case fire scenario for Fire Zone 20B is bound by the calculations performed for Fire Zone 13A and an unconfined oil spill will not adversely impact the exposed structural steel members located in Fire Zone 20B. The spill area required to produce the minimum fire size is large enough such that the 53 gallons of oil would be consumed prior to failure of the exposed structural steel.

NEDC 09-090, "*Exposed Structural Steel Impact*," will be revised to document this updated analysis.

e. CNS utilizes a combustible control program established in Administrative Procedure 0.7.1, "Control of Combustibles". This procedure establishes the combustible control zone levels for each fire zone in the plant. These control zone levels, along with plant walkdowns, were utilized as input to the Ignition Frequency Calculation transient storage influencing factor which supports the transient fire frequencies. Procedure 0.7.1 requires that paper, cardboard, scrap wood, rags and other trash shall not be allowed to accumulate in any area except in containers intended for the disposal of such debris which provides assurance that the 317 kW transient fire scenarios modeled in the FPRA would be bounding. Procedure 0.7.1 requires the Fire Protection group to evaluate conditions and specify compensatory measures, when necessary, and perform periodic tours to evaluate implementation of the procedure in the field. Transient Combustible Evaluations are processed prior to the introduction of new combustible materials into the plant as required by Procedure 0.7.1.

A 69 kW transient heat release rate was utilized for Fire Zones 8A (Auxiliary Relay Room) and 9A (Cable Spreading Room) based on several factors, such as these fire zones being subject to enhanced strict combustible controls (areas designated as "No Storage") and paper, cardboard, scrap wood, rags and other trash shall not be allowed to accumulate in the area. Since only small quantities of trash in temporary containers can be expected, a 69 kW peak heat release rate was determined to be appropriate to represent this quantity of combustibles. The 69 kW heat release rate bounds the small trash can fires reported in NUREG/CR-6850 Appendix G. The Auxiliary Relay Room (Fire Zone 8A) is a locked room requiring keyed access through Work Control and the Cable Spreading Room (Fire Zone 9A) is a badge access required area.

Enhanced transient and combustible controlled locations are also utilized for the areas around Instrument Racks 25-5 and 25-6 in Fire Zones 3C and 3D and the area above the TIP Room in Fire Zone 2C through the development of enhanced strict combustible controls such as designated "No Storage" area which prevent combustibles from accumulating in these areas. Specifically, the areas around Instrument Racks 25-5 and 25-6 in Fire Zones 3C and 3D are cordoned off with steel posts and chains, and the area above the TIP Room in Fire Zone 2C is accessible via stair only.

Refer to FPE RAI 08 for details of the enhanced combustible and hot work controls for these fire zones.

Request: Fire Modeling RAI 01 (continued)

f. *Regarding the use of the algebraic models:*

   i. *Please explain how fire location corner and wall proximity effects are accounted for in the method of McCaffrey, Quintiere, and Harkleroad for calculating HGL temperature; and in Alpert's method for calculating ceiling jet temperature.*

   ii. *Please describe in detail how the time to sprinkler actuation and the time to heat and smoke detector actuation was calculated. In particular, please describe and justify any use of steady-state models to time-varying conditions.*

   iii. *Please explain how the damage threshold for targets in a mixed convective/radiative environment was established. The response should also address FPRA F&O 3-9 under FSS-D1.*

   iv. *Please explain how the elevation and dimensions of ignition source fires were determined. If the height and dimensions were not adjusted following ignition of secondary combustibles, justify why not.*

NPPD Response:

This will be addressed in the 90-day response.

Request: Fire Modeling RAI 01 (continued)

g. *Regarding the use of the Consolidated Model of Fire Growth and Smoke Transport (CFAST) in a multi-compartment analysis, please provide the input files in electronic format (*.in and *.o) for all CFAST runs that were conducted in support of this multi-compartment analysis.*

NPPD Response:

The CFAST input files (*.in and *.o) for NEDC 10-024 were provided in an e-mail to Leslie Fields (NRC NFPA 805 Project Manager) from Bill Victor (CNS NFPA 805 Transition Project Licensing Lead) on January 7, 2013.

Request: Fire Modeling RAI 01 (continued)

h. *Regarding the use of Fire Dynamics Simulator (FDS) in the MCR abandonment study:*

   i. *Please provide the input files in electronic format (*.fds) for all FDS runs that were conducted in support of the MCR abandonment time study.*

ii. *Please provide justification for assuming an alarm set point of 8.2 percent per meter of smoke detector SD-1001 in the CSR.*

iii. *Please provide justification for using a response time index (RTI) of 132 $m^{1/2}s^{1/2}$ for the fusible link of the dampers between the MCR and the CSR.*

NPPD Response:

This RAI will be addressed in the 90-day response.

Request: Fire Modeling RAI 02

Section 4.5.1.2, "Fire PRA" of the Transition Report 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, "Fire Modeling V&V," for a discussion of the verification and validation (V&V) of the fire models that were used. Furthermore, Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," of the Transition Report states that "Calculational models and numerical methods used in support of compliance with 10 CFR 50.48(c) were verified and validated as required by Section 2.7.3.2 of NFPA 805."

Regarding the V&V of fire models:

a. *Attachment J of the Transition Report states that the algebraic models implemented in the FDTs and Fire Induced Vulnerability Evaluation (FIVE), Rev.1, were used to characterize flame radiation, flame height, plume temperature, ceiling jet temperature and HGL temperature. However, the FDTs and/or FIVE, Rev. 1 spreadsheets were not used to perform the calculations, but selected algebraic models from NUREG-1805, "Fire Dynamics Tools (FDT^S) Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program," and FIVE, Rev. 1, were used in a new spreadsheet (or set of spreadsheets). Please describe how this new (set of) spreadsheet(s) was verified (i.e., how was it ensured that the empirical equations and correlations were coded correctly and that the solutions are identical to those that would be obtained with the corresponding chapters in NUREG-1805 or FIVE, Rev. 1).*

NPPD Response:

The Fire Modeling Workbook was verified, by "black box" testing, to ensure that the results were identical to the verified and validated models. "Black box" testing (also called functional testing) is testing that ignores the internal mechanism of a system or component and focuses solely on the outputs generated in response to selected inputs and execution conditions.

The process compared results from the Fire Modeling Workbook to those produced by the NUREG-1805 Fire Dynamic Tools and Fire-Induced Vulnerability Evaluation when identical inputs were entered into both. Since the correlations from NUREG-1805 Fire Dynamic Tools and Fire-Induced Vulnerability Evaluation, Revision 1, were verified and validated in NUREG-

1824, and the results match the results produced by the Fire Modeling Workbook, by the transitive property, the Fire Modeling Workbook is verified and validated with respect to NUREG-1824.

The results of this verification are documented in NEDC 10-020, "Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and Fire PRA Applications."

Request: Fire Modeling RAI 02 (continued)

b. *For V&V of the aforementioned algebraic models, reference is made to NUREG-1824, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications." Please provide technical details to demonstrate that the algebraic models have been applied within the validated range of input parameters, or to justify the application of the equations outside the validated range reported in NUREG-1824.*

c. *Please provide technical details to demonstrate that CFAST has been applied in the multi-compartment analysis for zones 7A and 8A and the sensitive equipment HGL study within the validated range of input parameters, or to justify the application of the model outside the validated range reported in NUREG-1824.*

d. *Please provide technical details to demonstrate that FDS has been applied in the MCR abandonment study and plume/HGL study within the validated range of input parameters, or to justify the application of the model outside the validated range reported in NUREG-1824.*

e. *Please provide the V&V basis for the method that models a smoke detector as a heat detector and uses a temperature increase of 10°C as the criterion for detector actuation. The response to this question should also address FPRA F&O 3-1 under FSS-D1.*

NPPD Response:

These RAI elements will be addressed in the 120-day (element b) and 90-day (elements c, d, and e) responses, respectively.

Request: Fire Modeling RAI 02 (continued)

f. *Please provide the V&V basis for the plume temperature equation (3.2.9) in the book by Zalosh on Industrial Fire Protection Engineering that is used in the structural steel analysis for fire zones 13A and 208.*

NPPD Response:

Calculations using Zalosh's plume temperature equation (3.2.9) will be removed from Calculation NEDC 09-090. As a bounding approach for Fire Zone 13A, the exposure temperature was analyzed as the calculated centerline plume temperature using NUREG-1805 FDT 09, "*Estimating Centerline Plume Temperature of a Buoyant Fire Plume.*" Given a

403.5MW fire, a fire area of 2421 ft², an ambient temperature of 104°F, and an elevation above the fire source of 67.5 ft, the centerline plume temperature is calculated as 1187°F.

A plume calculation was not required for Fire Zone 20B. For the unconfined spill of 53 gallons of oil and a spill area of 777 ft², FDT 03, "*Estimating Burning Characteristics of Liquid Pool Fire, Heat Release Rate, Burning Duration, and Flame Height,*" calculated the fire would burn out in 54 seconds and therefore would not cause the exposed steel members to be compromised. The impact on the structural steel for the worst-case fire scenario for Fire Zone 20B is bound by the calculations performed for Fire Zone 13A and an unconfined oil spill will not adversely impact the exposed structural steel members located in Fire Zone 20B. The spill area required to produce the calculated fire size is large enough such that the 53 gallons of oil would be consumed prior to failure of the exposed structural steel.

NEDC 09-090, "*Exposed Structural Steel Impact*," will be revised to document this updated analysis.

Request: Fire Modeling RAI 03

Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," of the Transition Report states that "Engineering methods and numerical models used in support of compliance with 10 CFR 50.48(c) were and are used with the same limitations and assumptions supported by the V&V for the methods as required by Section 2.7.3.3 of NFPA 805."

Regarding the limitations of use, FPRA F&O 3-12 under FSS-D1 states that there are no clear limits on the applicability of the ZOI parameters. Please identify uses, if any, of the fire modeling tools outside the limits of applicability of the method and, for those cases, explain how the use of the fire modeling approach was justified.

NPPD Response:

The limitations and assumptions associated with the fire modeling tools are documented in NUREG-1824 and Calculation NEDC 10-020, "*Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and Fire PRA Applications.*"

In most cases, the subject correlations have been applied within the limits of applicability reported in NUREG-1824. Cases where the models have been applied outside of the defined limits have been justified as acceptable as follows:

Flame Height (Method of Heskestad)

The correlation is used within the limits of its range of applicability with the exceptions of the fire scenarios provided below. Scenarios in which flame height exceeds compartment ceiling height were addressed on a scenario-by-scenario basis, as appropriate, in the compartment-specific Detailed Fire Modeling Reports. Justification and evaluation of this limitation and the impact on zone of influence (ZOI) is provided in the applicable individual reports and summarized below:

Fire Compartment	Fire Zone	Ignition Source	Validity Statement
CB-A	7A	SA-CPSR-A	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A	7A	SA-CPSR-B	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A	7A	SA-CPSR-C	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A	7A	SW-P-BPA	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A	7A	SW-P-BPB	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A	7A	SW-P-BPC	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A	7A	SW-P-BPD	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
CB-A-1	8H	EE-IVTR-1A	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-A-1	8H	EE-SWGR-125 1A	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-A-1	8H	EE-SWGR-250 1A	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-B	8G	EE-SWGR-125 1B	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-B	8G	EE-SWGR-250 1B	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.

Fire Compartment	Fire Zone	Ignition Source	Validity Statement
CB-E	9A	EE-PNL-CPP	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	EE-PNL-NBPP	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	EE-PNL-RPSPP1A	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	EE-PNL-RPSPP1B	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	LRP-PNL-PL1	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	LRP-PNL-PL2	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	PC-CS-H2_O2I	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	PC-CS-H2_O2II	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	PMIS-MUX-LNK2	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.

Fire Compartment	Fire Zone	Ignition Source	Validity Statement
CB-E	9A	RFC-CC-1A	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	RFC-CC-1B	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-E	9A	APARS BD	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-F	9B	Transient Scenario TS#1	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
CB-F	9B	Transient Scenario TS#2	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from horizontal flame spread along cable trays which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
DG-A	14A	DG-D-1	The calculated flame height exceeds the ceiling height of the fire zone, however, this large diesel oil fire damage state results in whole room damage bounding the ZOI.
DG-B	14B	DG-D-2	The calculated flame height exceeds the ceiling height of the fire zone, however, this large diesel oil fire damage state results in whole room damage bounding the ZOI.
IS-A	20A	FP-P-C	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
IS-A	20A	SW-P-A	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
IS-A	20A	SW-P-B	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
IS-A	20A	SW-P-C	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
IS-A	20A	SW-P-D	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
NCS	13B	EE-SWGR-4160A	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.

Fire Compartment	Fire Zone	Ignition Source	Validity Statement
NCS	13B	EE-SWGR-4160B	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
NCS	13B	EE-SWGR-4160C	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
NCS	13B	EE-SWGR-4160D	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
NCS	13B	EE-SWGR-4160E	The calculated flame height exceeds the ceiling height of the fire zone, however, the calculations conservatively assume the fire diameter remains constant. The fire growth in this scenario results from fire spread to adjacent electrical cabinet vertical sections which would result in an increase of fire diameter and a decrease in flame height. Therefore, the calculated zone of influence is appropriate for analysis of this hazard.
RB	1A	CS-P-A	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	1B	CS-P-B	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	1D	RHR-P-B	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	1D	RHR-P-D	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	1G	CRD-P-A	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	1G	CRD-P-B	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	4C	RWCU-P-PP	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	4D	RRLO-P-A1	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	4D	RRLO-P-A2	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	4D	RRLO-P-A3	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	4D	RRLO-P-B1	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.

Fire Compartment	Fire Zone	Ignition Source	Validity Statement
RB	4D	RRLO-P-B2	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	4D	RRLO-P-B3	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	5B	RRMG-GEN-MGA	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
RB	5B	RRMG-GEN-MGB	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
TB-A	11B	CW-P-VPA	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.
TB-A	11B	CW-P-VPB	The calculated flame height exceeds the ceiling height of the fire zone, however, this large oil fire damage state results in whole room damage bounding the ZOI.

Plume Temperature (Method of Heskestad)

The following limitation applies to the Heskestad correlation for plume temperature:

- *The correlation will under-predict the plume temperature if the ambient temperature is at an elevated temperature. In this situation, the difference between the plume temperature and the ambient temperature will be small, the thermal plume will cool less effectively, and the correlation will subsequently underestimate the temperature.*

The correlation is used within the limits of its range of applicability with the exceptions of the fire scenarios discussed below. The Heskestad correlation for estimating plume temperature was given a grade of YELLOW- in NUREG-1824. Because Heskestad based this correlation on empirical data, it was deemed physically appropriate. However, the correlation frequently under-predicts the plume temperature outside of uncertainty due to the fact that the equation does not take the effects of a hot gas layer into consideration. The experimental data used to validate the equation results from a scenario in which a hot gas layer developed and altered the plume temperature. The Heskestad correlation under-predicted the plume temperature at heights closer to the ceiling and the hot gas layer, but predicted results within experimental uncertainty at lower elevations where the effects of the hot gas layer had little impact on the plume temperature. Therefore, the correlation should not be used for predicting plume temperatures at elevations within the hot gas layer. A study was conducted to analyze the effect of the hot gas layer on plume temperatures and is documented in Appendix B of Calculation NEDC 10-020, "*Verification and Validation of Fire Modeling Tools and Approached for Use in NFPA 805 and Fire PRA Applications*."

A comparison between the results of FDS simulations and NUREG-1805 FDT09, "*Estimating Centerline Temperature of a Buoyant Fire Plume*," revealed that there are certain configurations in which the plume and HGL interaction impacts centerline plume temperature estimates. In these specific cases, FDT09 may under-estimate plume temperatures at certain elevations. The table below lists the fire zones at CNS and provides a designated classification for each according to the degree of impact of the plume and HGL interaction. The categories are defined as follows:

- **Category I** – Room dimensions preclude HGL and plume interaction since HGL formation is unlikely. Category I compartments can be classified as rooms larger than 25,000 cubic feet with ceiling heights of at least 15 feet.

- **Category II** – Room dimensions require HGL and plume interaction analysis. FDT09 may under-estimate plume temperatures in rooms with these dimensions. Category II compartments can be classified as rooms smaller than 25,000 cubic feet with ceiling heights above 10 feet. Compartments which are 8,000 cubic feet or larger classified as Category II with a ceiling height of greater than 10 feet have a deviation point at approximately 5.3 feet above the fire source. Compartments which are between 6,000 cubic feet and 8,000 cubic feet with a ceiling height of greater than 10 feet have a deviation point at approximately 4.6 feet above the fire source.

  The deviation point is the highest elevation above a fire source in which FDT 09 results are similar to the baseline case. Elevations above the fire source which are below the deviation point do not experience significant adverse effects from the plume and HGL interacting. Elevations above the fire source which are above the deviation point will experience adverse effects from the plume and HGL interacting.

- **Category III** – Ceiling height is very low and HGL and plume interaction is bounded by plume calculations in FDT09. Category III compartments can be classified as rooms of any volume with ceiling heights of 10 feet or below.

The impact of this study on CNS fire scenarios is documented on a fire zone level in the fire compartment specific Detailed Fire Modeling Reports and summarized below:

Fire Compartment	Fire Zone	Category	Plume and Hot Gas Layer Interaction Analysis
RB	1A	I	Not applicable - Category I
RB	1B	II	All targets assumed to fail from the fire elevation to the ceiling.
RB	1D	I	Not applicable - Category I
RB-E	1F	I	Not applicable - Category I
RB	1G	II	All targets assumed to fail from the fire elevation to the ceiling.
RB	2A-1	I	Not applicable - Category I
RB	2A-2	I	Not applicable - Category I
RB	2A-3	I	Not applicable - Category I
RB	2C	I	Not applicable - Category I
TB-C	2E	I	Not applicable - Category I
RB-J	3A	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
RB-K	3B	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
RB	3C	I	Not applicable - Category I
RB	3D	I	Not applicable - Category I
RB	3E-1	I	Not applicable - Category I
RB	3E-2	I	Not applicable - Category I
RB	4A	I	Not applicable - Category I

Fire Compartment	Fire Zone	Category	Plume and Hot Gas Layer Interaction Analysis
RB	4C	I	Not applicable - Category I
RB	4D	II	Not applicable. Although this is classified as a Category II fire zone, the east and south boundaries are open to Fire Zones 4A and 4C, precluding the possibly of hot gas accumulation in the fire zone.
RB	5B	I	Not applicable - Category I
CB-A	7A	I	Not applicable - Category I
CB-G	8A	II	All targets assumed to fail from the fire elevation to the ceiling
CB-C	8B	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
CB-A	8C	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
CB-A	8D	II	All targets assumed to fail from the fire elevation to the ceiling.
CB-A-1	8E	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
CB-B	8F	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
CB-B	8G	II	All targets assumed to fail from the fire elevation to the ceiling.
CB-A-1	8H	II	All targets assumed to fail from the fire elevation to the ceiling.
CB-E	9A	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
CB-F	9B	II	All targets assumed to fail from the fire elevation to the ceiling.
TB-A	11B	I	Not applicable - Category I
TB-A	11F	I	Not applicable - Category I
TB-A	12D	I	Not applicable - Category I
TB-A	13A	I	Not applicable - Category I
NCS	13B	I	Not applicable - Category I
NCS	13C	II	All targets assumed to fail from the fire elevation to the ceiling.
DG-A	14A	I	Not applicable - Category I
DG-B	14B	I	Not applicable - Category I
IS-A	20A	II	All targets assumed to fail from the fire elevation to the ceiling and 69 kW screening.
YD	YARD	I	Not applicable - Category I

Due to compartment volume, ceiling height, and small 69kW heat release rate, these 69 kW fires screen from the plume and hot gas layer interaction analysis as the fires will not lead to the formation of a hot gas layer in Fire Zones 3A, 3B, 8B, 8C, 8E, 8F, 9A, and 20A, therefore, the use of Heskestad's correlation for calculating plume temperatures associated with these hazards is deemed appropriate.

Fire zones classified as Category II, as noted in the table above, were further analyzed to address the plume and hot gas layer phenomenon. The zones of interaction were analyzed for potential effects on the target sets and severity factors. These analyses are documented in Detailed Fire Modeling Reports for each Fire Compartment.

Hot Gas Layer – Natural Ventilation (McCaffrey, Quintiere, and Harkleroad – MQH)

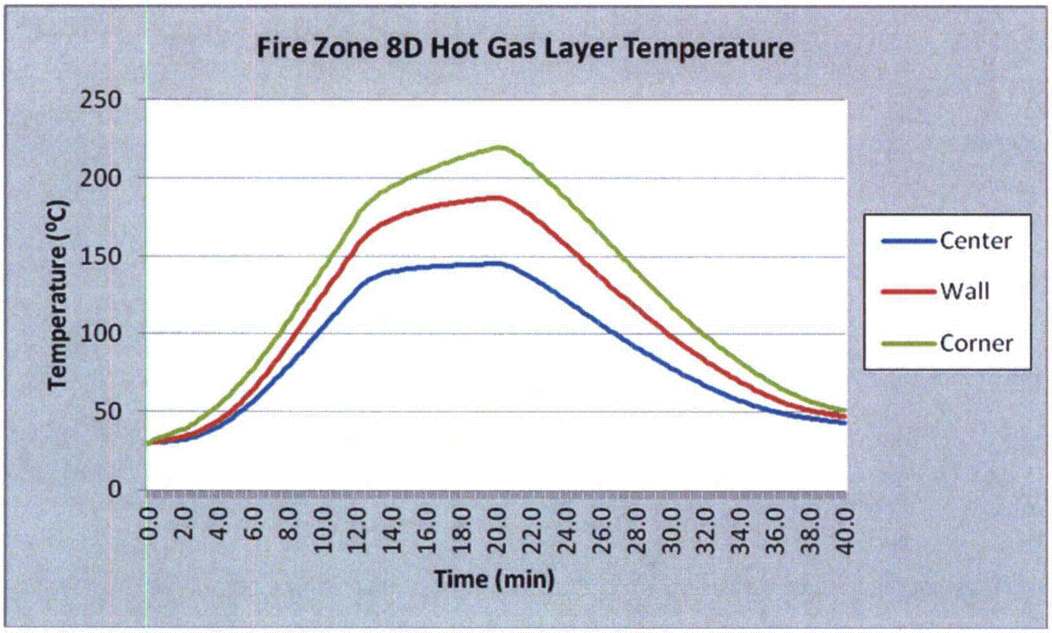
The following limitation applies to the MQH natural ventilation hot gas layer calculations:

- *These correlations assume that the fire is located in the center of the compartment or away from the walls. If the fire is flush with a wall or in a corner of the compartment, the MQH correlation is not valid with coefficient 6.85. The smoke layer height correlation assumes an average constant value of upper-layer density throughout the smoke-filling process.*

The correlation is used within the limits of its range of applicability with the exceptions of the fire scenarios discussed below. Scenarios in which the ignition source is located within two (2) feet of a wall or corner were addressed on a scenario-by-scenario basis. Justification and evaluation of this limitation and the impact on the zone of influence (ZOI) are provided below:

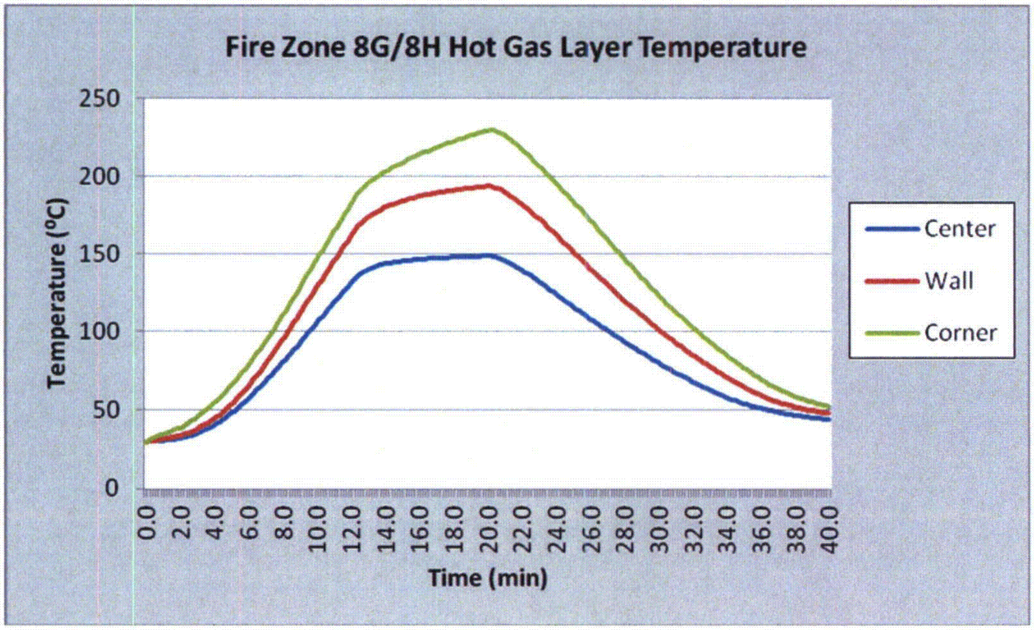
Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-A	7A	LRP-RACK- LIR-CT-C-A	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 7A is a large compartment (> 2000 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, the results from the MQH correlation are not used to determine target impacts.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-A	8D	EE-CHG-125 1C EE-CHG-250 1C	2	These scenarios model 211 kW electrical panel fires located within 2 feet of a wall and the fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. The Swing Charger Room in Fire Zone 8D was modeled using the same inputs and assumptions presented in NEDC 09-091, *Detailed Fire Modeling Report - Fire Compartment CB-A*. Results of the CFAST analysis are provided below for a 211 kW fire in the Swing Charger Room located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330□C, therefore, target failures are limited to the zone of influence of the 211 kW fire and results from the MQH correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.



Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-A-1	8H	EE-CHG-125 1A EE-CHG-250 1A	4	These scenarios model 211 kW electrical panel fires located within 2 feet of a corner and the fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. Fire Zone 8H was modeled using the same inputs and assumptions presented in NEDC 10-043, Detailed Fire Modeling Report - Fire Compartment CB-A-1. Results of the CFAST analysis are provided below for a 211 kW fire in Fire Zone 8H located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330°C, therefore, target failures are limited to the zone of influence of the 211 kW fire and results from the MQH correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-B	8G	EE-CHG-125 1B EE-CHG-250 1B	4	These scenarios model 211 kW electrical panel fires located within 2 feet of a corner and the fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. Fire Zone 8G was modeled using the same inputs and assumptions presented in NEDC 10-049, Detailed Fire Modeling Report - Fire Compartment CB-B. Results of the CFAST analysis are provided below for a 211 kW fire in Fire Zone 8G located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330°C, therefore, target failures are limited to the zone of influence of the 211 kW fire and results from the MQH correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.



Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-E	9A	EE-PNL-CCP1A	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 9A is a large compartment (> 2300 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-E	9A	EE-PNL-CCP1B	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 9A is a large compartment (> 2300 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
CB-E	9A	EE-PNL-DCA	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 9A is a large compartment (> 2300 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
CB-E	9A	EE-PNL-DCB	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 9A is a large compartment (> 2300 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
RB	1A	CS-P-A	2	This scenario models a pump containing 28 gallons of lube oil. Three fire scenarios (damage states) are considered for this pump, a large oil fire, a small oil fire, and an electrical fire. The large oil fire assumes a 100% spill of all 28 gallons in an unconfined spill, resulting in a 67 MW fire resulting in whole room damage within 1 minute. Assuming all targets fail within 1 minute bounds the results of the MQH correlation since this is a worst case scenario in terms of target failures. The small oil fire and the electrical fire result in a 772 kW fire and a 211 kW fire, respectively. These fires do not propagate to secondary combustibles. Fire Zone 1A is a compartment with a high ceiling, which precludes the formation of a hot gas layer for these fire scenarios. Target failures are limited to the zone of influence of the 772 kW and 211 kW fires, therefore, the results from the MQH correlation are not used to determine target impacts for these scenarios.
RB	2A-1	EE-PNL-AA3	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2A-1 is a large compartment (> 1300 m³, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire and the MQH correlation is not applicable to this analysis.
RB	2A-1	EE-PNL-BB3	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2A-1 is a large compartment (> 1300 m³, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire and the MQH correlation is not applicable to this analysis.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
RB	2A-2	HPI-CS-RB2	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2A-2 is a large compartment (> 2500 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	2A-2	LRP-RACK-LIR-HV-R-AC	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2A-2 is a large compartment (> 2500 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	2A-2	LRP-RACK-LIR-HV-R-BD	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2A-2 is a large compartment (> 2500 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	2A-3	EE-PNL-CPP2	2	This scenario models a 69 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2A-3 is a large compartment (> 1200 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire and the MQH correlation is not applicable to this analysis.
RB	2C	LRP-PNL-25-14	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2C is a large compartment (> 5500 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	2C	PAS-P-P1	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2C is a large compartment (> 5500 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	2C	PAS-P-P2	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2C is a large compartment (> 5500 m^3, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
RB	2C	RMV-RM-4	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 2C is a large compartment (> 5500 m³, with high ceiling), open to the remainder of the 903'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	3E-1	LRP-RACK- LIR-HV-R-BF	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 3E-1 is a compartment with a high ceiling, open to the remainder of the 932'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	3E-2	HPI-CS-RB1	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 3E-2 is a compartment with a high ceiling, open to the remainder of the 932'-6" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	4C	LRP-PNL-12-4-99	2	This scenario models a 211 kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 4C is a large compartment (> 2700 m³, with high ceiling), open to the remainder of the 958'-3" elevation of the Reactor Building. The fire zone configuration precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire and the MQH correlation is not applicable to this analysis.
RB	5B	LRP-RACK- LIR-HV-MG-EF	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 5B is a large compartment (> 6100 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
RB	5B	LRP-RACK- LIR-HV-R-EF	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 5B is a large compartment (> 6100 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
RB	5B	LRP-RACK- LIR-HV-R-FP	2	This scenario models a 211kW electrical panel fire and the fire propagates to a single 24" cable tray, resulting in a peak heat release rate of 320 kW. Fire Zone 5B is a large compartment (> 6100 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 320 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	11F	RFC-CC-2A	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 11F is a large compartment (> 1900 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
TB-A	11F	RFC-CC-2B	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 11F is a large compartment (> 1900 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	11F	RFC-CC-3	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 11F is a large compartment (> 1900 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	11F	RFC-CC-4	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 11F is a large compartment (> 1900 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	11F	TELECOMMUNICATIONS FIBER DIST. BOX	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 11F is a large compartment (> 1900 m³), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	13A	HPI-CS-TG2	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 13A is a large compartment (> 67,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	13A	HV-PNL- AC-T-1A	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 13A is a large compartment (> 67,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	13A	LRP-PNL-TDT1	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 13A is a large compartment (> 67,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	13A	LRP-PNL-TDT2	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 13A is a large compartment (> 67,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	13A	LRP-RACK-IRC	2	This scenario models a 211kW electrical panel fire and the fire propagates to two adjacent vertical sections, resulting in a peak heat release rate of ~600 kW. Fire Zone 13A is a large compartment (> 67,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 600 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
TB-A	13A	LRP-RACK-LR131A	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 13A is a large compartment (> 67,000 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.
TB-A	13A	LRP-RACK-LR131B	2	This scenario models a 211kW electrical panel fire and the fire does not propagate to secondary combustibles. Fire Zone 13A is a large compartment (> 67,000 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the MQH correlation are not used to determine target impacts.

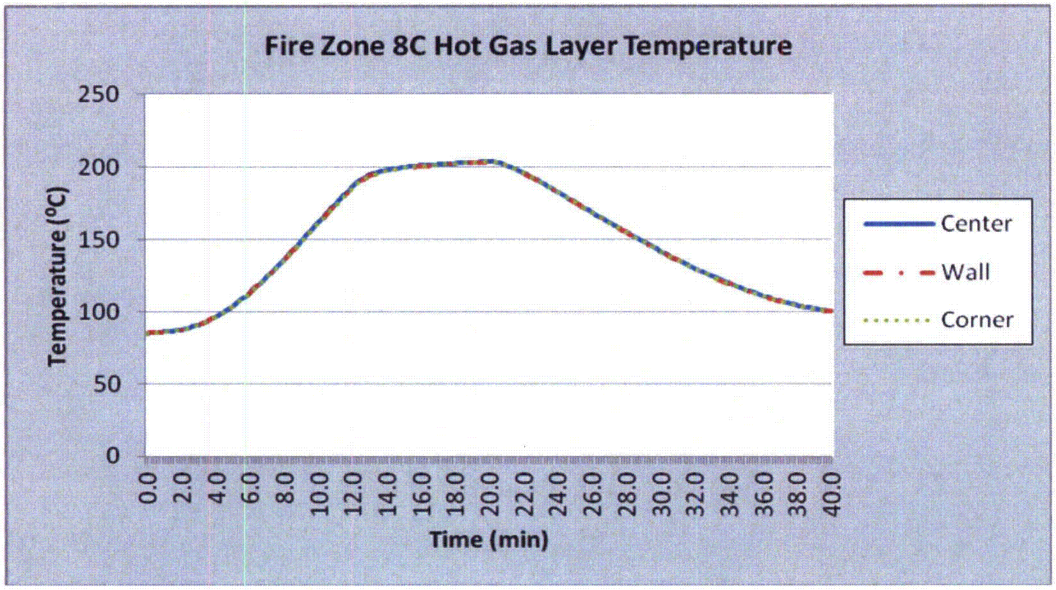
Hot Gas Layer – Forced Ventilation – (Method of Foote, Pagni, and Alvares - FPA)

The following limitation applies to the FPA forced ventilation hot gas layer calculations:

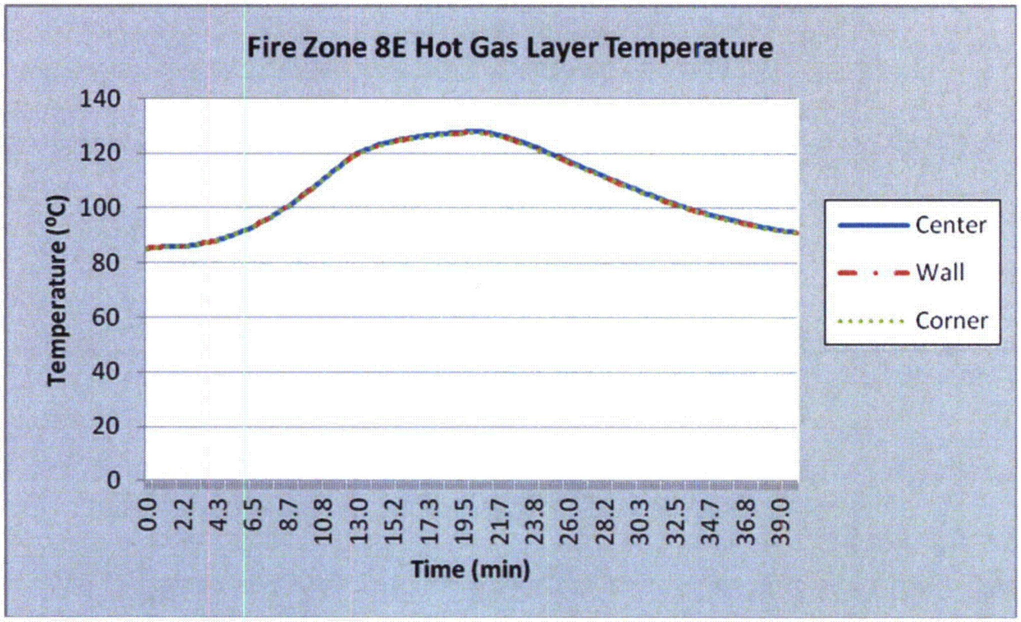
- These correlations do not explicitly account for evaluation of the fire source, and they assume that the fire is located in the center of the compartment or away from the walls. If the fire is flush with a wall or in a corner of the compartment, the FPA correlation is not valid with coefficient 0.63.

The correlation is used within the limits of its range of applicability with the exceptions of the fire scenarios provided below. Scenarios in which the ignition source is located within two (2) feet of a wall or corner were addressed on a scenario-by-scenario basis. Justification and evaluation of this limitation and the impact on the ZOI are provided below:

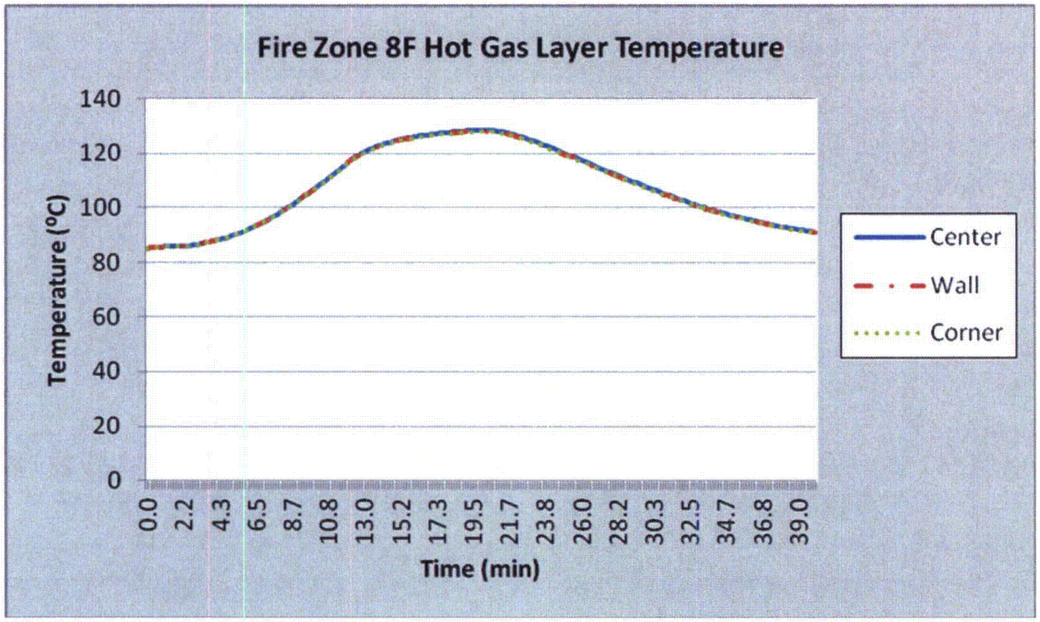
Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-A	8C	EE-CHG-24 1A1	2	These scenarios model 69 kW and 211 kW electrical fires located within 2 feet of a wall and the fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. Fire Zone 8C was modeled using the same inputs and assumptions presented in NEDC 09-091, *Detailed Fire Modeling Report - Fire Compartment CB-A*. Results of the CFAST analysis are provided below for a 211 kW fire in Fire Zone 8C located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330°C, therefore, target failures are limited to the zone of influence of the 69 kW and 211 kW fires and results from the FPA correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.
CB-A	8C	EE-CHG-24 1A2	2	
CB-A	8C	EE-PNL-CDP1A	2	
CB-A	8C	EE-XFMR-CDP1A	2	
CB-A	8C	RPS-CC-RPSA	2	



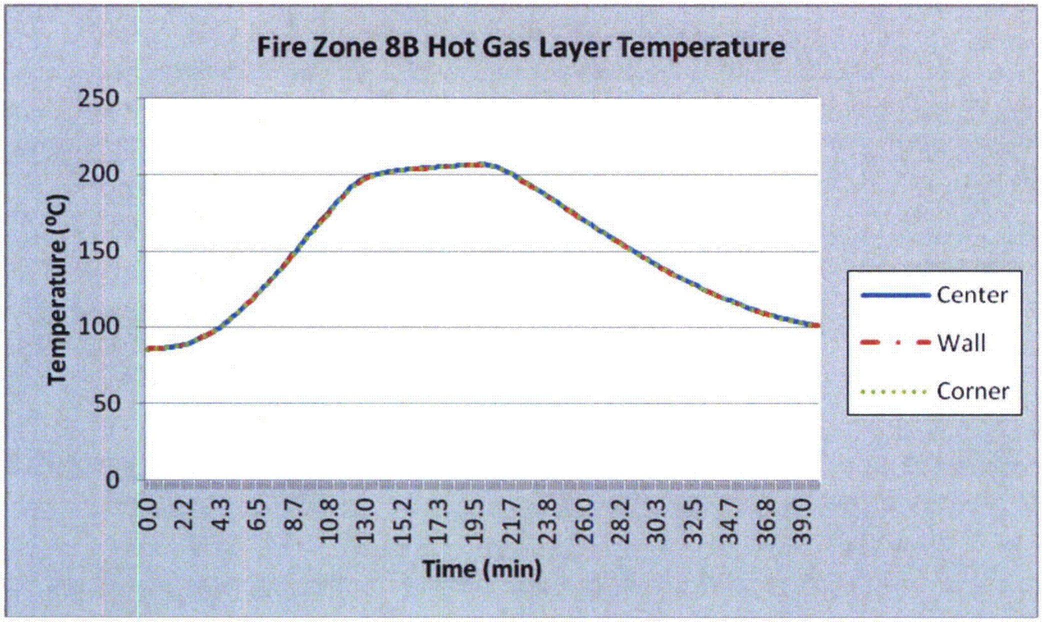
Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-A-1	8E	EE-PNL-A	2	These scenarios model 69 kW electrical panel fires located within 2 feet of a corner. The fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. Fire Zone 8E was modeled using the same inputs and assumptions presented in NEDC 10-043, *Detailed Fire Modeling Report - Fire Compartment CB-A-1*. Results of the CFAST analysis are provided below for a 69 kW fire in Fire Zone 8E located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330°C, therefore, target failures are limited to the zone of influence of the 69 kW fire and results from the FPA correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.
CB-A-1	8E	EE-PNL-AA2	2	
CB-A-1	8E	EE-SW-A	2	



Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-B	8F	EE-PNL-B	2	These scenarios model 69 kW electrical panel fires located within 2 feet of a corner. The fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. Fire Zone 8F was modeled using the same inputs and assumptions presented in NEDC 10-049, *Detailed Fire Modeling Report - Fire Compartment CB-B*. Results of the CFAST analysis are provided below for a 69 kW fire in Fire Zone 8F located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330°C, therefore, target failures are limited to the zone of influence of the 69 kW fire and results from the FPA correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.
CB-B	8F	EE-PNL-BB2	2	
CB-B	8F	EE-SW-B	2	



Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
CB-C	8B	EE-CHG-24 1B1	2	These scenarios model 69 kW and 211 kW electrical fires located within 2 feet of a wall. The fires do not propagate to secondary combustibles. A sensitivity study was performed using NIST's CFAST to determine the impact of fire location on hot gas layer temperatures. Fire Zone 8B was modeled using the same inputs and assumptions presented in NEDC 10-048, *Detailed Fire Modeling Report - Fire Compartment CB-C*. Results of the CFAST analysis are provided below for a 211 kW fire in Fire Zone 8B located in the center of the room, at a wall, and in a corner. For all three configurations, the peak hot gas layer temperature is below the critical failure temperature of 330°C, therefore, target failures are limited to the zone of influence of the 69 kW and 211 kW fires and results from the FPA correlation are not required to determine target impacts. CFAST was used within the limits of its range of applicability and the analyses were performed within the validated range of NUREG-1824. Refer to the table at the end of this response for evaluation of the relevant normalized parameters.
CB-C	8B	EE-CHG-24 1B2	2	
CB-C	8B	EE-PNL-CDP1B	2	
CB-C	8B	EE-XFMR-CDP1B	2	
CB-C	8B	RPS-CC-RPSB	2	



Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
DG-A	14A	EE-SWGR-4160DG1	2	This scenario models a 211 kW electrical panel fire. The fire propagates to one adjacent vertical section, resulting in a peak heat release rate of 422 kW. Fire Zone 14A is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 422 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
DG-A	14A	EE-XFMR-MCCDG1	2	This scenario models a 69 kW transformer fire. The fire does not propagate to secondary combustibles. Fire Zone 14A is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
DG-A	14A	LRP-RACK- LIR-HV-DG-A	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 14A is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
DG-A	14A	LRP-RACK- LIR-HV-DG-C	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 14A is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
DG-B	14B	EE-SWGR-4160DG2	2	This scenario models a 211 kW electrical panel fire. The fire propagates to one adjacent vertical section, resulting in a peak heat release rate of 422 kW. Fire Zone 14B is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 422 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
DG-B	14B	EE-XFMR-MCCDG2	2	This scenario models a 69 kW transformer fire. The fire does not propagate to secondary combustibles. Fire Zone 14B is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
DG-B	14B	LRP-RACK- LIR-HV-DG-B	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 14B is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
DG-B	14B	LRP-RACK- LIR-HV-DG-D	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 14B is a large compartment (> 2,000 m³, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
IS-A	20A	EE-PNL-DPISA	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 20A has a volume greater than 600 m³, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
IS-A	20A	EE-PNL-DPISB	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 20A has a volume greater than 600 m³, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
IS-A	20A	FP-P-C	2	This scenario models a pump containing 5 gallons of lube oil. Three fire scenarios are considered for this pump, a large oil fire, a small oil fire, and an electrical fire. The large oil fire assumes a 100% spill of all 5 gallons in an unconfined spill, resulting in a 47 MW fire and whole room damage within 1 minute. Assuming all targets fail within 1 minute bounds the results of the FPA correlation since this is a worst case scenario in terms of target failures. The small oil fire and the electrical fire result in a 772 kW fire and a 211 kW fire, respectively. These fires do not propagate to secondary combustibles. Fire Zone 20A has a volume greater than 600 m³, with a high ceiling, which precludes the formation of a hot gas layer for these fire scenarios. Target failures are limited to the zone of influence of the 772 kW and 211 kW fires, therefore, the results from the FPA correlation are not required to determine target impacts for these scenarios.
IS-A	20A	FP-PNL-C	2	This scenario models a 211 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 20A has a volume greater than 600 m³, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.

Fire Compartment	Fire Zone	Ignition Source	Location Factor	Validity Statement
IS-A	20A	LRP-PNL-S191	2	This scenario models a 211 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 20A has a volume greater than 600 m^3, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
IS-A	20A	LRP-PNL-S192	2	This scenario models a 211 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 20A has a volume greater than 600 m^3, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
NCS	13B	EE-PNL-AA1	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 13B is a large compartment (> 1,800 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
NCS	13B	EE-PNL-BB1	2	This scenario models a 69 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 13B is a large compartment (> 1,800 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 69 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
NCS	13B	BATTERY CHARGER/RECTIFIER (5.3ALT STRATEGY)	2	This scenario models a 211 kW battery charger fire. The fire does not propagate to secondary combustibles. Fire Zone 13B is a large compartment (> 1,800 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
RB-K	3B	LRP-RACK- LIR-HV-C-A	2	This scenario models a 211 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 3B has a volume greater than 450 m^3, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
RB-K	3B	LRP-RACK- LIR-HV-C-RF	2	This scenario models a 211 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 3B has a volume greater than 450 m^3, with a high ceiling, which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.
TB-C	2E	LRP-RACK- LIR-HV-R-1K	2	This scenario models a 211 kW electrical panel fire. The fire does not propagate to secondary combustibles. Fire Zone 2E is a large compartment (> 1000 m^3, with high ceiling), which precludes the formation of a hot gas layer for this fire scenario. Target failures are limited to the zone of influence of the 211 kW fire, therefore, results from the FPA correlation are not required to determine target impacts.

The following table provides the justification that the normalized parameters are within the validation range for the CFAST hot gas layer location factor sensitivity studies performed for Fire Zones 8B, 8C, 8D, 8E, 8F, 8G, and 8H:

Normalized Parameters – Hot Gas Layer Location Factor Sensitivity Studies (CFAST)			
Quantity	Normalized Parameter	Validation Range	Validity Statement
Fire Froude Number	N/A	0.4 - 2.4	The Froude Number is predominately used to validate the plume temperatures and flame heights. Since the CFAST analysis was used exclusively to calculate the HGL temperature, the item of foremost importance is the amount of energy (heat release rate) being released into the fire zone, and a Froude Number outside of the validated range would not invalidate the results.
Flame Length relative to Ceiling Height	N/A	0.2 - 1.0	The primary application of this parameter is to determine if the flame length exceeds the ceiling height. The concern is that for this type of configuration when the normalized parameter would be calculated as greater than one, aside from being outside of the validated range, the models for predicting this phenomenon have not been verified or validated. NUREG-1934, *Nuclear Power Plant Fire Modeling Application Guide*, states that if the hot gas layer temperature is not a significant source of heat flux to a target, then the significance of this parameter could decrease in the case of a target temperature calculation, provided the target distance is within the validated parameter space (i.e. not too close). The models analyze hot gas layer development exclusively and do not calculate damage to targets within the flame height or targets which may be subjected to flame radiation, therefore, this parameter is not applicable to this analysis.
Ceiling Jet Radial Distance relative to Ceiling Height	N/A	1.2 - 1.7	The primary application of this parameter is to determine target damage near the ceiling and to determine the time to detector and sprinkler activation when using the ceiling jet correlation. These CFAST models are not used to determine the time to detection and sprinkler activation. Additionally, ceiling jet targets are not included in these analyses.
Equivalency Ratio	N/A	0.04 - 0.6	Per NUREG-1934, the underlying consideration for this parameter is that conditions in the enclosure are not expected to be worse in a fire where the combustion process is affected by lack of oxygen than they would be under fire conditions where the combustion process is assumed unaffected. This parameter is not applicable because the lower oxygen limit in the CFAST analysis is set to zero which means the fire will not be limited by lack of oxygen.
Compartment Aspect Ratio - Length (Fire Zone 8B)	1.9	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Width (Fire Zone 8B)	1.2	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Length (Fire Zone 8C)	1.9	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Width (Fire Zone 8C)	1.3	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Length (Fire Zone 8D)	1.9	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Width (Fire Zone 8D)	1.0	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Length (Fire Zone 8E)	2.5	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.

Normalized Parameters – Hot Gas Layer Location Factor Sensitivity Studies (CFAST)			
Quantity	Normalized Parameter	Validation Range	Validity Statement
Compartment Aspect Ratio - Width (Fire Zone 8E)	1.8	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Length (Fire Zone 8F)	2.5	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Width (Fire Zone 8F)	1.7	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Length (Fire Zone 8G)	1.3	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Width (Fire Zone 8G)	1.3	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Length (Fire Zone 8H)	1.3	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Compartment Aspect Ratio - Width (Fire Zone 8H)	1.3	0.6 - 5.7	The calculated normalized parameter for this analysis is within the validation range.
Radial Distance relative to Fire Diameter	N/A	2.2 - 5.7	This parameter is not applicable to the analysis. There are no radiant targets analyzed in the model. Hot gas layer development is the only fire effect analyzed.

NEDC 10-020, "*Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and Fire PRA Applications*," will be revised to document these sensitivity studies.

<u>Request</u>: Fire Modeling RAI 04

Section 4.5.1.2, "Fire PRA" of the Transition Report states that fire modeling was performed as part of the FPRA development (NFPA 805, Section 4.2.4.2). This requires that qualified fire modeling and PRA personnel work together. Furthermore, Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," of the Transition Report states that "For personnel performing fire modeling or Fire PRA development and evaluation, NPPD will develop and maintain qualification requirements for individuals assigned various tasks. Position Specific Guides will be developed to identify and document required training and mentoring to ensure individuals are appropriately qualified per the requirements of NFPA 805 Section 2.7.3.4 to perform assigned work."

Regarding qualifications of users of engineering analyses and numerical models (i.e., fire modeling techniques):

a. Please describe the process/procedures for qualifying engineers/personnel performing the fire analyses and modeling activities.

b. *Please explain how the necessary communication and exchange of information between fire modeling analysts and FPRA personnel was accomplished and any direction/guidance provided by one group to the other was confirmed to be implemented correctly.*

<u>NPPD Response</u>:

a. EPM Fire Protection Engineers were responsible for preparing and reviewing the fire modeling analyses and modeling activities. The members of the EPM Fire Protection personnel are Master Degreed Fire Protection Engineers from Worcester Polytechnic Institute.

EPM Fire Protection Engineers are required to be qualified to the following EPM Engineering Division Procedures:

- Procedure EPM-DP-FP-001 – Detailed Fire Modeling
- Procedure EPM-DP-FP-002 – Performance of Field Walkdowns
- Procedure EPM-DP-FP-011 – SAFE Date Entry for Fire Modeling Scenarios

b. EPM provided fire scenario frequencies (including ignition frequency, severity factors, and non-suppression probabilities) and associated target failures for each fire scenario damage state developed using the Detailed Fire Modeling Workbooks. The target failures were entered into EPM's proprietary SAFE software to develop Level 1 FPRA Failure Reports. The Level 1 FPRA Failure Report is a Microsoft Excel spreadsheet file for each fire scenario damage state. EPM transmitted each fire scenario damage state Level 1 FPRA Failure Report under signed cover letter to the Scientech PRA personnel. As part of this transmittal, EPM provides a Microsoft Excel spreadsheet file containing the fire scenario damage state frequencies (including ignition frequency, severity factors, and non-suppression probabilities) associated with each Level 1 FPRA Failure Report to be utilized by the Scientech PRA team for quantification.

EPM and Scientech personnel operated as a single team throughout the NFPA 805 project, ensuring communication, guidance and recommendations between the fire modeling analysts and the Fire PRA analysts.

<u>Request</u>: Fire Modeling RAI 05

Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," of the Transition Report states that "Uncertainty analyses were performed as required by 2.7.3.5 of NFPA 805 and the results were considered in the context of the application. This is of particular interest in fire modeling and Fire PRA development used to support performance-based approach."

Regarding the uncertainty analysis for fire modeling:

a. *Please describe how the uncertainty associated with the fire model input parameters (compartment geometry, radiative fraction, thermophysical properties, etc.) was addressed for this application and accounted for in the analyses.*

b. *Please describe how the "model" and "completeness" uncertainties were addressed for this application and accounted for in the analyses. NUREG-1934, "Nuclear Power Plant Fire Modeling Application Guide," provides guidance on quantifying model/completeness uncertainty.*

NPPD Response:

a. Fire modeling has been performed within the Fire PRA, utilizing codes and standards developed by industry and NRC staff which have been verified and validated in authoritative publications, such as NUREG-1824, "*Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications.*" In general, the fire modeling in support of the Fire Risk Evaluations has been performed using conservative methods and input parameters that are based upon NUREG/CR-6850, "*Fire PRA Methodology for Nuclear Power Facilities.*" This pragmatic approach is used given the current state of knowledge regarding the uncertainties related to the application of the fire modeling tools and associated input parameters for specific plant configurations. A characterization of uncertainties associated with detailed fire modeling has been documented in Section 7 of each fire compartment-specific Detailed Fire Modeling Report and is summarized below:

The detailed fire modeling task develops a probabilistic output in the form of target failure probabilities and are subject to both aleatory and epistemic uncertainty.

Appendix V of NUREG/CR-6850 suggests that to the extent possible, modeling parameters should be expressed as probability distributions and propagated through the analysis to arrive at target failure probability distributions. These distributions should be based on the variation of experimental results as well as the analyst's judgment. In addition, to the extent possible more than one fire model can be applied and probabilities assigned to the outcome which describe the degree of belief that each model is the correct one.

The propagation of fire for each non-screened fire source has been described by a fire model (represented by a fire growth event tree) which addresses the specific characteristics of the source and the configuration of secondary combustibles. Aleatory uncertainties identified within the fire modeling parameters include:

- Detector response reliability and availability
- Automatic suppression system reliability and availability
- Manual suppression reliability with respect to time available

Epistemic uncertainties which impact the zone of influence and time to damage range include:

- Heat release rates (peak HRR, time to reach peak, steady burning time, decay time)
- Number of cabinet cable bundles
- Ignition source fire diameter
- Room ventilation conditions
- Sprinkler Response Time Index (RTI), C factor, and activation temperature
- Detector activation temperature, geometry and obscuration activation
- Soot yield
- Fire growth assumptions (cable tray empirical rule set, barrier delay)
- Cable fire spread characteristics for horizontal and vertical trays
- Transient fires (peak HRR, time to reach peak, location factor, detection time)
- Oil fires (spill assumptions)
- Assumed target location
- Target damage threshold criteria
- Manual detection time
- Mean prompt suppression rate
- Manual suppression rate
- Welding and cutting target damage set
- Transient target impacts

With respect to the PRA, a quantitative characterization has not been developed as the quantitative results are conservatively biased for key contributors. Rather than developing a quantitative characterization, an alternate estimate of the mean value for CDF and LERF can be estimated to be a factor of 5 to 10 lower than calculated with a 90 percentile range of a factor of 10 on the lower end and 5 on the higher end. Due to the uncertainty with each of these parameters, the fire modeling task has selected conservative values for each.

Fire models should be created with a substantial safety margin. Per NEI 04-02, there is no clear definition of an adequate safety margin. However, the safety margin should be sufficient to bound the uncertainty within a particular calculation or application. The detailed fire modeling calculations provide a list of items that are modeled conservatively and that provide safety margin. Some examples include the following items:

- Fire scenarios involving electrical cabinets (including the electrical split fraction of pump fires) utilize the 98th percentile HRR for the severity factor calculated out to the nearest FPRA target. This is considered conservative.
- The fire elevation in most cases is at the top of the cabinet or pump body. This is considered conservative, since the combustion process will occur where the fuel mixes with oxygen, which is not always at the top of the ignition source.
- The radiant fraction utilized is 0.4. This represents a 33% increase over the normally recommended value of 0.3.

- The convective heat release rate fraction utilized is 0.7. The normally recommended value is between 0.6 and 0.65, and thus the use of 0.7 is conservative.
- For transient fire impacts, a large bounding transient zone assumes all targets within its Zone of Influence (ZOI) are affected by a fire. Time to damage is calculated based on the most severe (closest) target. This is considered conservative, since a transient fire would actually have a much smaller zone of influence and varying damage times. This approach is implemented to minimize the multitude of transient scenarios to be analyzed.
- For hot gas layer calculations, no equipment or structural steel is credited as a heat sink, since the closed-form correlations used do not account for heat loss to these items.
- Not all cable trays are filled to capacity. By assuming full, this provides conservative estimates of the contribution of cable insulation to the fire and the corresponding time to damage.
- As the fire propagates to secondary combustibles, the fire is conservatively modeled as one single fire using the fire modeling closed-form correlations. The resulting plume temperature estimates used in this analysis are therefore also conservative, since in actuality, the fire would be distributed over a large surface area, and would be less severe at the target location.
- Target damage is assumed to occur when the exposure environment meets or exceeds the damage threshold. No additional time delay due to thermal response is given.
- The fire elevation for transient fires is 2-feet. This is considered conservative since most transient fires are expected to be below this height or even at floor level.
- Oil fires are analyzed as both unconfined and confined spills with 20-minute durations. Unconfined spills result in large heat release rates, but usually burn for seconds. The oil fires have been conservatively analyzed for 20-minutes to account for the uncertainty in the oil spill size.
- High energy arcing fault scenarios are conservatively assumed to be at peak fire intensity for 20-minutes from time zero, even though the initial arcing fault is expected to consume the contents of the cabinet and burn for only a few minutes.
- Fire brigade intervention is not credited prior to 85-minutes. Fire Brigade drills indicated that typical manual suppression times can be expected to be much less (i.e., 20 minutes).

b. NUREG-1934 states that "model" uncertainty is estimated via the processes of verification and validation and "completeness" uncertainty refers to the fact that a model may not be a complete description of the phenomena it is designed to predict. Completeness uncertainty is addressed, indirectly, by the same process used to address the model uncertainty and model and completeness uncertainty are closely related, and it would be impractical to evaluate them separately. Model uncertainty is based primarily on comparisons of model predictions with experimental measurements as documented in NUREG-1824 and other model validation studies.

All of the fire models used and listed in Attachment J of the CNS NFPA 805 Transition Report are within or very near experimental uncertainty, as determined by NUREG-1824, "*Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications,*" Final Report, dated April 2007. Each model is discussed as follows:

Hot Gas Layer Temperature using FDTs

The predictive capability of these parameters using FDTs is characterized as YELLOW+ according to Table 3-1 of NUREG-1824.

A YELLOW± characterization is given "*If the first criterion is satisfied and the calculated relative differences are outside the experimental uncertainty but indicate a consistent pattern of model over-prediction or under-prediction, then the model predictive capability is characterized as YELLOW+ for over-prediction, and YELLOW– for under-prediction. The model prediction for the specific attribute may be useful within the ranges of experiments in this study, and as described in Tables 2-4 and 2-5, but the users should use caution when interpreting the results of the model. A complete understanding of model assumptions and scenario applicability to these V&V results is necessary. The model may be used if the grade is YELLOW+ when the user ensures that model over-prediction reflects conservatism. The user must exercise caution when using models with capabilities described as YELLOW±.*"

NUREG 1824, Volume 3, Section 6.1 states that: "*The FDTs models for HGL temperature capture the appropriate physics and are based on appropriate empirical data. FDTs generally over-predict HGL temperature, outside of uncertainty.*" The over-prediction is expected to lead to conservative results and increased safety margin.

Hot Gas Layer Height and Temperature using FDS

The predictive capability of these parameters in FDS is characterized as GREEN according to Table 3-1 of NUREG-1824.

A GREEN characterization is given "*If both criteria are satisfied (i.e., the model physics are appropriate for the calculation being made and the calculated relative differences are within or very near experimental uncertainty), then the V&V team concluded that the fire model prediction is accurate for the ranges of experiments in this study, and as described in Tables 2-4 and 2-5. A grade of GREEN indicates the model can be used with confidence to calculate the specific attribute. The user should recognize, however, that the accuracy of the model prediction is still somewhat uncertain and for some attributes, such as smoke concentration and room pressure, these uncertainties may be rather large. It is important to note that a grade of GREEN indicates validation only in the parameter space defined by the test series used in this study; that is, when the model is used within the ranges of the parameters defined by the experiments, it is validated.*"

The NUREG-1824, Volume 7, Section 6.1 summary states: *"FDS is suitable for predicting HGL temperature and height, with no specific caveats, in both the room of origin and adjacent rooms. In terms of the ranking system adopted in this report, FDS merits a Green for this category, based on... The FDS predictions of the HGL temperature and height are, with a few exceptions, within experimental uncertainty."*

<u>Hot Gas Layer Temperature and Height using CFAST</u>

The predictive capability of these parameters in CFAST is characterized as GREEN according to Table 3-1 of NUREG-1824. The GREEN designation is discussed above under the "Hot Gas Layer Height and Temperature using FDS" heading. Specifically, the GREEN designation was assigned to the CFAST HGL temperature parameter calculated in the fire compartment of origin. Compartments remote from the fire were assigned a yellow designation.

The NUREG-1824, Volume 5, Section 6.1 summary states: *"The CFAST predictions of the HGL temperature and height are, with a few exceptions, within or close to experimental uncertainty. The CFAST predictions are typical of those found in other studies where the HGL temperature is typically somewhat over-predicted and HGL height somewhat lower than experimental measurements. These differences are likely attributable to simplifications in the model dealing with mixing between the layers, entrainment in the fire plume, and flow through vents. Still, predictions are mostly within 10% to 20% of experimental measurements."*

<u>Ceiling Jet Temperature using Alpert Correlation</u>

The predictive capability of this parameter using the Alpert correlation in the fire model FIVE is characterized as YELLOW+ according to Table 3-1 of NUREG-1824. The YELLOW+ designation is discussed above under the "Hot Gas Layer Temperature using FDTs" heading. Specifically, the NUREG-1824, Volume 5, Section 6.2 summary states:

> The Alpert correlation under-predicts ceiling jet temperatures in compartment fires with an established hot gas layer. This result is expected because the correlation was developed without considering HGL effects. The original version of FIVE accounted for HGL effects by adding the ceiling jet and HGL temperature. This practice results in consistent over-predictions of the ceiling jet temperature. The approach of adding ceiling jet temperatures to the calculated hot gas layer continues to be the recommended method for FIVE-Rev1 users. Based on the above discussion, a classification of Yellow+ is recommended if HGL effects on the ceiling jet temperature are considered using the approach described in the above bullet. The Alpert correlation by itself is not intended to be used in rooms with an established hot gas layer.

The approach of adding the hot gas layer temperature to the ceiling jet temperature was not used for fire modeling at CNS. The primary application of the ceiling jet correlation at CNS was the determination of detection and suppression timing, in which the ceiling jet velocity is a sub-model in the analysis. Including the effects of a hot gas layer would result in shorter detection and suppression times, and therefore the use of the ceiling jet correlation at CNS is considered conservative. The use of the ceiling jet correlation for target damage is bounded by the use of the point source radiation model and is justified and discussed in detail in the response to FM RAI 02 (b), which is a 90-day response.

Plume Temperature using FDTs

The predictive capability of this parameter using FDTs is characterized as YELLOW- according to Table 3-1 of NUREG-1824. The YELLOW- designation is discussed above under the "Hot Gas Layer Temperature using FDTs" heading.

The NUREG-1824, Volume 3, Section 6.2 summary states: "*The FDTs model for plume temperature is based on appropriate empirical data and is physically appropriate. FDTs generally under-predicts plume temperature, outside of uncertainty, because of the effects of the hot gas layer on test measurements of plume temperature. The FDTs model is not appropriate for predicting the plume temperatures at elevations within a hot gas layer.*"

The use of the FDTs plume correlation for fire modeling applications at CNS was used within the limitations given in NUREG-1824. The effects of a the plume and hot gas layer interaction were analyzed and documented in detail in Appendix B of NEDC 10-020, "Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and Fire PRA Applications." The use of the FDTs plume correlation was used in accordance with the results of this analysis.

Plume Temperature using FDS

The predictive capability of this parameter using FDS is characterized as YELLOW according to Table 3-1 of NUREG-1824.

A YELLOW characterization is given "*If the first criterion is satisfied and the calculated relative differences are outside experimental uncertainty with no consistent pattern of over- or under-prediction, then the model predictive capability is characterized as YELLOW. A YELLOW classification is also used despite a consistent pattern of under- or over-prediction if the experimental data set is limited. Caution should be exercised when using a fire model for predicting these attributes. In this case, the user is referred to the details related to the experimental conditions and validation results documented in Volumes 2 through 6. The user is advised to review and understand the model assumptions and inputs, as well as the conditions and results to determine and justify the appropriateness of the model prediction to the fire scenario for which it is being used.*"

The NUREG-1824, Volume 7, Section 6.3 summary states: "*The FDS hydrodynamic solver is well-suited for this application. FDS over-predicts the lower plume temperature in BE #2 because it over-predicts the flame height. FDS predicts the FM/SNL plume* *temperature to within experimental uncertainty. The simulations of BE #2 and the FM/SNL series are the most time-consuming of all six test series, mainly because of the need for a fairly fine numerical grid near the plume. It is important that a user understand that considerable computation time may be necessary to well-resolve temperatures within the fire plume. Even with a relatively fine grid, it is still challenging to accurately predict plume temperatures, especially in the fire itself or just above the flame tip. There are only nine plume temperature measurements in the data set. A more definitive conclusion about the accuracy of FDS in predicting plume temperature would require more experimental data."*

Per the guidance given in NUREG-1934, a $D^*/\delta x$ ratio of 5 to 10 produces favorable FDS results at moderate computational cost. This guidance was used for the two CNS FDS applications that analyzed plume temperatures. The first is the plume and hot gas layer interaction study found in Appendix B of NEDC 10-020, "Verification and Validation of Fire Modeling Tools and Approaches for Use in NFPA 805 and Fire PRA Applications" and the second is the Main Control Room Abandonment Analysis found in Attachment 9 of NEDC 08-041. The $D^*/\delta x$ ratio for the critical mesh used in each study is 7.42 and 6.04, respectively, ensuring that the mesh is fine enough to analyze plume temperatures in each case. In addition, the plume temperatures within the flaming region are not the focal point of either study.

Flame Height using FDTs

The predictive capability of this parameter using FDTs is characterized as GREEN according to Table 3-1 of NUREG-1824. The GREEN designation is discussed above under the "Hot Gas Layer Height and Temperature using FDS" heading.

The NUREG-1824, Volume 5, Section 6.3 summary states: *"The FDTs model predicted flame heights consistent with visual test observations."*

Smoke Concentration using FDS

The predictive capability of this parameter in FDS is characterized as YELLOW according to Table 3-1 of NUREG-1824. The YELLOW designation is discussed above under the "Plume Temperature using FDS" heading.

The NUREG-1824, Volume 7, Section 6.6 summary states: "FDS is capable of transporting smoke throughout a compartment, assuming that the production rate is known and that its transport properties are comparable to gaseous exhaust products. This assumption may break down in closed-door fires, or if an appreciable part of the flame extends into the upper layer. FDS over-predicts the smoke concentration in all of the BE #3 tests. For the open-door tests, it is possible to explain the discrepancy in terms of the uncertainty of both the specified smoke yield and the optical measurement of the smoke concentration. There is no clear explanation for the discrepancy in the closed-door tests. FDS does not over-predict the CO concentration, another fixed yield product of incomplete combustion, in either the open- or closed-door tests. No firm conclusions can be drawn from this one data set. The measurements in the closed-door experiments are inconsistent with basic conservation of mass arguments, or there is a fundamental change in the combustion process as the fire becomes oxygen-starved. FDS does not have a sub-model to adjust the production rate or the optical properties of smoke, regardless of whether or not this would explain the discrepancy between the measurements and the model predictions."

Smoke concentration was analyzed in NEDC 08-041, "Main Control Room Forced Abandonment," which was used to determine the probability of Main Control Room abandonment at CNS following a fire scenario in the Main Control Room Complex. Smoke concentration was over-predicted for both the open-door and closed-door test configurations as indicated in NUREG-1824, therefore, FDS predictions are expected to result in conservative results for this analysis.

The smoke production rates used in the model are known and were derived from Table 3-4.14 of the SFPE Handbook of Fire Protection Engineering, 3rd Edition. Transport properties of the smoke are expected to be comparable to gaseous exhaust products.

Radiant Heat using FDTs

The predictive capability of this parameter in FDTs is characterized as YELLOW according to Table 3-1 of NUREG-1824. The YELLOW designation is discussed above under the "Plume Temperature using FDS" heading.

The NUREG-1824, Volume 3, Section 6.4 summary states: "*The FDTs point source radiation and solid flame radiation model in general are based on appropriate empirical data and is physically appropriate with consideration of the simplifying assumptions. The FDTs point source radiation and solid flame radiation model are not valid for elevations within a hot gas layer. FDTs predictions had no clear trend. The model under- and over-predicted, outside uncertainty. The point source radiation model is intended for predicting radiation from flames in an unobstructed and smoke-clear path between flames and targets.*"

Only the FDTs point source radiation model was used for fire modeling at CNS. NUREG-1824 indicates that there is no clear trend in under- or over-prediction for the point source model. The model over-predicted heat flux for locations immersed in a hot gas layer, which is likely due to smoke and the HGL preventing radiation from reaching the gauges. This over-prediction is expected to lead to conservative results and increased safety margin. In a smaller number of cases, the model under-predicted heat flux due to contribution of radiation from the HGL. In order to account for this potential under-prediction, conservatism has been built into the use of the radiation model at CNS, including the use of a radiant heat release rate fraction of 0.4, as opposed to the normally recommended value of 0.3.

In addition, NUREG-1824 indicates that the point source model is not intended to be used for locations relatively close to the fire. For fire modeling at CNS, targets located close to the fire have conservatively been failed within the early stages of fire growth.

Radiant Heat using FDS

The predictive capability of this parameter in FDS is characterized as YELLOW according to Table 3-1 of NUREG-1824. The YELLOW designation is discussed above under the "Plume Temperature using FDS" heading.

Even though the FDS Radiant Heat Model was given a Yellow designation, NUREG 1824, Volume 7, Section 6.8 states that: *"FDS has the appropriate radiation and solid phase models for predicting the radiative and convective heat flux to targets, assuming the targets are relatively simple in shape. FDS is capable of predicting the surface temperature of a target, assuming that its shape is relatively simple and its composition fairly uniform. FDS predictions of heat flux and surface temperature are generally within experimental uncertainty, but there are numerous exceptions attributable to a variety of reasons. The accuracy of the predictions generally decreases as the targets move closer to, or go inside of, the fire. There is not enough near-field data to challenge the model in this regard."*

FDS was used to calculate radiant heat exposure at CNS for two applications. The first application was to determine the radiant heat exposure to an electrical cabinet from a transient fire. The second application was to determine the heat flux levels at potential targets from a transient fire. For both applications, the limitations outlined in NUREG 1824 are not of concern based on the following:

1) Heat flux is not being calculated for any targets inside of the fire. For both FDS analyses performed, all potential radiant heat targets are located a minimum of 3 feet horizontally away from the fire.

2) All targets are simple in shape and not complex in nature. The targets analyzed in the two FDS models are a flat sheet metal panel and heat flux monitoring devices located independent of obstructions. In both instances, the targets are of simple geometry and uniform composition.

Since the model was not used outside of the limitations identified, it is concluded that the FDS predictions of heat flux is within experimental uncertainty.

Attachment 2

Revisions to the Cooper Nuclear Station
License Amendment Request To Adopt National Fire Protection Association
Standard 805 Performance-Based Standard For
Fire Protection For Light Water Reactor Generating Plants

This attachment provides changes to the National Fire Protection Association (NFPA) 805 License Amendment Request based on the responses to the Requests for Additional Information (RAI) provided in Attachment 1. The changes are presented in underline/strikeout format, or as replacement pages.

1. Section 4.1.2.3 is revised to include the following NFPA 805 Chapter 3 requirements for which Nuclear Regulatory Commission (NRC) approval is requested, as well as deletion of Chapter 3 requirement for which NRC approval is no longer requested:

   - 3.2.3(1) – Approval is requested for use of performance-based inspection frequencies.
   - 3.3.3 – Approval is requested for previous utilization of paints and coatings for which documentation is not available to demonstrate testing under ASTM E-136, or an equivalent test method.
   - ~~3.3.7.2 – Approval is requested for the configuration of the bulk storage hydrogen gas cylinders, which have their long axis pointing toward the Intake Structure.~~

   Reference: Response to FPE RAI 01, FPE RAI 04, and FPE RAI 13.

2. Section 4.2.2, Subsection "Overview of Evaluation Process" is revised to read:
   "In all cases, the reliance on EEEEs to demonstrate compliance with NRPA 805 requirements was documented in the LAR. The basis of acceptability of each of the credited EEEEs referenced in Attachments A and C remains valid and each EEEE was determined to meet the NEI 04-02, "Guidance for Implementing a Risk-Informed, Performance Based Fire Protection Program Under 10 CFR 50.48(c)," criteria as documented in the detailed review performed in NEDC 12-008."

   Reference: Response to FPE RAI 11.

3. Table 4-3 is revised to insert the following line items:

Fire Area	Fire Zone	Description	NFPA 805 Regulatory Basis Type of Feature or System		Required for? S L E R D	Required Fire Protection Feature and System Notes
DW	Drywell		4.2.3.2 – Deterministic Approach			
DW	Drywell	Drywell	None	N/A	-- -- -- -- --	

Reference: Response to FPE RAI 18.

4. Attachment A, Table B-1 is revised as follows:

NFPA 805 Element	NFPA 805 Requirement	Compliance Statement	Compliance Basis	Reference Document
3.2.3 Procedures	Procedures shall be established for implementation of the fire protection program. In addition to procedures that could be required by other sections of the standard, the procedures to accomplish the following shall be established:	Complies	~~CNS Technical Specification (TS) 5.4.1d requires that written procedures be established, implemented, and maintained for fire protection program implementation.~~ ~~Note - This License Amendment Request deletes TS 5.4.1d. See Attachment N.~~ 10 CFR 50.48(c)(1) incorporates by reference NFPA 805, which in turn requires Fire Protection procedures per this NFPA 805 Element. Procedure 0.23 implements the CNS Fire Protection Program.	~~CNS Technical Specifications, through License Amendment 241~~ Procedure 0.23, Rev. 66, CNS Fire Protection Plan
3.2.3 Procedures (1)	Inspection, testing, and maintenance for fire protection systems and features credited by the fire protection program	~~Complies with Required Action~~ Submit for NRC Approval	~~Inspection, testing, and maintenance requirements for credited fire protection systems and features are described in the Technical Requirements Manual (TRM), a document incorporated by reference into the CNS Updated Safety Analysis Report. This includes~~	~~CNS Technical Requirements Manual, Rev. 10/28/11~~ None

NFPA 805 Element	NFPA 805 Requirement	Compliance Statement	Compliance Basis	Reference Document
			surveillances for the fire main, automatic suppression systems, high pressure carbon dioxide extinguishing system, Halon suppression system, fire detection systems, standpipe and hose systems, fire pumps, fire barriers, and penetration seals. The fire protection systems and features are inspected, tested, and maintained in accordance with the 6, 7, and 15 series of CNS Procedures. Implementation Item S-3.1 – During the implementation of the NFPA 805 licensing basis, performance-based surveillance frequencies will be established as described in Electric Power Research Institute (EPRI) Technical Report (TR) 1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features". The performance-based surveillance frequencies will be evaluated in the monitoring program in accordance with NFPA 805 FAQ 10-0059. See Attachment S, Table S-3. NRC approval of the use of EPRI Technical Report TR-1006756 in establishing performance-based inspection, testing, and maintenance frequencies for fire protection systems and features credited by the fire protection program is being	

NFPA 805 Element	NFPA 805 Requirement	Compliance Statement	Compliance Basis	Reference Document
			requested in Attachment L.	
3.3.7.2 [Bulk Flammable Gas Storage – Container Restrictions]	Outdoor high-pressure flammable gas storage containers shall be located so that the long axis is not pointed at buildings.	~~Submit for NRC Approval~~ Complies	Bulk storage of hydrogen gas, in D.O.T.-approved high pressure cylinders, is located in a separate structure ~~totally separate building~~ approximately 80 feet east of the Water Treatment Building. ~~The long axis of the hydrogen storage containers is pointed towards the Intake Structure to the north.~~ Although the structure is not a fully enclosed (open east boundary to the Missouri River) building, the intent of the requirement is met based on the walls of the hydrogen storage structure being constructed of one (1) foot thick poured concrete and each hydrogen container is provided with two (2) mounting frames that provide the necessary support and restraint in the event of failure. The Intake Structure is located approximately 100 feet north of the hydrogen storage structure. ~~However, the building is located approximately 100 feet south of the Intake Structure. In addition, the walls of the hydrogen storage structure are constructed of 1 foot reinforced poured concrete and each hydrogen container is provided with two mounting frames that provide the necessary restraint in the event of failure. Refer to Attachment L for further details on the request for~~	Drawing 4003, Rev N39, Overall Site & Vicinity Plan Drawing 4044, Rev. 1, Gas Bottle Storage Building Drawing 4519, Rev. N01, Gas Bottle Storage Building

NFPA 805 Element	NFPA 805 Requirement	Compliance Statement	Compliance Basis	Reference Document
			NRC approval of the current configuration of the bulk hydrogen storage containers inside the hydrogen storage structure with long axis pointed towards the Intake Structure.	
3.5.6 [Water Supply - Pump Start/Stop Requirements]-	Fire pumps shall be provided with automatic start and manual stop only.	Complies Submit for NRC Approval	Complies Per Drawings A10-308468 Sht. 1 and Sht. 2, the electric motor driven fire pump FP-P-E is provided with automatic start and manual stop. Per Drawing A10-308583, the engine driven fire pump FP-P-D is provided with automatic start and manual stop. Submit for NRC Approval Refer to Attachment L for further details on the request for NRC approval for the remote stop of fire pump FP-P-E from the Control Room.	Drawing A10-308468 Sht. 1, Rev. N03, Fire Pump Controller 1C Drawing A10-308468 Sht. 2, Rev. N06, Fire Pump Controller 1C Drawing A10-308583, Rev. 3, Engine Driven Fire Pump Controller

Reference: Response to FPE RAI 04, FPE RAI 07, FPE RAI 13, and FPE RAI 15.

5. Table B-3 is revised to insert the following pages:

   C-237
   C-238
   C-239

   Reference: Response to FPE RAI 18.

Table B-3 Fire Area Transition

Fire Area	Description
DW	Drywell

Fire Zone	Description
DRYWELL	DRYWELL

Regulatory Basis

4.2.3.2 - Deterministic Approach

Performance Goal	Method of Accomplishment	Comments / VFDR
Decay Heat Removal	SPC Train A or B will be operated to maintain Suppression Pool temperature.	Fires are not postulated in the Drywell with the Reactor in Power Operation, Startup, or in Safe and Stable with RHR aligned in the Suppression Pool cooling mode of operation, because the Drywell is inerted during these times.
Process Monitoring	The following indications will be used to support the Process Monitoring function: - RPV water level and pressure [from Control Room] - Suppression Pool level and temperature [from Control Room] - CS, RHR, and SW flow indications [from Control Room]	Fires are not postulated in the Drywell with the Reactor in Power Operation, Startup, or in Safe and Stable with RHR aligned in the Suppression Pool cooling mode of operation, because the Drywell is inerted during these times.
Inventory and Pressure Control	RPV isolation will be accomplished by manual isolation of main steam lines, other discharge paths inboard of the MSIVs, and other system pressure boundaries. RPV over-pressure protection will be provided by SRVs. Only the self-activated spring lift mode is credited for over-pressure protection. ADS will be used to reduce RPV pressure for operation of either Core Spray Train A or Train B to maintain RPV level.	Fires are not postulated in the Drywell with the Reactor in Power Operation, Startup, or in Safe and Stable with RHR aligned in the Suppression Pool cooling mode of operation, because the Drywell is inerted during these times.

FPE RAI 18

Table B-3 Fire Area Transition

Fire Area DW

Description Drywell

Reactivity Control	Subcritical conditions will be achieved and maintained by insertion of the control rods caused by de-energizing RPS. The reactor scram will be the result of an automatic RPS trip or from operator initiation of a manual trip.	None
Vital Auxiliaries	Mechanical: - REC will be supplied by Train A or B to provide the cooling supply to the ECCS. - SW Train A or B will be operated to provide the cooling supply to the REC system and RHR Heat Exchangers. Electrical (AC/DC): - Offsite Emergency Transformer aligned to 4160V Bus 1F or 1G - 125/250 VDC Trains A and B are available [from Control Room] HVAC: - RCIC/CS Trains A and B - Quad area cooling - AC Switchgear Rooms - Essential Control Building HVAC system - DC Switchgear Rooms - Essential Control Building HVAC system - Battery Rooms - Essential Control Building HVAC system - Auxiliary Relay Room and RPS MG Set Rooms - Essential Control Building HVAC system	Fires are not postulated in the Drywell with the Reactor in Power Operation, Startup, or in Safe and Stable with RHR aligned in the Suppression Pool cooling mode of operation, because the Drywell is inerted during these times.

FPE RAI 18

Reference Document / Document Detail

CNS Calculation NEDC 11-019 "Nuclear Safety Capability Assessment"

Licensing Actions

None

Existing Engineering Equivalency Evaluations (EEEE)

None

Variances from Deterministic Requirements (VFDR)

None

Table B-3 Fire Area Transition

Fire Area	Description
DW	Drywell

Required Fire Protection Systems and Features

Fire Zone	Type of System	Specific Type of System	Local (L) Remote (R) Full (F) Partial (P)	Detection Actuates Suppression?	Required System?				
					S	L	E	R	D
Drywell	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Legend:

Table Field: "Required System?"	
S	- Required for Chapter 4 Separation Criteria
L	- Required for NRC-Approved Exemption
E	- Required for Existing Engineering Equivalency Evaluation
R	- Required for Risk Significance
D	- Required to maintain adequate balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

FPE RAI 18

Fire Suppression Activities Effect on Nuclear Safety Performance Criteria

Based on the inerting of the Drywell fires are not postulated for this area except during failure of the inerting system. There is no installed supression systems in the drywell therefore there is no flooding potential concern for the activation of the system. The plant fire brigade is trained to discharge water in a judicious manner and instructed to direct hose streams and portable extinguishers at the base of the fire to limit the amount of overspray beyond the immediate Fire Zone. For this reason, fire brigade activities are not expected to fail components not immediately involved in the fire scenario. It has been concluded that water impingement on cables is not a concern. Since it is shown that suppression effects will not impact the NSPC, the Fire Area configuration is deemed acceptable.

Fire Area Comments

Fires are not postulated in the Drywell with the Reactor in Power Operation, Startup, or in Safe and Stable with RHR aligned in the Suppression Pool cooling mode of operation, because the Drywell is inerted during these times.

6. Table I-1 and subsequent discussion is revised as follows:

Table I-1 CNS Power Block Definition

Building/Structure	Fire Area(s)
Reactor Building	RB-A, RB-B, RB-CF, RB-DI, RB-E, RB-FN, RB-J, RB-K, RB-M, RB-N, RB-P, RB-T, RB-V, TB-C, DW
Control Building	CB-A, CB-A-1, CB-B, CB-C, CB-D
Turbine Generator Building	TB-A
Diesel Generator Building	DG-A, DG-B
Water Treatment Building	TB-A
Intake Structure	IS-A
Radwaste Building	TB-A
Augmented Radwaste Building	TB-A
Fire Pump House	YD~~*~~
~~Transformer Yard~~	~~YD*~~
Offgas Building	TB-A
Optimum Water Chemistry Building	YD
Hydrogen Storage Building	~~TB-A~~YD
Multi-Purpose Facility (MPF)	TB-A
~~Yard~~ Offsite power distribution equipment (i.e., main transformers, emergency transformer, and start-up transformer), portions of the non-safety power distribution system (i.e., 161 kV switchyard and 345 kV switchyard), and the diesel generator oil storage transfer pumps	YD~~*~~

~~*A large area called the Yard (Fire Area YD) has been included in the power block and encompasses all locations inside the owner-controlled area that have equipment required for nuclear plant operations, and that are not contained in any other Nuclear Safety Capability Assessment (NSCA) fire areas. The equipment in YD includes such items as offsite power distribution equipment, portions of the non-safety power distribution system, and the fire pump house.~~ The following structures are excluded from the power block on the basis that they are not required to meet either the nuclear safety performance criteria or the radioactive release performance criteria as described in Section 1.5 of NFPA 805:

Building / Structure Identification

Communications Building	ISFSI Pad
Condensate Storage Tanks	Maintenance Training Facility
Control House	Meteorological Tower
Craft Change Building	Security Building
Dining Hall	Sewage Treatment Plant
FAB Shop	Technical Support Building
Fire Protection Tanks	Toilet Building
Flammable Liquid Storage	Training Center
F.O. Storage Tank	Utility Building
Hazardous Material Storage	West Warehouse

The Office Building contains only limited NSCA credited components, cabling associated with the Critical Switchgear Room HVAC and ADS logic. Cables for operation of Critical Switchgear Room HVAC may potentially be impacted in the Office Building (Fire Area TB-A, Fire Zone 19B). Fire zone 19B is adjacent to the north wall of the 4160F Critical Switchgear Room (Fire RB-J, Fire Zone 3A). The area of Fire Zone 19B which is adjacent to the Critical Switchgear Room consists of the corridor outside of the main control room area. There are limited combustibles and a lack of fixed ignition sources in the immediate area of the Critical Switchgear Room barrier. Therefore, a fire in this area would have a negligible impact on room heat up in Fire Zone 3A. ADS-LOGIC is a dummy component modeling the automatic circuitry for the manual mode for depressurization of the ADS system. The component has been assigned to each fire zone to prevent spurious lifting due to fire damage. Use of the ADS inhibit switch blocks spurious ADS auto-initiation signal.

The Office Building does not contain any other components and/or cables which are included in the NSCA, NPO, or the Fire PRA. The Office Building does not contain radiological sources within the scope of the radiological release requirements of NFPA 805. On this basis NPPD is excluding the Office Building from the Power Block so as to prevent having to meet NFPA 805 Chapter 3 requirements for this low fire risk structure.

The South Radiological Material Storage Building, South Warehouse, and Low Level Radioactive Waste Storage Pad contain contaminated/radioactive material and have been included in the radioactive release review.

Reference: Response to FPE RAI 02.

7. Attachment L is revised as follows.

Approval Request 2, Basis for Request:

~~This is similar to the request made by Arkansas Nuclear One, Unit 2.~~

Approval Request 3, Basis for Request:

This is similar to the request made by Fort Calhoun Station (ADAMS Accession Number ML11276A118)~~, and Arkansas Nuclear One, Unit 2~~.

Approval Request 4, Basis for Request:

> This is similar to the request made by Waterford Steam Electric Station, Unit 3 (ADAMS Accession Number ML113220230)~~, and Arkansas Nuclear One, Unit 2~~.

Approval Request 5 is deleted in entirety.

New Approval Request 11 is proposed as follows:

Approval Request 11

NFPA 805, Section 3.2.3(1)

NFPA 805, Section 3.2.3(1) states:

> *"Procedures shall be established for implementation of the fire protection program. In addition to procedures that could be required by other sections of the standard, the procedures to accomplish the following shall be established:*
>
> *Inspection, testing, and maintenance for fire protection systems and features credited by the fire protection program."*

Cooper Nuclear Station will utilize performance-based methods to establish the appropriate inspection, testing, and maintenance frequencies for fire protection systems and features required by NFPA 805. Performance-based inspection, testing, and maintenance frequencies will be established as described in Electric Power Research Institute (EPRI) Technical Report TR-1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features", Final Report, July 2003.

Basis for Request:

NFPA 805 Section 2.6, *Monitoring*, requires that "*A monitoring program shall be established to ensure that the availability and reliability of the fire protection systems and features are maintained and to assess the performance of the fire protection program in meeting the performance criteria. Monitoring shall ensure that the assumptions in the engineering analysis remain valid."*

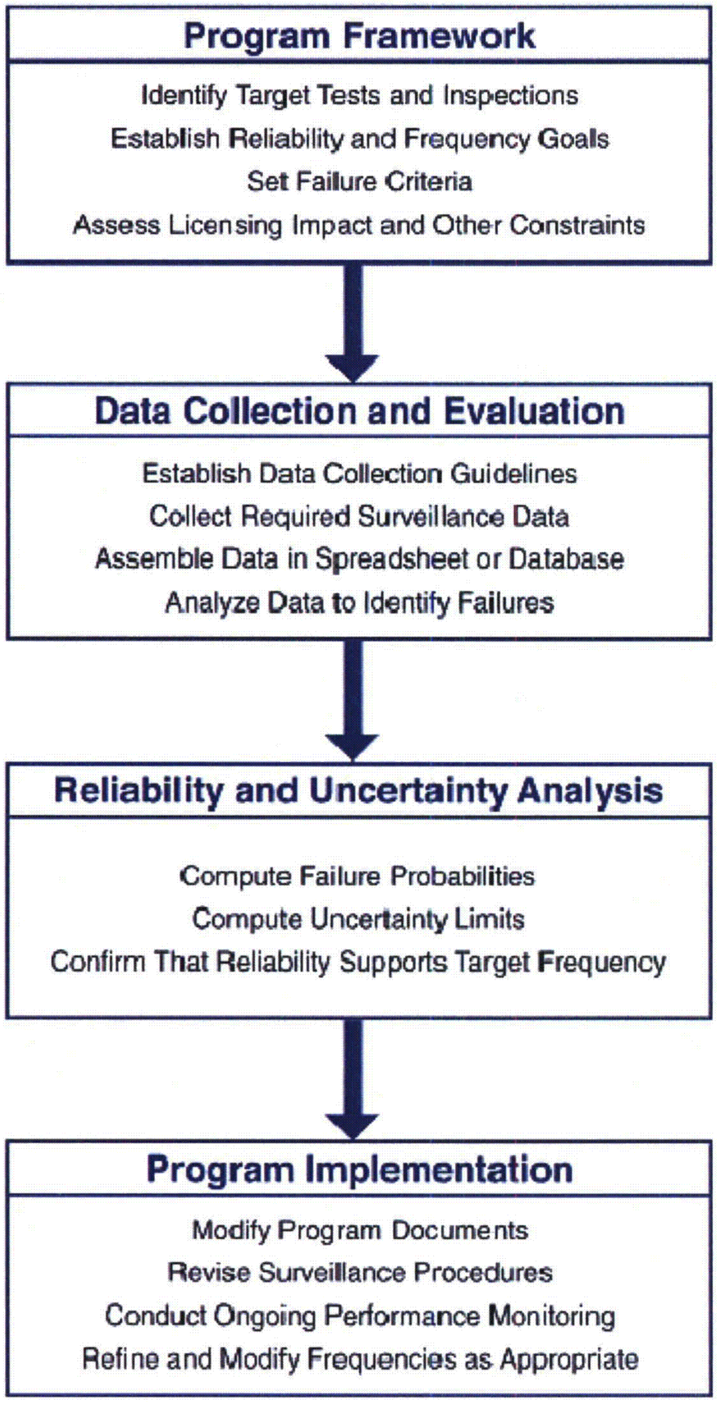
NFPA 805 Section 2.6.1, *Availability, Reliability, and Performance Levels,* requires that *"Acceptable levels of availability, reliability, and performance shall be established."*

NFPA 805 Section 2.6.2 requires that "*Methods to monitor availability, reliability, and performance shall be established. The methods shall consider the plant operating experience and industry operating experience."*

The scope and frequency of the inspection, testing, and maintenance activities for fire protection systems and features required in the fire protection program have been established based on the previously approved Technical Specifications/License Controlled Documents and appropriate NFPA codes. This request does not involve the use of the EPRI Technical Report TR-1006756 to establish the scope of those activities as that is determined by the required systems review identified in Table 4-3.

This request is specific to the use of EPRI Technical Report TR-1006756 to establish the appropriate inspection, testing, and maintenance frequencies for fire protection systems and features credited by the fire protection program. As stated in EPRI Technical Report TR-1006756 Section 10.1, "*The goal of a performance-based surveillance program is to adjust test and inspection frequencies commensurate with equipment performance and desired reliability.*" This goal is consistent with the stated requirements of NFPA 805 Section 2.6. The EPRI Technical Report TR-1006756 provides an accepted method to establish appropriate inspection, testing, and maintenance frequencies which ensure the required NFPA 805 availability, reliability, and performance goals are maintained.

The target tests, inspections and maintenance will be those activities for the NFPA 805 required Fire Protection systems and features. The reliability and frequency goals will be established to ensure the assumptions in the NFPA 805 engineering analysis remain valid. The failure criterion will be established based on the required Fire Protection systems and features credited functions and will ensure those functions are maintained. Data collection and analysis will follow the Technical Report TR-1006756 document guidance. The failure probability will be determined based on the Technical Report TR-1006756 guidance and a 95% confidence level will be utilized. The performance monitoring will be performed in conjunction with the Monitoring program required by NFPA 805 section 2.6 and it will ensure site specific operating experience is considered in the monitoring process. The following is a flow chart that identifies the basic process that will be utilized.



EPRI TR-1006756 - Figure 10-1
Flowchart for Performance-Based Surveillance Program

Acceptance Criteria Evaluation:

Nuclear Safety and Radiological Release Performance Criteria:

Use of performance-based test frequencies established per EPRI Technical Report TR-1006756 methods combined with NFPA 805 Section 2.6, *Monitoring Program*, will ensure that the availability and reliability of the fire protection systems and features are maintained to the levels assumed in the NFPA 805 engineering analysis. Therefore, there is no adverse impact to Nuclear Safety Performance Criteria by the use of the performance-based methods in EPRI Technical Report TR-1006756.

The radiological release performance criteria are satisfied based on the determination of limiting radioactive release. Fire protection systems and features are credited as part of that evaluation. Use of performance-based test frequencies established per EPRI Technical Report TR-1006756 methods combined with NFPA 805 Section 2.6, Monitoring Program will ensure that the availability and reliability of the fire protection systems and features are maintained to the levels assumed in the NFPA 805 engineering analysis which includes those assumptions credited to meet the Radioactive Release performance criteria. Therefore, there is no adverse impact to Radioactive Release performance criteria.

Safety Margin and Defense-in-Depth:

Use of performance-based test frequencies established per EPRI Technical Report TR-1006756 methods combined with NFPA 805 Section 2.6, Monitoring Program will ensure that the availability and reliability of the fire protection systems and features are maintained to the levels assumed in the NFPA 805 engineering analysis which includes those assumptions credited in the Risk Evaluation safety margin discussions. In addition, the use of these methods in no way invalidates the inherent safety margins contained in the codes used for design and maintenance of fire protection systems and features. Therefore, the safety margin inherent and credited in the analysis has been preserved.

NEI 04-02, Section 5.3.5.2 describes three echelons for defense-in-depth:

1) Preventing fires from starting (e.g., combustible/hot work controls),
2) Detecting fires quickly and extinguishing those that occur, thereby limiting damage (e.g., fire detection systems, automatic fire suppression, manual fire suppression, pre-fire plans), and
3) Providing adequate level of fire protection for structures, systems and components important to safety so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed (e.g., fire barriers, fire rated cable, success path remains free of fire damage, recovery actions).

Echelon 1 is not affected by the use of EPRI Technical Report TR-1006756 methods. Use of performance-based test frequencies established per EPRI Technical Report TR-1006756 methods combined with NFPA 805 Section 2.6 *Monitoring Program,* will ensure that the availability and reliability of the fire protection systems and features credited for

DID are maintained to the levels assumed in the NFPA 805 engineering analysis. Therefore, there is no adverse impact to echelons 2 and 3 for the defense in depth.

Conclusion:

NRC approval is requested for use of the performance-based methods contained in EPRI Technical Report TR-1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features", Final Report, July 2003 to establish the appropriate inspection, testing, and maintenance frequencies for fire protection systems and features required by NFPA 805. As described above, this approach is considered acceptable because it:

(A) Satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release;
(B) Maintains safety margins; and
(C) Maintains fire protection defense-in-depth (fire prevention, fire detection, fire suppression, mitigation, and post-fire nuclear safety capability).

Reference: Response to RAI FPE RAI 04, FPE RAI 13, and FPE RAI 16.

8. Attachment S, Table S-2 is revised to include this additional modification:

Table S-2 Plant Modifications Committed

Item	Rank	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S-2.8	Low	Fire damage to some Motor Operator Valves (MOVs) will not allow the valve to be operated from the Control Room. Currently, there are compensatory measures to remove the control power fuse(s) at the MCC or DC starter and pushing the contactor to open or close MOV.	Install safe and reliable controls for the MOVs at or near there respective MCC or DC starter. The controls will provide position indication, a control switch, an isolation switch and control power fuses to each affected MOV control circuit. This will be implemented with CED 6033461.	N	Y	Some risk benefit would be realized because of simplifying the recovery action from removing control fuses and pushing contactors to operate from a remote control panel. The Fire PRA does not quantify the difference in the risk between the different recovery actions. Compensatory measure for NFPA 805: Appropriate compensatory measures will be established per CNS Procedure 0.23, as required, until the modification is implemented. Compensatory measure for 10 CFR 50 Appendix R: Yes. Alternate compensatory measures in the form of Operator Manual Actions as documented in Procedures 5.4FIRE S/D and 5.4POST-FIRE are in place for this issue. The alternate compensatory measures are implemented per CNS Procedure 0.23.

Reference: Response to SSD RAI 09.

9. Attachment S, Table S-3 is revised as follows:

Item	Description	LAR Section / Source
S-3.1	During the implementation of the NFPA 805 licensing basis, performance-based surveillance frequencies will be established as described in Electric Power Research Institute (EPRI) Technical Report 1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features". The performance-based surveillance frequencies will be evaluated in the monitoring program in accordance with NFPA 805 FAQ 10-0059.	Attachment A L
S-3.30	Verify the validity of the change-in-risk following implementation of Table S-2 modifications. Change in risk differences resulting from this verification using as-built modification information will be evaluated in accordance with the proposed License Condition 2.C(4) requirements detailed in Attachment M of this Transition Report to determine if NRC approval is required.	PRA RAI 19

Reference: Response to FPE RAI 04 and PRA RAI-19.