FPL.

April 16, 2013
10 CFR 50.90
L-2013-107

U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555-0001

Re: Turkey Point Nuclear Generating Station Units 3 and 4
Docket Nos. 50-250 and 50-251
Response to Request for Additional Information Regarding License Amendment Request No. 216 - Transition to 10 CFR 50.48(c) - NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Generating Plants (2001 Edition)

By Florida Power and Light Company (FPL) letter L-2012-092 dated June 28, 2012, in accordance with the provisions of 10 CFR 50.90, "Application of License or Construction Permit," FPL requested an amendment to the Renewed Facility Operating License (RFOL) for Turkey Point Nuclear Generating Station Units 3 and 4. The license Amendment Request (LAR) will enable FPL to adopt a new fire protection licensing basis which complies with the requirements in 10 CFR 50.48(a) and (c) and the guidance in Revision 1 of Regulatory Guide (RG) 1.205.

On September 5, 2012, the NRC Staff requested supplemental information regarding the LAR. By FPL letter L-2012-354 dated September 19, 2012, the supplemental information was provided.

On March 15, 2013, the NRC Staff requested additional information regarding the LAR. Based on discussions with the NRC Staff, the additional information requested was prioritized and the response to the request for additional information is to be provided in three separate submittals. The attachment to this letter provides the 90-day response to the request for additional information.

The supplemental information does not impact the 10 CFR 50.92 evaluation of "No Significant Hazards Consideration" previously provided in FPL letter L-2012-092.

This letter makes no new commitments or changes any existing commitments.

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NRR

If you should have any questions regarding this application, please contact Robert Tomonto, Licensing Manager, at 305-246-7327.
I declare under penalty of perjury that the foregoing is true and correct.

Executed on April 16, 2013.

Michael Kiley
Vice President
Turkey Point Nuclear Generating Station

Attachment

cc: Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point
USNRC Project Manager for Turkey Point
Ms. Cindy Becker, Florida Department of Health

L-2013-107 Attachment

Response to Request for Additional Information Regarding License Amendment Request No. 216 90-Day Response

Florida Power and Light Company
Turkey Point Nuclear Generating Station Units 3 and 4
Transition to 10 CFR 50.48(c) - NFPA 805
Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition

PTN RAI PRA 01.e - Plant Partitioning

Please clarify the following dispositions to fire PRA Facts and Observations (F&Os) and Supporting Requirement (SR) assessment identified in Attachment V of the LAR (as amended by the LAR Supplement dated September 19, 2012) that appear to have the potential to noticeably impact the fire PRA results and do not seem fully resolved:

e) F&O 1-34 against FSS-G4, F&O 2-1 against PP-B7, F&O 3-2 against PP-B2, F&O 3-3 against PP-B3, F&O 3-4 against PP-B1 and PP-B5, and F&O 3-5 against PP-B5:

Section 2.2 of the Plant Partitioning and Fire Ignition Frequency report states that the fire compartment analysis for the purposes of fire risk assessment is consistent with the basis for fire areas and zones defined in the plant Fire Protection Program; therefore boundary requirements are adequate to meet partitioning criteria for the fire risk assessment. However, these F&Os cite lack of bases for fire barrier credit in the PRA. Discuss the bases that support fire barrier functionality credited in the FPRA in the following. Include discussion of the walkdown criteria used for judging the sufficiently of fire barriers:

i. Fire barrier conformance to tests and standards

ii. Manholes as separate compartments

iii. Crediting non-fire-rated construction

iv. Crediting special spatial separation

v. Crediting non-fire-rated active barriers

RESPONSE:

i) A walkdown was performed to ensure that credited barriers were both substantial and were created in accordance with guidance from NUREG/CR-6850 (Section 1.3.1, p. 1-2, 1st paragraph) that states "a fire compartment is a well-defined enclosed room, not necessarily with fire barriers. Fire compartments generally fall within a fire area, and are bounded by non-combustible barriers where heat and products of combustion from a fire within the enclosure will be substantially confined. Boundaries of a fire compartment may have open equipment hatches, stairways, doorways, or unsealed penetrations." As part of the fire PRA analysis an imaginary line for the boundary was not drawn, rather failures in adjacent zones caused both directly and indirectly by a fire scenario in the zone being analyzed were considered and the associated risk was calculated during the PRA analysis. Additionally, a multi-compartment analysis (MCA) was performed to assess the impact of a fire impacting adjacent compartments.

ii) Per the fire hazards analysis (FSAR Appendix 9.6A, Section 3.11.5.1.b), "manholes containing redundant safe shutdown cable have been sealed to prevent the introduction of flammable liquids due to spills above or in the vicinity of the manholes. All sealant material shall be chemically resistant to combustible liquids and shall not burn readily." While the FHA does not consider manholes as rated fire barriers, the PRA does credit manholes as significant fire deterrents where "heat and products of combustions from a fire within the enclosure will be substantially confined" (excerpt from NUREG/CR-6850 quote sited in item i above).

iii) In support of the response to this RAI a walkdown was conducted of all accessible fire zones to ensure that all barriers credited are of substantial build and capable of confining heat and products of combustion. The following zones were inaccessible during walkdown and could not be directly viewed from outside the zone:

FIRE ZONE	FIRE AREA	Description
001	AAA	Units 3 and 4 Holdup Tank A
002	AAA	Units 3 and 4 Holdup Tank B
003	AAA	Units 3 and 4 Holdup Tank C
008	A	Units 3 and 4 Waste Holdup Tank Room
010	A	Units 3 and 4 Radioactive Pipeway
017	A	Units 3 and 4 Spent Resin Storage Tank Room
018	A	Units 3 and 4 Area Beneath Waste Evaporator Skid
019	H	Unit 3 West Electrical Penetration Room
020	I	Unit 3 South Electrical Penetration Room
026	J	Unit 4 North Electrical Penetration Room
027	K	Unit 4 West Electrical Penetration Room
030	D	Unit 4 Pipe and Valve Room
035	F	Units 3 and 4 Valve Room
040	E	Unit 3 Pipe and Valve Room
050	F	Units 3 and 4 Purification Demineralizers Room
111	AAA	Unit 4 Volume Control Tank
112	AAA	Unit 3 Volume Control Tank
060	Q	Unit 3 Containment
059	P	Unit 4 Containment

These zones have been verified per the Fire Barrier drawings (5610-A-60 through 63) to have substantial barriers, i.e. reinforced concrete. The MCA evaluates the impact of breach of these fire zone boundaries.

iv) Spatial separation was not credited as a fire barrier. Openings between fire zones were addressed with respect to targets on the other side of an opening which are within the zone of influence of an ignition source. Targets were evaluated for fire damage regardless of the zone in which they were located. Additionally, the MCA considers the spread of fire between adjacent zones with openings between the zones in evaluating the potential for a hot gas layer formation impact on the adjacent zones.

v) No active barriers are credited for the fire PRA analysis. Unless otherwise verified to have only a fire damper or seal penetration the MCA conservatively assumes a door failure between fire compartments. The MCA does not credit a barrier failure probability for zones with openings between the zones.

PTN RAI PRA 01.h

Please clarify the following dispositions to fire PRA F&Os and SR assessment identified in Attachment V of the LAR (as amended by the LAR Supplement dated September 19, 2012) that appear to have the potential to noticeably impact the fire PRA results and do not seem fully resolved:

h) F&O 3-5 against SF-A1: Section 3.13 of the Fire PRA Summary report states that the site is in a "seismically inactive area". However, the September 2010 Generic Issue 199 memorandum on updated probabilistic seismic hazard estimates identifies an updated seismic hazard applicable to Turkey Point. Provide further justification specific to fire vulnerabilities such as fuel, ignition sources, and oxidizers that fire scenarios unique to seismic interaction are adequately evaluated in light of this new data.

RESPONSE:

The disposition of this F&O listed in Table V-3 of Attachment V of the LAR states, "The low seismic spectra applicable to the Turkey Point site have been validated via the Individual Plant Examination of External Events (IPEEE) with respect to the potential for causing unique fire scenarios. Their potential for causing damage to pipes or tanks containing combustible gases or liquids or to initiation of electrical fires is considered negligible."

The Individual Plant Examination (IPE), referenced in the IPEEE, states, in Section 3.74, "Turkey Point is located in South Florida which has very little history of seismic activity and whose geological nature is not conducive to seismic events. Nevertheless, permanent safety-related plant installations are designed and constructed to withstand the effects of seismic events. II/I criteria are applied to systems and components whose failure could affect operation of safety related equipment. Plant Procedures (currently AP-190.67 and ADM 016.1) control the installation of "temporary" components, such as gas cylinders. Therefore, fires induced through seismic events are not considered an important hazard at Turkey Point." Note that procedure AP-190.67 no longer exists; however, 0-ADM-033, PTN Industrial Safety Program, also controls the installation of "temporary" components, such as gas cylinders.

The seismic hazard analysis in the GI-199 report reported a low seismic core damage frequency, certainly not anything significantly different from other estimates, such as the recent Stevenson and Associates report, 11C4957-RPT-002 Rev. 0, Turkey Point 3 & 4 Seismic Adequacy Assessment, which states, "At plant HCLPF levels of 0.3g and even 0.25g the SCDF is barely in the 10^{-6} range which is readily classified as remote." Given this fact, and the aforementioned measures taken at Turkey Point for permanent, safety-related plant installations and control of temporary components such as gas cylinders, the new data in GI-199 does not create a need for re-evaluation of seismic-fire vulnerabilities.

PTN RAI PRA01.u - HEAF Thermolag Impact

Please clarify the following dispositions to fire PRA F&Os and SR assessment identified in Attachment V of the LAR (as amended by the LAR Supplement dated September 19, 2012) that appear to have the potential to noticeably impact the fire PRA results and do not seem fully resolved:

u) F&O 10-4 against FSS-C8: Justify the qualification of the credited fire wrap cited in this F&O related to thermal resistance, flame impingement, and impact from HEAF. Include in this justification, beyond the informal hose-stream test described during the audit, discussion of any engineering assessment to support assumptions made about the functionality of this barrier. Alternatively, provide the impact on CDF/LERF and Δ CDF and Δ LERF when credit for this wrap is removed.

RESPONSE:

Credit is taken for Electrical Raceway Fire Barrier Systems (ERFBS, Thermolag) protecting raceways in the vicinity of a potential High Energy Arcing Fault (HEAF) fire at switchgear (SWGR) and load centers (LCs). The damage distance identified for HEAF is 3 feet horizontal from the front and back of the panel and 5 feet vertical (per NUREG/CR-6850, Section M.4.2, 8th bullet) from the top of the panel with a distance of 1 foot horizontal above the top of the panel (per NUREG/CR-6850, Section M.4.2, 6th bullet). Thermolag credited raceways were identified in compartments with HEAF scenarios. The compartments were walked down and the location of these raceways identified. Fire Zones 068 (4kV SWGR 4A Room) and 071 (4kV SWGR 3A Room) contained Thermolag raceways within the damage distance. These 4kV SWGR have louvers on the front of the bus bar housing section located at the top-center of the SWGR cubicles. The top of the SWGR cubicles is solid metal. The top of the bus bar housing is solid metal above the louvers. Therefore, it is unlikely that Thermolag raceways running over the center of the SWGR above the solid SWGR top panel (A1524 and A1525, in Fire Zone 068) will incur damage from a HEAF. There is one Thermolag raceway (3A058 and 4A058) in the each SWGR Fire Zones that is near the ceiling running south over SWGR cubicles 9 and 10 about 3 feet over the SWGR. These raceways travel across the switchgear front/back. Although they travel above the section of the switchgear with the vents (front side), the vent is oriented downwards and any HEAF energy coming through the vents would tend to disperse horizontally and downward and would not impact these Thermolag raceways which are a distance of approximately 3 feet above the switchgear. The direction of the HEAF energy will concentrate through the vents and in the direction downward from the vents which will prevent significant energy/mechanical damage to the thermolagged raceways facing the solid SWGR panel section. Therefore, no damage to the Thermolag beyond that associated with the post HEAF fire, for which the Thermolag is qualified/analyzed, is expected to occur.

PTN RAI PRA 01.x - F&O 10-14 against FSS-A5 REV C

Please clarify the following dispositions to fire PRA F&Os and SR assessment identified in Attachment V of the LAR (as amended by the LAR Supplement dated September 19, 2012) that appear to have the potential to noticeably impact the fire PRA results and do not seem fully resolved:

x) Identify plant-specific configurations where the Generic Fire Modeling Treatments may not be conservative and provide the impact of this non-conservatism on CDF, LERF, ΔCDF and ΔLERF.

RESPONSE:

The Generic Fire Modeling Treatments report was developed to provide conservative Zone of Influence (ZOI) and hot gas layer information for various types of ignition sources. The ZOIs are defined with a vertical component that is computed from a thermal plume model and the horizontal component is derived from a thermal radiation calculation. Both ZOI components use empirical models that are based on open configuration fires with input parameters biased such that the result is conservative when applied to NUREG/CR-6850 Appendix E Ignition Source Discretized Distribution Cases 1 – 8, liquid fuel fires, and self-ignited cable tray fires when used within the specified limitations. Key ZOI dimension conservatisms in the Generic Fire Modeling Treatments report include the use of steady-state target damage thresholds, a fire diameter that maximizes the ZOI dimension, a lower panel ZOI dimension that is based on a radiating panel, a characteristic panel dimension that maximizes the ZOI dimension, and an application limit of 80°C (176°F) within an enclosure. Several adaptations have been developed for conservatively applying the results to configurations that do not conform to the limitations specified in the Generic Fire Modeling Treatments, including adjustments for wall and corner effects and applications in enclosures in which the hot gas layer temperature may exceed 80°C (176°F). These include the use of the 'Image' Method as described in NIST-GCR-90-580 to adjust the plume entrainment characteristics so that that the ZOIs may be applied in wall and corner locations and the use of extended ZOIs that account for the increased heat flux from a hot gas layer that is above 80°C (176°F).

The hot gas layer information is provided as time at which the hot gas layer temperature reaches a threshold temperature over a range of ventilation conditions. The calculation includes multiple conservative assumptions, including the use of an enclosure that minimizes heat losses through the boundary, the assumption of an adiabatic floor, the assumption that a fire reaches the peak heat release rate in ten seconds, the use of a fuel property specification that maximizes the enclosure temperature, the assumption that the hot gas layer effects apply throughout the space, and a vent orientation that maximizes the enclosure temperature. The hot gas layer information in the Generic Fire Modeling Treatments report is applicable to fires involving the ignition source only. Adaptations have been developed to accommodate situations in which the ignition source involves two horizontal cable trays having a total cross-sectional dimension of 0.9 m (3 ft).

Additional conservatism broadly applied at PTN for the ZOI and hot gas layer information includes the exclusion of the room volume below the fire base, the selection of the greatest horizontal ZOI dimension as being representative of all horizontal ZOI dimensions, and the selection of the most adverse ventilation fraction. In addition, field implementation includes rounding to ZOI dimensions to the next whole foot value and the inclusion of targets that are near the ZOI boundary, both of which may add conservatism to the model application depending on the particular conditions and values involved.

Although the ZOI dimensions and hot gas layer information provided in the Generic Fire Modeling treatments is conservative when applied within the applicable limitations, the conservatism may be decreased or eliminated if they are applied outside their limitations or conservative adaptations to the limitations. The response to PTN RAI FMOD 04 (Generic Treatments Limitations) identifies two general plant specific applications in 0493060006.003, Rev. 2 that fall outside the original or expanded limitations. These applications are as follows (see response to PTN RAI FMOD 04 (Generic Treatments Limitations)):

- Application of the Generic Fire Modeling Treatments hot gas layer data within enclosures that have an aspect ratio greater than five for scenarios that are not treated as full room burnouts.
- Application of the Generic Fire Modeling Treatments hot gas layer data and ZOI dimensions to ignition sources that involve secondary combustibles and do not lead to full room burnout.

The hot gas layer information is provided for enclosures having an aspect ratio up to five per NUREG-1824, Volume 5, Section 3.2. In situations where the model is applied to enclosures having a larger aspect ratio, the behavior transitions to a channel flow typical of a corridor configuration. Localized effects in the vicinity of the fire could be more severe than the average conditions throughout the enclosure length and thus a non-conservative result could be generated. NUREG-1934 describes a method to apply a fire model in a conservative manner under these conditions. This method involves the modification of the enclosure dimensions such that the application falls within the model limitation and the hot gas layer temperature result are conservative. The application of the Generic Fire Modeling Treatments hot gas layer data used in PTN enclosures with aspect ratios greater than five in Report 0493060006.003, Rev. 2 will be updated using the recommended approach in NUREG-1934. The CDF and LERF contribution from the affected scenarios will be updated accordingly in conjunction with the incorporation of the panel factor sensitivity evaluation into the base fire PRA.

The application of the Generic Fire Modeling Treatments hot gas layer data to fire scenarios that involve secondary combustibles is outside the original limits. However, additional scenarios have been developed that provide hot gas layer data for configurations involving two cable trays with a total cross-sectional dimension of 0.9 m (3 ft) in Supplement 2 to the Generic Fire Modeling Treatments. The response to PTN RAI FMOD 01.j (Secondary Combustible ZOI) and PTN RAI FMOD 01.k (Secondary Combustible Fire Propagation) address aspects of the method as applied to ignition source – cable tray configurations involving two or fewer cable trays. When the results are applied to configurations involving two or more cable trays or cable tray configurations involving a total cross sectional width greater than 0.9 m (3 ft), a non-conservative result could be generated because the heat release rate will be underestimated.

Additional scenarios will be developed for PTN specific ignition source-cable tray configurations involving three or more cable trays using the guidance provided in NUREG/CR-6850 and NUREG/CR-7010, Volume 1 for fire propagation, flame spread, and heat release rate per unit area. Report 0493060006.003, Rev. 2 will be updated to include the hot gas layer results associated with the PTN specific ignition source-cable tray configurations. The CDF and LERF (and change in CDF and LERF) contribution from the affected scenarios will be updated accordingly in conjunction with the incorporation of the panel factor sensitivity evaluation into the base fire PRA (see PTN RAI PRA 01.t (Non-Cable Secondary Combustible Impact).

PTN RAI PRA 01.dd - Generic Fire Model ZOIs

Please clarify the following dispositions to fire PRA F&Os and SR assessment identified in Attachment V of the LAR (as amended by the LAR Supplement dated September 19, 2012) that appear to have the potential to noticeably impact the fire PRA results and do not seem fully resolved:

dd) F&O 10-17 against FSS-D1: Confirm that selection of generic models to define target selection damage from HGL effects to specific scenarios including applying a larger zone of influence (ZOI) when needed (as cited in the F&O) was performed and identify where this is documented.

RESPONSE:

The generic fire modeling defined a standard ZOI based on the fire ignition source. Attachment B of the Turkey Point Fire Scenario Report identifies this ZOI for the ignition sources. Individual scenarios were created based upon the ignition source. The ZOI was identified in the notes section of Attachment A to the Scenario Report but not as a separate field. A spreadsheet has been created showing the horizontal ZOI and vertical ZOI for each scenario. The spreadsheet information will be incorporated into the next update of the Scenario Report. The HGL analysis is currently being updated to eliminate the credit for the panel factors. Any changes to the zone of influence used as a result of this update will be incorporated into the Scenario Report, including scenarios where a larger ZOI was used in order to allow credit for a longer time to hot gas layer. The current evaluation has provisions for using this larger ZOI but it has not been used in the current HGL analysis.

PTN RAI PRA 20 – FPRA F&Os and Internal Gap Assessment (GA) Inconsistencies
The evaluations presented in the licensee's gap assessment performed on the internal events PRA identified just one gap associated with an SR; however, the fire PRA peer reviews identified numerous findings where internal events SRs are referenced as part of the finding. Explain this apparent inconsistency, and confirm that findings identified the fire PRA peer reviews do not question the quality of the internal events PRA. If some of the internal event findings do pertain to the internal events PRA, then provide a disposition of these findings.

RESPONSE:

The fire PRA peer review was focused on the fire PRA, including its interface with the internal events PRA. Attachment V of the LAR documents the disposition of the fire PRA peer review findings, including any issues associated with the references to the internal events SRs.

PTN RAI PRA 21 – IEPRA Gap Assessment to Latest Standard

Staff noted several differences between the supporting requirement language documented within the Gap Assessment and that within the ASME/ANS PRA RA-Sa-2009 Standard (e.g., DA-D6, LE-B1, etc.). Confirm the version of the ASME/ANS PRA Standard against which the Internal Events PRA Gap Assessment was performed. The quality of the internal events PRA against the requirements of RG 1.200, Rev. 2 needs to be established to the extent the fire PRA may be negatively impacted. If the ASME/AMS PRA RA-Sa-2009 Standard was not used, perform a gap self-assessment of the Internal Events PRA model and indicate how any identified gaps were dispositioned. If the ASME/AMS PRA RA-Sa-2009 Standard was used, identify all instances where the supporting requirement language documented within the Gap Assessment differs from that within the ASME/AMS PRA RA-Sa-2009 Standard, as clarified/qualified by Rev. 2 of RG 1.200, and justify the continued validity of the conclusions drawn in the Gap Assessment for those supporting requirements.

RESPONSE:

The entire Turkey Point gap analysis was checked to ensure that the supporting requirement language therein reflected that in the ASME/ANS PRA RA-Sa-2009 Standard and RG 1.200, Rev. 2. The instances discovered in the NRC audit (DA-D6 and LE-B1) were corrected, and their responses reviewed to ensure they met the latest DA-D6 and LE-B1 requirements. No other errors in the gap analysis were discovered.

PTN RAI PRA 22

Provide general overview of the gap assessments performed against the then-current versions of the standard (including RG 1.200 clarifications) following the 2002 internal events peer review. Identify documentation for gap assessment performed or the summarized results from each assessment. In addition, discuss the process and procedures installed to ensure that newly endorsed revisions to the standard are reviewed and that gap assessments are promptly performed.

RESPONSE:

The original PRA peer review, based on NEI 00-02, was conducted in January 2002. Upon issuance of the ASME PRA Standard and RG 1.200, the Standard requirements were cross-referenced to the applicable NEI 00-02 requirements and a gap analysis based on the Standard was created. As the Standard and RG 1.200 were revised, the gap analysis was updated. In April 2012, focused peer reviews were conducted for the human reliability analysis and the internal flooding analysis, and the results of these reviews were incorporated into the overall gap analysis. In the past, there was no process or procedure to ensure that newly endorsed revisions to the standard are reviewed and that gap assessments are promptly performed; however, gap analysis updates have always been performed within a short time following publication of updates to the ASME PRA Standard and RG 1.200. The relevant FPL fleet PRA procedure, EN-AA-105-1000, PRA Configuration Control and Model Maintenance, was recently updated to include a provision for updating the gap analysis within six months of the issuance of a new revision of the ASME PRA Standard or RG 1.200.

PTN RAI PRA 23 – Qualifications of Peer Review Team

Based on a review of the 2011 internal events focused scope peer review resumes the staff infers that peer review team including the lead reviewer lacked HRA review expertise as defined in the ASME/ANS PRA Standard to perform a focused scope peer review on HRA. Perform a new focused scope peer review on HRA.

RESPONSE:

It is acknowledged that the resumes for the Human Reliability Analysis (HRA) review team included in the focused peer review report did not reference much HRA experience. However, upon further investigation, the experience and qualifications of the lead reviewer and the other peer review team members were found to fulfill the ASME/ANS PRA Standard requirements for necessary expertise to lead the HRA focused peer review. Westinghouse is in the process of revising the peer review report to include this information. The updated resumes of the team members are available upon request.

PTN RAI PRA 24 - Minimum Acceptable Values for Probabilities of HFEs

Provide the results (e.g., CDF, LERF, ΔCDF, ΔLERF) of a sensitivity study performed on the internal events PRA utilizing guidance provided in NUREG-1921 to establish minimum acceptable values for joint HEPs.

RESPONSE:

The relevant excerpt from the preface of NUREG-1921 is shown below.

"NUREG-1792 [9] and EPRI 1021081 [10] address the need to consider a minimum value for the joint probability of multiple Human Failure Events (HFEs). The following is stated in NUREG-1792:

The resulting joint probability of the Human Error Probabilities (HEPs) in an accident sequence should be such that it is in line with the above characteristics [which are the conditions under which the operator actions may be dependent] and the following guidance, unless otherwise justified:

The total combined probability of all the HFEs in the same accident sequence/cut set should not be less than a justified value. It is suggested that the value not be below ~1E-05 since it is typically hard to defend that other dependent failure modes that are not usually treated (e.g., random events such as even a heart attack) cannot occur. Depending on the independent HFE values, the combined probability may need to be higher.

EPRI 1021081 recognizes this statement in NUREG-1792 and goes on to address the issue further in the following discussion:

NUREG-1792 introduces formally the concept of a limiting value on the combined HEP, and the use of such a value is widely regarded as being expected in regulatory applications. While it may not have been intended as an absolute limit, but more as a sort of trigger, to have the analyst check lower joint HEPs to see if some underlying dependence had been overlooked, it has often been interpreted as absolute.

When a limiting value for the combined HEP for a group of HFEs is proposed, it would be applied when the prescribed approach for dealing with dependency results in a total combined HEP that is less than that limiting value. A strict application of the guidance from NUREG-1792 above would be to apply the limiting value even if the HFEs were considered to be independent according to the criteria the analyst has adopted for determining the degree of dependence or independence.

This has caused difficulty in applying the Significance Determination Process (SDP) of the NRC's Reactor Oversight Process, particularly for shutdown events, where operator action is usually an important part of the response, and where the initiating event may have been due, to some extent, to human action. Using a minimum value of 1×10^{-5} has resulted in findings that would otherwise have characterized an event or condition as having very low risk becoming "white" findings.

Therefore, while it might be reasonable to adopt some sort of limit, it needs to be done carefully, so that the results of PRAs are not distorted by arbitrary assignments of probabilities. As discussed in detail later on, any limiting values should be consistent within the context of the scenarios in which they are applied.

For fire HRA, it is recommended that the application of a lower bound follow the same guidance as was applied to the internal events PRA."

Two sensitivity cases were run to evaluate the impact of using a floor of 1E-05 and a floor of 1E-06 on the internal events core damage frequency (CDF) and large early release frequency (LERF). The original baseline CDF quantification used an HRA dependency analysis with a floor of 0. Using a floor of 1E-05 for combinations of human failure events (HFEs), the CDF increased by 46%. A floor of 1E-06 produced a CDF increase of 4%. Comparing the cutsets from the original baseline and those from the 1E-05 floor case, the cutsets responsible for the majority of the increase either included anywhere from 3 to 7 HFEs, and most of these included an HFE which occurs several hours following the initiating event and has a cue which is alarmed in the control room. This is significant, as this characteristic is identified as necessary to qualify the HFE combination as having very low dependence per Tables 4-3 and 4-4 of EPRI Report 1021081 (referenced in the NUREG-1921 excerpt above). Examination of the top 100 cutsets, looking for the HFE combinations affected by the assigned floor value of 1E-05, all but one of these included an HFE which occurs several hours following the initiating event and has a cue which is alarmed in the control room. The one cutset that did not include such an HFE was discussed with Dr. Gareth Parry, the author of EPRI Report 1021081, who concluded that it also qualified for a very low dependency and the associated floor of 1E-06.

In summary, all of the HFE combinations in the top 100 cutsets that are affected by the assignment of a floor of 1E-05 qualify for a floor of 1E-06 per EPRI Report 1021081, as interpreted by its author, Gareth Parry. Therefore, the CDF increase of 4% using an HFE combination floor of 1E-06 is a reasonable estimate of the increase realized when applying the HFE combination floor philosophy from NUREG-1921, NUREG-1792, and EPRI Report 1021081.

The same cases were run for LERF. The impact on LERF of the HFE combination floors was more significant. Using a floor of 1E-05 for combinations of human failure events (HFEs), the LERF increased by a factor of six. A review of the combinations against the guidance of EPRI Report 1021081 showed that, like the CDF HFE combinations, the LERF HFE combinations in the top 100 cutsets qualified for a floor of 1E-06. However, a floor of 1E-06 still produced a LERF increase of about 51%.

A review of the LERF cutsets with a floor of 1E-06 revealed that the increase was dominated by a single steam generator tube rupture (SGTR) sequence. The sequence was a SGTR, followed by successful AFW and HHSI, but the operators failed to cooldown and depressurize to isolate the leak, failed to attempt to refill the RWST, failed to initiate opposite-unit HHSI using the opposite unit's RWST as an injection source, and failed to maintain water in the faulted steam generator for scrubbing. A priority following a SGTR is to cool down the RCS to reduce and, eventually, terminate the leakage through the broken tube. If no action were taken to depressurize the RCS, leakage through the broken tube would have to be continuously made up by charging or high head safety injection (HHSI). This would eventually (over many hours) lead to depletion of the RWST. The MAAP run for this HFE shows that it takes 7.2 hours to deplete the RWST to the low-level setpoint at 155,000 gallons, and 12.8 hours to the low-low level setpoint of 60,000 gallons. At the low-level setpoint of 155,000 gallons, the operators would have their cue to refill the RWST, and they would have more than 5.6 hours (the time for the RWST to drain from 155,000 gallons to 60,000 gallons) to accomplish this. At the 60,000 gallon RWST level, the operators receive the cue to initiate HHSI from the opposite unit's RWST. This entails simply starting the other unit's HHSI pumps. The final operator error is failing to maintain SG level above the break (assumed to be the top of the tubes), so some scrubbing of the fission products would occur and the magnitude of the release would be reduced.

Given the number of operator actions, the very long times available to perform these actions, the time separation for their cues, the fact that the TSC and EOF would be manned early in the scenario, and that there would be a shift change during the scenario, the HFE combination probability for the no-threshold HRA, as calculated by the HRA Calculator, was significantly lower than the 1E-05 and 1E-06 thresholds. Based on these characteristics, an argument can be made that the combination probability should be less than 1E-06. Further, the sequence probably should not be considered a LERF sequence at all. In NUREG/CR-6595, Appendix A, LERF is defined as "the frequency of those accidents leading to significant, unmitigated releases from containment in a time frame prior to effective evacuation of the close-in population such that there is a potential for early health effects." Since this scenario will not result in core damage until well beyond 12 hours following the SGTR, decay heat level will be reduced, and core damage progression will be slow, the sequence is very likely not a viable LERF sequence. The release should not be large or early. If this one sequence is not counted as a LERF sequence, the LERF increase for the 1E-05 threshold is 125%, and the LERF increase for the 1E-06 threshold is 11%.

The sensitivity studies were performed for Unit 3; however, the units are sufficiently symmetric that the studies apply for Unit 4 as well.

PTN RAI PRA 26 – Statement of Knowledge Correlation
Provide the results (e.g., CDF, LERF, ΔCDF, ΔLERF) of a sensitivity performed on the internal events PRA accounting for the state-of-knowledge correlation.

RESPONSE:
The top 500 CDF and LERF cutsets from the Unit 3 Turkey Point internal events model used in the NFPA-805 fire PRA were examined for cutsets that contained two or more basic events referencing the same failure rate, and, therefore, were subject to the state-of-knowledge correlation. These cutsets were extracted and pasted into an Excel spreadsheet where the state-of-knowledge correlation was applied and the cutset frequencies adjusted. The delta CDF and delta LERF were calculated, and extrapolated to approximate the effect on total CDF and LERF. The results are shown in the table below.

Sensitivity Results

Baseline CDF	8.33E-07 per year
State-of-Knowledge Correlation CDF	8.48E-07 per year
Delta CDF	1.48E-08 per year
Percent Increase	1.8%
Baseline LERF	2.66E-08 per year
State-of-Knowledge Correlation LERF	2.74E-08 per year
Delta LERF	7.58E-10 per year
Percent Increase	2.8%

The sensitivity analysis was performed for Unit 3 only. The Unit 3 and Unit 4 models and results are quite symmetric; therefore, the conclusions from the Unit 3 sensitivity analysis are applicable to Unit 4.

The percent increase values shown in the table above for the internal events model should be bounding for the fire PRA, as, due to the substantial number of PRA components failed due to the fire initiators, there are typically fewer cutsets in the fire PRA results with multiple basic events in the same cutset sharing the same failure rate source.

PTN RAI PRA 27.a – IEPRA F&Os

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

a) F&Os IE-2 and HR-3: both of these F&Os were given a level of significance of "B" during the 2002 Internal Events PRA Peer Review; however, neither was dispositioned in the LAR. Provide a disposition for these F&Os and discuss their impact on the fire PRA.

RESPONSE:

These F&Os have been addressed and resolved. There should be no impact on the fire PRA.

F&O IE-2 Description

The disposition of dual unit initiators and dual unit success criteria is not clear. The following observations were made:

1) Loss of grid is called a "dual unit initiator" with a frequency of 0.053. The derivation for 0.053 is dominated by switchyard faults, which the IPE notebook implies would be a single unit initiator.

2) Loss of a DC bus on either unit will require the other unit to shutdown, but it is not explained why this is not a dual unit initiator.

3) There are no guidelines for dual unit success criteria.

F&O IE-2 Response

1) The LOOP initiators are now split into 5 different initiators. There are 4 dual-unit initiators: plant-centered, weather-induced, grid-related, and grid blackout; and 1 single-unit initiator. The two units share one switchyard, so it is assumed that switchyard faults cause a dual-unit LOOP. The single-unit LOOP is dominated by unit-specific startup transformer faults which are on the periphery of the switchyard and cause a loss of offsite power to only one unit.

2) This is because the other unit would have to shut down due to Tech Specs. As such, it would not be an immediate reactor trip, but a controlled shutdown.

3) Dual-unit success criteria are discussed fully in the AS Notebook and the SC calculation PTN-08-014. The effects of the dual-unit initiating events on the opposite-unit systems are modeled.

F&O HR-3 Description

Human errors for inter-unit cross ties are not accounted for under conditions of outage for the other unit and special initiating events.

F&O HR-3 Response

Flags representing the status of the opposite-unit (operating or shutdown) were added to the model to account for the effect of the opposite unit's mode on the different system crossties.

PTN RAI PRA 27.c – IEPRA F&Os

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

c) F&O HR-G7-01 against HR-G7: based on peer review comments, HEPs credited for dual-unit initiating events require two reactor operators per the manpower requirements Specifications), only 3 total ROs are required to support both units. Assess the risk impact for those instances when only 3 ROs would be present.

RESPONSE:

While PTN Technical Specifications require only 3 ROs for dual-unit operation, the scheduling of 4 reactor operators (ROs) has been a long-standing, administratively-controlled policy. According to Operations, 4 ROs are on shift approximately 98% of the time.

For the 2% of the time that there are only 3 ROs, the unassigned RO would assist both units, performing BOP and ONOP activities as prioritized by the control room supervision. This would really only impact risk if both units simultaneously suffer some kind of equipment failure that requires a 2nd RO's assistance. The low probability of this significantly limits the risk impact of having only 3 ROs.

The two dual-unit initiating event categories are Loss of Instrument Air and Loss of Offsite Power (LOOP).

An analysis of the cutsets shows that dual-unit Loss of Instrument air contributes to less that 1% of the total CDF. Furthermore, the recovery actions for either unit would lead operators to a common procedure (0-ONOP-013). The recovery actions performed for one unit would almost certainly also restore instrument air for the other.

Dual-unit LOOPs that involve human failure events (HFEs) constitute ~12.5% of the total risk. 99% of the cutsets include a failure to initiate feed-and-bleed and/or a failure to use standby steam generator feedwater (SSGFW). Like instrument air, SSGFW is a shared system and the recovery actions for either unit require turning on the same pumps and opening valves that are close to each other and could be manipulated by the same field operator in a short amount of time. As for feed-and-bleed scenarios, of all the LOOPs with HFEs, 86% involve a failure to initiate feed-and-bleed. Realistically, if both units simultaneously required feed-and-bleed, the third RO would assist one unit, and the unassisted RO on the other unit would perform recovery actions alone until the third RO was done with the other unit. As a bounding analysis, it is assumed the third RO must perform all of the recovery actions twice. Even when using HRA Calculator and doubling the response and manipulation times, the human error probability (HEP) is unaffected. The remaining cutsets initiated by a dual-unit LOOP consist mostly of station blackout cutsets which have no operator actions other than recovery of offsite power, which is handled by personnel outside the control room, and, therefore, would not be affected by one fewer RO.

In summary, the administrative control of control room staffing (maintaining 4 ROs 98% of the time), combined with minimal impact on the HFEs most often found in the cutsets initiated by dual-unit initiators, minimize the risk impact of the practice of having only three ROs a small percentage of the time.

PTN RAI PRA 27.d – IEPRA F&Os

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

d) F&O IE-9: the peer review noted that random RCP seal failure has not been modeled as a random initiating event, independently or as part of the small LOCA frequency. In light of the licensee's disposition, provide justification for not including capturing random RCP seal LOCAs in the model, and discuss why methods such as the zero-frequency method or Bayesian updating, which estimates non-zero frequencies even when there has been no occurrence, are not employed.

RESPONSE:

A review of NUREG/CR-5750 revealed that the random seal LOCA frequency is 2.5E-3 per year, and is based on 2 events: a 1975 event at Robinson-2, and a 1980 event at ANO-1. The incident at ANO-1 can be discounted not only due to the fact that it was 20 years ago and design changes have likely been made to preclude similar events, but also due to the fact that ANO-1 is a B&W plant with substantial differences in RCP and RCP seal design. As for the Robinson-2 incident, this event was occurred almost 40 years ago, when RCP and RCP seal design was substantially different. In the incident at Robinson-2, the RCP which had the seal failure had been stopped earlier after failure of the No. 1 seal, restarted several hours later, and stopped again. Given the current sensitivity to RCP seals, it is unlikely that an RCP would be restarted after indications of a failed No. 1 seal today. The incident at Robinson-2 was discounted due to changes in seal design and seal-related operating practices and procedures implemented in the last 37 years.

The reason that a zero-frequency method or Bayesian updating, which estimates non-zero frequencies even when there has been no occurrence, were not used for a specific random RCP seal LOCA initiator is that RCP seal LOCA initiators are modeled functionally in the PRA as a failure of seal cooling and seal injection.

Finally, the addition of a random RCP seal LOCA initiator to the internal events PRA would have no effect on the fire PRA used for NFPA 805.

PTN RAI PRA 27.f – IEPRA F&Os

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

f) F&O SY-2: as discussed in the peer review, the Robinson Nuclear Plant CCW system experienced relief valve opening coincident with maintenance on the surge tank level indication. In light of the peer review observation that the CCW model does not include the relief valve or the surge tank level instrumentation, clarify that this precursor to loss of CCW was reviewed and reflected in the PRA. If not, justify its exclusion.

RESPONSE:

The loss of CCW initiating event is represented in the Turkey Point PRA model as an initiating event fault tree. The purpose of the initiating event fault tree is to model the effects of the plant configuration on the likelihood of the initiating event. This fault tree does not include a spurious actuation of a relief valve opening coincident with surge tank level indication maintenance unavailability. Resolution of initiating event fault trees throughout the industry does not typically reach this level.

The loss of CCW event at Robinson was recovered within a few minutes. In addition, this event occurred during a refueling outage while conducting a surveillance test which is only performed during refueling outages.

Given the fact that the event occurred during a refueling outage, conducting a test that is only performed during a refueling outage, coupled with the fact that the loss of CCW was recovered within a few minutes, and that with the exception of loss of offsite power events, initiating event recovery is not modeled in PRAs, it is appropriate that this event is not counted in the calculation of the loss of CCW initiating event frequency for an on-line PRA model.

PTN RAI PRA 27.g – IEPRA F&Os

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

g) F&O DA-4: the licensee's disposition to this F&O notes data used in the current PRA model utilizes plant-specific data derived from plant records between 1992 and 2006. In the licensee's evaluation of Supporting Requirement DA-C1 documented in the gap assessment, a timeframe from 1997 to 2006 was noted instead. Describe the process by which data is updated, and confirm the time periods encompassed by latest data update. In addition, provide justification of any excluded data (e.g., provide evidence via design or operational change that the data are no longer applicable).

RESPONSE:

The time window for the initiating event frequency analysis extends from 01/1992 through 12/2006, and uses plant-specific transient history and the latest generic industry data. The test and maintenance unavailability's were created using data from the 10-year period from 01/1997 through 12/2006 from Equipment Out of Service (EOOS) logs, Reactor Operator narrative logs, Equipment Clearance Order (ECO) records, and files maintained by site engineering personnel. The Component Failure Rate analysis used historical functional failure data gathered from the time window extending from 01/1997 to 12/2006, and the latest generic industry data.

The selection of time windows for data analysis is driven by two objectives: 1) to select a time window that is representative of the current operation and maintenance practices, and 2) to select a time window that contains enough data to generate a statistically robust estimate of initiating event frequencies, test and maintenance unavailability's, and component failure rates. Using the last ten years of operational data satisfies these two objectives. Further, there are some important components modeled in the PRA which were not installed until just prior to 1997, e.g., the diesel-driven standby steam generator feedwater pump and the extra diesel-driven instrument air compressors. The extra six years (1992 to 1997) of data used for the initiating event analysis is simply a bonus, and is not affected by the fairly recent addition of the diesel-driven standby steam generator feedwater pump and the extra diesel-driven instrument air compressors. Pre-1992 data is questionable regarding its applicability due to major modifications made to both units in 1991.

PTN RAI SSA06 HEAF Thermolag Impact

SSA06 Table V-3 Disposition of 2010 TPN Fire PRA PEER Review "Finding" F&Os #10-4 identifies wrap as qualified for High Energy Arcing Fault (HEAF) protection because the "The hose stream test imposed on the fire barrier qualification subsequent to fire exposure is considered to provide a comparable level challenge to the Thermolag barrier as would the HEAF force applied at the onset of fire exposure." Provide more technical justification for this disposition. Describe the temperature and pressure parameters, design criteria, and installation standards that are being used to make this assumption.

RESPONSE:

See Response to RAI PRA 01.u.

PTN RAI SSA 08 - CCW to RCP Thermal Barrier Cooling

MOV–4-626 CCW U4 thermal barrier return

MOV–3-626 CCW U3 thermal barrier return

MOV-3-716A CCW U3 thermal barrier supply

MOV-4-716A CCW U4 thermal barrier supply

Specifically address the failure scenarios, required position(s), safe shutdown analysis logic alternatives, and recovery action sequences for either closing or opening these valves as required for the given fire area.

RESPONSE:

NRC Triennial Fire Protection Inspection Report [IR 05000250/2004007 and 05000251/2004007], Section 1R05.01.b.1 (URI 05000251/2004007-001), identified that in Fire Area/Fire Zone U/067 the RCP thermal barrier cooling valves MOV-4-716B and MOV-4-626 could be subject to spurious closing, and that plant procedures did not include mitigation strategy against spurious closure of MOV-4-626.

Inspection Report Section 1R05.05.b.1 (URI 05000250,251/2004007-006) identified that in Fire Areas/Fire Zones MM/106, MM/106R and MM/097 timely alignment verification of the RCP thermal barrier cooling valves MOV-3/4-716A was not provided.

RAI SSA 08 requests information on the failure scenarios, required safe shutdown positions, safe shutdown analysis logic alternatives and recovery actions for MOV-3/4-626 and MOV-3/4-716A in Fire Areas HH (Units 3 and 4 Cable Spreading Room), CC (Units 3 and 4 Auxiliary Building North-South Breezeway), U (4160 V Switchgear 4B) and V (4160 V Switchgear 4A).

The following documents provide the safe shutdown components' failure modes, safe shutdown analyses logic diagrams and analyses methodology, and the recovery actions where needed. These documents provide the deterministic safe shutdown analysis and will be revised to reflect the results of the FPRA and the modifications identified in the License Amendment Request [LAR] Transition Report Attachment S [Table S-3 Implementation Item 18]:

5610-M-722A Revision 0, NSCA Fire Shutdown Analysis Basis Document

5610-M-723A Revision 0, NSCA Fire Shutdown Analysis Essential Equipment List

PTN-BFJR-10-010 Revision 3, Turkey Point Nuclear Plant Fire Risk Evaluation

The above documents provide detailed analyses for the RCP seal injection and the thermal barrier cooling components. The following provides a summary of the failure modes of MOV-3/4-626 and MOV-3/4-716A, followed by a brief analyses summary of the RCP sealing cooling methodology credited for each of the four specified fire areas:

MOV-3/4-626 - Normal, Failed and Required Positions

- Normal Position: Open
- Failed Power: As-is
- Failed Air: N/A
- Required HSD: Operable
- Required CSD: Operable

MOV-3/4-716A - Normal, Failed and Required Positions

- Normal Position: Open
- Failed Power: As-is
- Failed Air: N/A
- Required HSD: Open
- Required CSD: Open

Note: MOV-3/4-716A is normally open with its breaker administratively maintained open.

Strategy for Fire Areas CC (Units 3 and 4 Auxiliary Building North-South Breezeway) and HH (Units 3 and 4 Cable Spreading Room) for Units 3 and 4

- Failure scenarios:
  - Fire in area CC or HH resulting in abandonment of the control room
  - Loss of offsite power assumed per GL 86-10, Response to Question 5.3.10 and Appendix D of NEI 00-01
  - Fire prevents A and B train Emergency Diesel Generators from starting / powering their respective switchgear
  - Resultant loss of AC power results in a loss of RCP seal cooling
  - CCW flow path is isolated from the Alternate Shutdown Panel to prevent thermal shock to the RCP seals
- Required position(s):
  - MOV-3/4-626 – closed
  - MOV-3/4-716A – open with breaker maintained open
- Safe shutdown analysis logic alternatives – none because of extent of damage which may occur because of postulated deterministic fire in these areas
- Recovery action sequences:

- RCP thermal barrier cooling is isolated by closing MOV-3/4-626 from the Alternate Shutdown Panel prior to the operation of the credited 3/4B Component Cooling Water Pumps.
- This is a defense-in-depth recovery action and was not considered risk significant.

Strategy for Fire Area U (4160 V Switchgear 4B) for Unit 3

- RCP seal injection and thermal barrier cooling remain available because a postulated fire in the 4B Switchgear Room has little effect on Unit 3 operations.

Strategy for Fire Area U (4160 V Switchgear 4B) for Unit 4

- Failure scenarios:
  - No failure scenarios identified following committed plant modifications
  - 4A Charging Pump is verified running or started from the Control Room
  - 4A Charging Pump Speed Controller (SC-4-151A) available to ensure adequate RCP seal injection flow exists regardless of position of Charging Flow Control Valve (HCV-4-121), Charging Isolation Valves (CV-4-310A and CV-4-310B), and Pressurizer Aux. Spray Valve (CV-4-311)
  - Source of water to suction of charging pumps verified free of fire damage via boric acid blender path with the 4A Boric Acid Transfer Pump
  - Thermal barrier cooling is assumed isolated
    - Circuits for MOV-4-626 and MOV-4-716B are in the fire area
    - Restoration of thermal barrier cooling not required as RCP seal injection not lost
  - 4kV 4A Bus remains available following implementation of modifications to 4kV breaker 4AA11 [4A Turbine Plant Cooling Water Pump] circuits and RCP Under-frequency trip circuits to power the:
    - 4A Charging Pump
    - 4A Boric Acid Transfer Pump
- Required position(s):
  - MOV-4-626 – no required position because RCP seal injection not lost
  - MOV-4-716A – open with breaker maintained open
- Safe shutdown analysis logic alternatives:
  - Recovery action to align Refueling Water Storage Tank to suction of charging pumps prior to proceeding to cold shutdown

- No other alternatives considered or required because RCP seal injection not lost

- Recovery action sequences:
  - No recovery actions required for hot shutdown plant conditions to maintain RCP seal cooling
  - Recovery action to align Refueling Water Storage Tank to suction of charging pumps prior to proceeding to cold shutdown

<u>Strategy for Fire Area V (4160 V Switchgear 4A) for Unit 3</u>

- RCP seal injection and thermal barrier cooling remain available because a postulated fire in the 4A Switchgear Room has little effect on Unit 3 operations.

<u>Strategy for Fire Area V (4160 V Switchgear 4A) for Unit 4</u>

- Failure scenarios:
  - No failure scenarios identified following committed plant modifications
  - 4B Charging Pump is verified running or started from the Control Room
  - 4B Charging Pump Speed Controller (SC-4-152A) , Charging Flow Control Valve (HCV-4-121), Charging Isolation Valves (CV-4-310A and CV-4-310B), and Pressurizer Aux. Spray Valve (CV-4-311) control remain available from the control room to ensure adequate RCP seal injection flow
  - Source of water to suction of charging pumps verified free of fire damage via Refueling Water Storage Tank
  - Thermal barrier cooling valves lose power only – no spurious operation of MOV
  - 4kV 4B Bus remains available following implementation of modifications to 4kV breakers 4AB05 [4kV Bus 4AB Startup Transformer Feeder Breaker] and 4AB11 [4B Turbine Plant Cooling Water Pump] circuits and RCP Under-frequency trip circuits to power the:
  - 4B CCW pump
  - 4B Charging Pump
  - 4B Intake Cooling Water Pump
- Required position(s):
  - MOV-4-626 – open
    - No longer considered operable because of potential loss of power
    - Open is acceptable because RCP seal cooling not lost

- MOV-4-716A – open with breaker maintained open

- Safe shutdown analysis logic alternatives - no other alternatives considered or required because RCP seal cooling not lost
- Recovery action sequences:
  - No recovery actions required to maintain RCP seal cooling for hot shutdown or cold shutdown

Operations procedures will be revised as needed. This activity is tracked by LAR Transition Report Attachment S, Table S-3 Implementation Item 13.

PTN RAI SSA 13
LAR Attachment G provides in numerous fire areas (A, AAA, B, and C) recovery actions for risk reduction which requires operators to hook up alternate nitrogen bottles for AFW flow control valves. Provide a description of this procedure, including the storage location of the nitrogen bottles being used. Describe whether the hookups are required to modulate the control valves or do they remain in a desired position. Describe whether the operator is required to maintain a presence to throttle the valves or are they only required to reset the capability for remote operation.

LAR Attachment G provides in fire area CC recovery actions fire risk reduction to manually operate AFW flow control valves (apparently without nitrogen). Provide a description of these actions. Describe whether there is training for an operator to perform this function.

LAR Attachment G provides in fire area CC the same actions for alternative controls of AFW flow control valves and AFW pump operation in Units 3 and 4, however Unit 4 recovery action is defense-in-depth but Unit 3 recovery action is for risk reduction. Provide a detailed explanation as to the difference from the operator's perspective for the same fire area, including how the operator is instructed to proceed for a fire in this area.

For defense-in-depth recovery actions identified in the analysis, describe whether they will remain in the procedures for safe shutdown and alternate shutdown and thereby be included in feasibility evaluations.

RESPONSE:
Instrument air (IA) and nitrogen are aligned to the AFW flow control valves (FCVs) via check valves such that whichever is at a higher pressure provides the motive force to the FCVs. Without IA, nitrogen is required to modulate the FCVs. As long as there is a motive force, the FCVs can be remotely operated from the control room, meaning no constant operator presence is needed at the valves.

The nitrogen backup stations are located on the 18' elevation of each unit's respective Condensate Storage Tank (CST) enclosure, in the same area but below the actual AFW flow control valves. There are 2 stations for each unit (1 per train) and each station contains 5 nitrogen bottles (3 in-service and 2 in standby). At all times, 3 bottles at each station are valved in so that upon a loss of IA, nitrogen is automatically supplied to the AFW FCVs via check valves. The bottles are designed to last 2 hours and have an alarm that indicates when the pressure has dropped to 650 PSIG, which means approximately 45 minutes of motive force is left. Within these two hours, operators must swap bottles as instructed by the control room annunciator response procedure (ARP). The ARP refers to *-NOP-075.02, which directs operators to valve in the 2 standby bottles and valve out the 3 in-service bottles. These 2 fresh bottles are designed to last 90 minutes and the 650 PSIG alarm on the header would now indicate only 30 minutes of motive force left. After swapping bottles, the procedure has operators replace the empty bottles. Alternatively, 0-ONOP-013, Loss of Instrument Air, also calls for the replacement of nitrogen bottles if the pressure drops below 650 PSIG. This is done by disconnecting them from the nitrogen header, rolling them to the spare rack on the nearby wall, and bringing in spare bottles to reconnect to the header. Four spare nitrogen bottles are kept in each CST enclosure. Dozens of nitrogen bottles are also kept in the gas house in the RCA but require the Maintenance department for transport. Lastly there is a large nitrogen dewar from which the empty bottles can be refilled at the gas house.

If operators are unable to supply enough nitrogen to the FCVs, the ARP instructs operators to locally control the AFW FCVs using *-ONOP-075, Auxiliary Feedwater System Malfunction. This action consists of isolating the air/nitrogen lines to each FCV, bleeding off any air/nitrogen between the isolation valve and the FCV, unlocking the handwheel, locally opening the FCV, and using the local AFW flow and steam generator level indication to maintain steam generator levels. This operator action is specifically trained for as part of the Initial Nuclear Systems Operator OJT/TPE Qualification Guide (PTN 4401004).

The recovery actions for alternative controls of AFW FCVs related to fire area CC are NOT the same for both units. According the NFPA 805 LAR, the Unit 3 action is "Manually close AFW flow control valves' air isolation valves (3-40-263, 3-40-267, 3-40-270) in fire zone 116. Manually operate AFW flow control valves (CV-3-2831, CV-3-2832, CV-3-2833) in fire zone 116 to control train 2 AFW flow." The Unit 4 action is "Valve in additional nitrogen bottle using valves 4-40-1673 and 4-40-1674 in fire zone 113. Replace nitrogen bottles as necessary."
For Unit 3, the local, manual operation of the AFW FCVs is required because the fire is assumed to damage the controllers for the FCVs, precluding remote control, irrespective of IA or nitrogen availability. For Unit 4, only IA is lost, allowing remote control by having nitrogen bottles continue to supply the motive force to the FCVs. This defense-in-depth action is contained completely within the ARPs and ONOPs and is included in feasibility evaluations.

PTN RAI FPE 01.a - Incipient Detection System

LAR Attachment C (Table B-3) indicates fire areas HH (Cable Spreading Rooms), MM (MCRs), U (4160V Switchgear 4B Room), V (4160V Switchgear 4A Room), W (4160V Switchgear 3B Room), and X (4160V Switchgear 3A Room), will have modifications to install incipient detection systems (VEWFDS) to meet risk criteria or for DID. Fire Areas HH and MM will have in-panel mounted detection installed to meet risk criteria and Fire Areas U, V, W, and X will have area wide incipient detection systems installed for DID.

The incipient detection system in LAR Attachment S, Table S-1, is identified as a committed modification however; more information is required to better understand the extent of risk improvement being credited.

a) Because of the various vendor types of incipient detection systems, provide a description of the incipient detection system being installed/considered. If the system has not yet been designed or installed, provide the specified features for the proposed system along with a comparison of these specified design features to their role in satisfying or supporting the risk reduction features being credited in FAQ 08-0046 ([Accession No. ML093220426]. Include in this description the installation testing criteria to be met prior to operation.

RESPONSE:

The design for the incipient fire detection system will begin after FAQ 13-0001 is accepted by the NRC for the incipient detection in the control room (fire area MM). The design for the Cable Spreading Room will be done at the same time. The purchase specifications will specify in detail the design and functional features for the system to meet the requirements in FAQ 08-0046 (for the Cable Spreading Room) and FAQ 13-0001 (for the Main Control Room). The systems will be addressable. The level at which this occurs (specific cabinet or group of cabinets) is dependent on the vendor. Procedures will be developed to localize the alarm to the cabinet/component level.

LAR Attachment S, Table S-2 Items 3, 4 and 25 identify the panels where the incipient detection system will be installed. This system is being credited to reduce risk contribution from the respective panels and provide risk benefits for CDF and LERF.

The responses to RAI FPE 01.b, c, d and e provide additional information on the panel configuration, system design features, installation and testing. Guidelines as provided in NFPA 72, NFPA 76, FAQ 08-0046 and FAQ 13-0001 (when approved) will be utilized in developing the post-implementation testing criteria and in the preparation of response procedures when Alert and Alarm signals are received.

PTN RAI FPE 01.b - Incipient Detection System

LAR Attachment C (Table B-3) indicates fire areas HH (Cable Spread Rooms), MM (MCRs, Unit 3 and 4 Main Control Room), U (4160V Switchgear 4B Room), V (4160V Switchgear 4A Room), W (4160V Switchgear 3B Room), and X (4160V Switchgear 3A Room), will have modifications to install incipient detection systems (VEWFDS, Very Early Warning Fire Detection Systems) to meet risk criteria or for DID (Defense-in-Depth). Fire Areas HH and MM will have in-panel mounted detection installed to meet risk criteria and Fire Areas U, V, W, and X will have area wide incipient detection systems installed for DID.

The incipient detection system in LAR Attachment S, Table S-1, is identified as a committed modification however; more information is required to better understand the extent of risk improvement being credited.

b) Describe the physical separation of the cabinets in which incipient detection is being installed.

RESPONSE:

The panels in which the incipient detection system will be installed are identified in the LAR Attachment S, Table S-2 Items 3, 4 and 25. Plant drawing 5610-E-128 Sheet 1, Revision 62, identifies the layout of these panels. All panels except the Vertical Boards and the Communication panel listed below are cabinets with metal walls on all four sides. The metal top has sealed cable entry penetrations. The bottom is open for cable entry. The Control Consoles 3C01-3C02 and 4C01-4C02 have no separating metal wall between each pair. Vertical Boards 3/4C03, 3/4C04, 3/4C05 and 3/4C06 do not have back panels. Communication between two adjacent boards is restricted due to device mounting plates or devices installed on the sides. Communication Panel C600 is open on two sides.

PTN RAI FPE 01.c - Incipient Detection System

LAR Attachment C (Table B-3) indicates fire areas HH (Cable Spreading Rooms), MM (MCRs), U (4160V Switchgear 4B Room), V (4160V Switchgear 4A Room), W (4160V Switchgear 3B Room), and X (4160V Switchgear 3A Room), will have modifications to install incipient detection systems (VEWFDS) to meet risk criteria or for DID. Fire Areas HH and MM will have in-panel mounted detection installed to meet risk criteria and Fire Areas U, V, W, and X will have area wide incipient detection systems installed for DID.

The incipient detection system in LAR Attachment S, Table S-1, is identified as a committed modification however; more information is required to better understand the extent of risk improvement being credited.

c) Describe how each cabinet will be addressable by the detection system. Describe whether the sampling will be independent for each cabinet or will sample be taken by common header.

RESPONSE:

The design for the incipient fire detection system will begin after the receipt of NRC final approval of FAQ 13-0001 and guidance on the credit of the incipient detection that can be taken in the PRA analyses. The proposed incipient detection system will be per FAQs 08-0046 and 13-0001 and will have the following design features:

- The system will be aspirating air sampling detector system consisting of Aspirating Fire Detector [AFD] unit and air sampling ports.
- The AFD unit will be addressable from a central fire detection system monitoring panel.
- The AFD unit will have multiple numbers of sample pipes [zones]. Each pipe [zone] will have multiple sampling ports. The quantity of the sample pipes and sample ports that can be processed by an AFD unit varies with different vendors.
- Each panel identified in LAR Attachment S, Table S-2 Items 3, 4 and 25 will be installed with a sampling port. Multiple sampling ports will be installed inside the open back vertical boards identified in the response to PTN RAI FPE 01.b. The number and location of the AFD units will be per the vendor's recommendations, plant configuration and per the guidelines of NFPA 76.
- PTN drawing 5610-E-128 Sheet 1, Revision 62, provides layout and location of each of the panels identified in LAR Attachment S, Table S-3 Items 3, 4 and 25. Panels in close proximity will be served by a common sample pipe. The total number of sample ports served by an AFD unit will be per the vendor's recommendations and will comply with NFPA 76.

PTN RAI FPE 01.d - Incipient Detection System

LAR Attachment C (Table B-3) indicates fire areas HH (Cable Spreading Rooms), MM (MCRs), U (4160V Switchgear 4B Room), V (4160V Switchgear 4A Room), W (4160V Switchgear 3B Room), and X (4160V Switchgear 3A Room), will have modifications to install incipient detection systems (VEWFDS) to meet risk criteria or for DID. Fire Areas HH and MM will have in-panel mounted detection installed to meet risk criteria and Fire Areas U, V, W, and X will have area wide incipient detection systems installed for DID.

The incipient detection system in LAR Attachment S, Table S-1, is identified as a committed modification however; more information is required to better understand the extent of risk improvement being credited.

d) Provide the codes of record for the design, installation, and testing.

RESPONSE:

The incipient fire detection system will comply with NFPA 72 and NFPA 76 current at the time of the start of the design. Additionally, the guidelines provided in the FAQ 08-0046 and the final approved version of FAQ 13-0001 will be utilized. The design, installation and testing of the system will be per the applicable FPL Engineering procedures and processes.

PTN RAI FPE 01.e - Incipient Detection System

LAR Attachment C (Table B-3) indicates fire areas HH (Cable Spreading Rooms), MM (MCRs), U (4160V Switchgear 4B Room), V (4160V Switchgear 4A Room), W (4160V Switchgear 3B Room), and X (4160V Switchgear 3A Room), will have modifications to install incipient detection systems (VEWFDS) to meet risk criteria or for DID. Fire Areas HH and MM will have in-panel mounted detection installed to meet risk criteria and Fire Areas U, V, W, and X will have area wide incipient detection systems installed for DID.

The incipient detection system in LAR Attachment S, Table S-1, is identified as a committed modification however; more information is required to better understand the extent of risk improvement being credited.

e) Based on the operator recognizing the impacted cabinet(s) fire location sufficiently early, describe what operator actions are necessary to limit fire impact and allow safe shutdown of the plant from the control room. Describe how the operator will be made aware of what must be done to remain in the control room for plant shutdown.

RESPONSE:

Alarm Response Procedures [ARPs] will be developed to guide the Operator response to the Alert and Alarm signals originating from the incipient detection system. At the Alert level signal, the Operations and Fire Brigade procedures will provide guidance on the following:

- Identify the panel or group of panels for the source of the signal
- Identify specific panels and specific sources within the panel. This activity will be performed by trained plant personnel using additional monitoring equipment recommended by the vendor of the selected system. Such monitoring and assessment equipment may include a combination of portable Aspirating Fire Detection [AFD] or infrared heat detectors.
- Initiate additional surveillance or fire watch as appropriate.
- Initiate Fire Brigade response if appropriate.
- Panel-specific troubleshooting procedures will provide guidance to assess the condition and to identify mitigation strategies. Technical support will assist in analyzing and assessing the condition. Guidance provided in NFPA 76 and FAQs 08-0046 and 13-0001 (when approved) will be utilized in developing procedures for panel specific mitigation actions.

At the Alarm level signal, the Operation procedures will provide guidance on the following:

- Re-assess the condition, identify that the alarm is for the previously identified panel or from a different panel.
- Initiate Fire Brigade response and station a fire watch as appropriate for the new condition.

- Panel-specific guidance documents will identify specific safe shutdown equipment that could be affected. Operation procedures will provide guidance in isolating circuits of the credited safe shutdown equipment from the Control Room / Cable Spreading Room, securing the credited equipment and to establish alternate controls, as applicable.
- Continue to assess the situation and determine if it meets the criteria for abandonment / evacuation of the Control Room.
- Evacuate Control Room if necessary and follow existing procedures.

PTN RAI FPE 01.f - Incipient Detection System Revision 0

LAR Attachment C (Table B-3) indicates fire areas HH (Cable Spreading Rooms), MM (MCRs), U (4160V Switchgear 4B Room), V (4160V Switchgear 4A Room), W (4160V Switchgear 3B Room), and X (4160V Switchgear 3A Room), will have modifications to install incipient detection systems (VEWFDS) to meet risk criteria or for DID. Fire Areas HH and MM will have in-panel mounted detection installed to meet risk criteria and Fire Areas U, V, W, and X will have area wide incipient detection systems installed for DID.

The incipient detection system in LAR Attachment S, Table S-1, is identified as a committed modification however; more information is required to better understand the extent of risk improvement being credited.

f) Additionally, area wide incipient detection is also being provided for DID in certain fire area (i.e.; fire areas U, V, W, and X). Provide a system description of the area wide incipient fire detection system(s) including design criteria, record NFPA code(s) for design and installation, testing, and maintenance.

RESPONSE:

LAR Attachment S, Table S-2 Item 32 identifies the fire areas where the area wide incipient detection system will be installed. This system is installed for defense-in-depth (DID) only and will be in addition to the existing early warning smoke detection system in the fire areas. The incipient detection system will comply with the latest version of NFPA 72 and NFPA 76 at the time of design initiation. This will be an aspirating fire detection (AFD) system. The AFD system will be addressable and will alarm at the central fire detection system monitoring panel. Separate AFD units will be installed, one each for Fire Area U and W. Also, new AFD units will be installed, one each for Fire Area V and X. The design, installation and testing of the system will be in accordance with the guidelines of NFPA 76 and per applicable FPL Engineering procedures and processes. Appropriate maintenance/surveillance procedures will be developed in accordance with the guidelines of NFPA 76 and the nuclear industry practices.

PTN RAI FPE 06 Containment Attachment T Clarification

For the exemption request identified in Attachment K as "LA-07 -19840327" and identified in Attachment T Clarification request #1, describe whether all of the modifications that were identified (related to separation issues in the containments) in the referenced safety evaluation are complete. If not, identify those that were not installed.

Additionally, characterize the intervening combustibles in question and provide an engineering justification for the acceptability of this configuration.

For Attachment T Clarification request #2 describe the current fire extinguisher configuration for the containment and provide an engineering justification for the acceptability of this configuration.

RESPONSE:

<u>Attachment T Clarification Request #1</u>

<u>The NRC Safety Evaluation dated March 27, 1984, Section 8.2 states:</u>

"The licensee proposes the following Unit 4 modifications:

1. Reroute the control cables for valve AOV-4-460 through the West Penetration Area and maintain the separation in excess of 20 feet from the cables for valves AOV-4-200 A, B and C as far as physically possible.
2. Reroute the control cables for valve AOV-4-387 through the West Penetation [sic] Area and maintain the separation in excess of 20 feet from the cables for valve HCV-4-137 as far as physically possible.
3. Reroute the control cables for AOV-4-310A through the West Penetration Area and maintain the separation in excess of 20 feet from the cables for valve AOV-4-310B as far as physically possible.
4. Provide a minimum of 20 feet of separation for cables between two trains of reactor coolant system hot and cold leg temperature instrumentation, wherever physically possible. Route the two trains, when provided, through separate penetration areas.
5. Provide 1-hour rated protection to the conduit for LT-4-460 to the maximum extent possible in the pressurizer missile shield wall area where separation from conduits for LT-4-459 is less than 20 feet.
6. Provide dedicated portable emergency lighting outside the containment unit for containment [sic, recte Containment] entry to facilitate manual operation of the valves.
7. The licensee will install radiant energy shields to separate the charging line isolation valve and associated cabling.

The licensee proposes the following Unit 3 modifications:

1. Reroute the control cables for AOV-3-460 through the West Penetration Area and maintain the separation in excess of 20 feet from the cables for valves AOV-3-200A, B, and C.

2. Reroute the control cables for AOV-3-310A through the West Penetration Area and maintain the separation in excess of 20 feet from the cables for valve AOV-3-310B.
3. Provide a minimum of 20 feet of separation for cables between two trains of reactor coolant system hot and cold leg temperature instrumentation where physically possible. Route the two trains, when provided, through separate penetration areas.
4. Provide 1-hour rated protection on the conduit for LT-3-460 to the maximum extent possible in the pressurizer missile shield wall area where separation from conduits for LT-3-459 is less than 20 feet.
5. Provide dedicated portable emergency lighting units outside the containment for containment entry to facilitate manual operation of valves.
6. The licensee will install radiant energy shields to separate the charging line, isolation valves and associated cabling."

<u>The NRC Safety Evaluation dated March 27, 1984, Section 8.3 states in part:</u>

"The licensee has proposed to either reroute redundant cables and equipment to provide 20 feet of separation, free of intervening combustibles, or provide 1-hour fire rated barriers and radiant energy shields on all redundant cables in both units except for the redundant equipment associated with operation of the pressurizer, including the pressurizer heaters, PORVs, block valves and level transmitters located on or within the pressurizer missile shield walls. These areas are void of in situ combustibles and are inaccessible during plant operation."

<u>The following modifications to raceways and cables identified in the SER above were performed to protect them with radiant energy shields inside the Unit 4 Containment:</u>

1. Per PTN-FPER-08-007, 5610-E-2000A, 5610-E-107A, and 5610-E-107 sheet 1; 4V460/LCV-4-460/T4C22/00E in conduit 4C1337 and 4V460/SV-4-460/T4C22/00F in conduit 4C1336 are protected with radiant energy shields to ensure AOV-4-460 remains available until separation in excess of 20 feet from the cables for valves AOV-4-200 A, B and C is attained. The cables for AOV-4-460 are routed through the West Penetration Area.
2. Per PTN-FPER-08-007, 5610-E-2000A, 5610-E-107 sheet 1, 5610-E-107A, and 5610-E-110A; 4V387/TB4128/T4C13/001 in conduit 4C192 is protected with a radiant energy shield to ensure AOV-4-387 remains available until separation in excess of 20 feet from the cables for valve HCV-4-137 is attained. The cables for AOV-4-387 are routed through the West Penetration Area.
3. Per PTN-FPER-08-007, 5610-E-2000A, and 5610-E-107 sheet 1; cables associated with AOV-4-310B were rerouted through the West Penetration Area and maintain the separation in excess of 20 feet from the cables for valve AOV-4-310A to a large extent. Although AOV-4-310B is routed through the West Penetration Room as opposed to the proposed modification to route AOV-4-310A through the West Penetration Room, the configuration provides an equivalent separation. Additionally, as discussed in the

analysis of proposed modification 7 below, the separation of the cables for these valves does not affect the ability to safely shutdown the plant for a fire in this area.

4. Per PTN-FPER-08-007, 5610-E-2000A, 5610-E-107 sheet 1, and 5610-E-110 sheet 1; the cables for two trains of reactor coolant system hot and cold leg temperature instrumentation for at least one loop have a minimum of 20 feet of separation. The two trains are routed through separate penetration areas.

5. Per 5610-E-2000A and 5610-E-108A; 4ILRCS/T4I24/LT460/001 in conduit 4C247 is in a radiant energy shield to the maximum extent possible in the pressurizer missile shield wall area and where separation from conduits for LT-4-459 is less than 20 feet to ensure LT-4-460 remains available. Additionally, 4ILRCS/T4I21/LT459/001 in conduit 4C226 is in a radiant energy shield to provide additional assurance that both level transmitters cannot be affected by a single fire.

6. Per 5610-A-62 sheet 3 and 5610-A-61 sheet 2; four portable lights (FL-2) are provided in the area west of the U4 Containment for Containment entry to facilitate manual operation of valves.

7. Per 5610-C-1465, a radiant energy shield was installed to separate the charging line isolation valves and associated cabling. This radiant energy shield is no longer being credited for safe shutdown. This was deemed acceptable per 5610-M-722A, 5610-M-722B, and PTN-FPER-08-007 because:

    a. Fire-induced failure of the charging isolation valves resulting in their spurious opening without being able to close would not challenge the plant's ability to safely shutdown because the charging pump speed controllers (SC-4-151A, SC-4-151B, SC-4-152A, SC-4-152B, SC-4-153A, SC-4-153B, HSC-4-151, HSC-4-152, and HSC-4-153) and the charging flow control valve (HCV-4-121) are available and unaffected by a fire in this area. With these components, the operator can control the rate of makeup to the plant and ensure that adequate cooling is provided to the RCP seals via RCP seal injection. These same components would also be used to prevent auxiliary spray flow while still providing RCS inventory control by isolating the normal charging and auxiliary spray flow path and providing makeup solely through the RCP seals.

    b. Fire-induced failure of the charging isolation valves resulting in their spurious closing without being able to open would not challenge the plant's ability to safely shutdown because RCS inventory can be met by providing makeup solely through the RCP seals via the RCP seal injection path.

Because spurious operation of these valves and/or failure of these valves to operate do not prevent the plant's ability to demonstrate a success path for the RCS Inventory Control Nuclear Safety Performance Criterion, credit for this modification was not necessary and would not provide a significant increase to the level of protection already provided.

The following modifications to raceways and cables identified in the SER above were performed to protect them with radiant energy shields inside the Unit 3 Containment:

1. Per PTN-FPER-08-007, 5610-E-2000A, 5610-E-100A, and 5610-E-100 sht. 1; 3V460/TB3885/T3C21/00B, 3V460/LCV460/TB3885/00C, and 3V460/SV460/TB3885/00D in conduits 3C1333 and 3C225 and in terminal box TB3885 are protected with radiant energy shields to ensure AOV-3-460 remains available until separation in excess of 20 feet from the cables for valves AOV-3-200 A, B and C is attained. The cables for AOV-3-460 are routed through the West Penetration Area.
2. Per PTN-FPER-08-007, 5610-E-2000A, and 5610-E-100 sheet 1; cables associated with AOV-3-310B were rerouted through the West Penetration Area and maintain the separation in excess of 20 feet from the cables for valve AOV-3-310A to a large extent. Although AOV-3-310B is routed through the West Penetration Room as opposed to the proposed modification to route AOV-3-310A through the West Penetration Room, the configuration provides an equivalent separation. Additionally, as discussed in the analysis of proposed modification 6 below, the separation of the cables for these valves does not affect the ability to safely shutdown the plant for a fire in this area.
3. Per PTN-FPER-08-007, 5610-E-2000A, 5610-E-100 sheet 1, and 5610-E-103 sheet 1; the cables for two trains of reactor coolant system hot and cold leg temperature instrumentation for at least one loop have a minimum of 20 feet of separation. The two trains are routed through separate penetration areas.
4. Per 5610-E-2000A and 5610-E-101A; 3ILRCS/TB3301/LT459/001 in conduits 3C094 and 3C094A are in radiant energy shields to the maximum extent possible in the pressurizer missile shield wall area and where separation from conduits for LT-3-460 is less than 20 feet to ensure LT-3-459 remains available.
5. Per 5610-A-62 sheet 3, 5610-A-61 sheet 2; Four portable lights (FL-2) are provided in the area west of the U4 Containment for Containment entry to facilitate manual operation of valves.
6. Per 5610-C-1465, a radiant energy shield was installed to separate the charging line isolation valves. This radiant energy shield is no longer being credited for safe shutdown. This was deemed acceptable per 5610-M-722A, 5610-M-722B, and PTN-FPER-08-007 because:
    a. Fire-induced failure of the charging isolation valves resulting in their spurious opening without being able to close would not challenge the plant's ability to safely shutdown because the charging pump speed controllers (SC-3-151A, SC-3-151B, SC-3-152A, SC-3-152B, SC-3-153A, SC-3-153B, HSC-3-151, HSC-3-152, and HSC-3-153) and the charging flow control valve (HCV-3-121) are available and unaffected by a fire in this area. With these components, the operator can control the rate of makeup to the plant and ensure that adequate cooling is provided to the RCP seals via RCP seal injection. These same components would also be used to prevent auxiliary spray flow while still providing RCS inventory

control by isolating the normal charging and auxiliary spray flow path and providing makeup solely through the RCP seals.

b. Fire-induced failure of the charging isolation valves resulting in their spurious closing without being able to open would not challenge the plant's ability to safely shutdown because RCS inventory can be met by providing makeup solely through the RCP seals via the RCP seal injection path.

Because spurious operation of these valves and/or failure of these valves to operate do not prevent the plant's ability to demonstrate a success path for the RCS Inventory Control Nuclear Safety Performance Criterion, additional modification to the plant was not necessary and would not provide a significant increase to the level of protection already provided.

The following provides a characterization of the intervening combustibles inside the Units 3 and 4 Containments:

Per PTN-FPER-08-007:

- Safe shutdown cable trays are generally located outside the secondary shield wall and run from about 5 ft. to 65 ft. above the floor
- All cables are covered with a fire retardant mastic material. Redundant cable trays are separated from each other by minimum horizontal and vertical distances of 1 ½ ft. and 4 ft. respectively
- All cables inside the missile shield walls are routed in conduit
- Combustible material in the area consists of lubricating oil contained in various components and fire retardant coated cables
- Lube oil associated with the Reactor Coolant Pumps (the largest potential combustible source in Containment) has an oil collection system associated with it which minimizes the potential of this combustible source from initiating a fire in Containment
- Lube oil associated with the Containment Polar Crane and Manipulator Crane Trolleys (the second largest potential combustible source in Containment) is unlikely to cause a fire in Containment because they are stored during plant operation
- The remaining combustible liquids in Containment are generally small in quantity, localized, well separated, not pressurized, and confined within the steel structure of the specific component to which they belong
- Access into Containment is controlled and limited, the possibility of introducing transient combustibles is substantially reduced

Conclusion:

With the exception of the erroneous statements provided in Section E of Exemption Requests P-1 and Q-1 of L-83-347 and Section 8.3 of the March 27, 1984 SER (i.e., the statements "free of intervening combustibles", "void of in situ combustibles", and "no in situ combustibles" which are the bases of the requested clarification provided in Attachment T, Clarification #1 of the PTN NFPA 805 LAR, this response to RAI FPE 06 for the PTN NFPA 805 LAR indicates an identical level of protection and intervening combustibles as described in the original letters from FPL to the NRC (L-83-347 and L-83-503) requesting the exemptions which was validated in PTN-FPER-08-007. The exact size and nature of the combustibles and the extent of the modifications described above demonstrate a level of protection which is adequate for the hazards identified. The use of absolute terms (e.g., free, void, and no) should be replaced to indicate levels of combustibles which have been evaluated to be adequate for the hazard in the area to provide a reasonable level of protection to required safe shutdown equipment.

Attachment T Clarification Request #2

The NRC Safety Evaluation dated March 27, 1984, Section 8.2 states:

"No hose stations are located inside containment, however, four portable fire extinguishers are available inside containment for use by the fire brigade."

The NRC Safety Evaluation dated August 12, 1987, Section 4.2 states:

"Portable fire extinguishers are located inside containment [sic, recte Containment] and in the immediate vicinity of each personnel access hatch."

The Attachment T Clarification Request for this Licensing Action provides the following details:

There is no mention of portable fire extinguishers in either of the FPL letters (L-83-347 or L-83-503) from which the 1984 Safety Evaluation originated. This configuration did exist at one point at PTN, but was changed to improve the fire protection capability of the plant. The change involved moving the portable fire extinguishers from inside containment in the immediate vicinity of the personnel access hatch to outside containment mounted on the access stair handrails.

The new configuration provides improved fire protection because:

- The extinguishers will be accessible for all fires inside containment, whereas a fire inside containment in the vicinity of the personnel access hatch could have prevented access to the extinguishers in their previous location

- Routine maintenance and checking of the extinguisher can be performed to ensure no issues exist with their operation, whereas the ability to access the extinguishers when they were inside containment was limited

Additionally, water extinguishers are staged inside containment during outages. These extinguishers are removed during operation due to concerns from elevated temperatures.

Conclusion:

The existing plant configuration provides improved fire protection over that required in the 1984 and 1987 Safety Evaluations. Transition of the existing Safety Evaluations with the clarification of the requirements to require (1) water extinguishers to be staged inside Containment during outages (to be removed prior to plant operation to avoid concerns with elevated temperatures) and (2) dry chemical extinguishers mounted outside Containment on the access stair handrails for fire brigade accessibility instead of existing requirements for four portable extinguishers inside Containment should be granted.

PTN RAI FMOD 01.f - Control Room Panel Vent Location with Respect to a Wall or Corner

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Specifically regarding the acceptability of CFAST for the control room abandonment time study:

f) In the case where the cabinet venting was within the minimum distance prescribed in the Generic Fire Modeling Treatments (2-ft), describe the location factor that was used in the Main Control Room analysis. Describe how the Generic Fire Modeling Treatments approach was applied and implemented in CFAST.

RESPONSE:

A walkdown was performed for all control room panels to confirm the location of the venting with respect to proximity to walls/corners. Only one panel for each unit was found with vents within 2 feet of a wall. The impact on overall results will be provided in the resolution of the 120 day RAIs related to control room fire analysis.

Turkey Point RAI FMOD 01.m – Main Control Room Abandonment Frequency

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]…." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

m) Section 3.2.1 of the Fire Scenario Report (Report 0493060006.004, Rev 4) discusses the results of the MCR Abandonment Study, documented in Hughes Report No. 0020-0010-000. The evaluation described in the Fire Scenario Report is said to be of a "preliminary" analysis and that the "final" analysis resulted in less conservative results, which ensures that it is reasonable to use the preliminary analysis for the risk evaluation. Provide further clarification about what is meant by "preliminary" and "final." Describe whether there are multiple revisions of the MCR Abandonment Study and if so, describe the differences between revisions.

RESPONSE:

The PRA analysis used a preliminary calculation to determine the amount of time before operator abandonment from the control room. While the original value was based on a calculation that was not final, it was believed to be conservative. This was validated after the calculation was finished and times to abandonment for each heat release rate bin were demonstrated to be greater than the value used in the PRA analysis. While the value used to perform the MCR analysis is conservative, the model and Fire Scenario Report will be updated in the future.

PTN RAI FMOD 01.n - Transient Fires Above Floor Elevation

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

n) The location of transient combustibles is discussed in Section 8.2 of the Fire Scenario Report. It is stated that transient fires are postulated at floor level, unless there is some fixed ledge or scaffolding to support a higher elevation transient fire source. Justify why other transient combustibles that could elevate the fire source base were not considered. Explain how an elevated transient fire source would affect the calculated ZOI.

RESPONSE:

The Zone of Influence associated with a transient fuel package is derived from a combination of thermal radiation and thermal plume computations augmented for the presence of a hot gas layer. The thermal radiation component relies on the flame height and the vertical component relies on the assumed entrainment base. The flame height is by definition measured from the base of the burning, which is where the fire entrainment base is located. For three-dimensional combustible objects, the burning base is taken to be its lowest combustible point which is usually the floor. If a higher point on the object were selected as the base, the implied assumption would be that burning is not occurring below the assumed base; in this case, the heat release rate would be lower.

The potential exists for transients to be located on a temporary elevated structure. The coincident location of a combustible and an ignition source on an elevated temporary structure is not addressed as it is a very unlikely configuration. The only likely ignition source associated with a temporary structure would be related to a faulted temporary electrical cable. The possibility of a temporary cable left unattended while energized while in the proximity of transient combustibles on an elevated structures is highly unlikely. Such a configuration is not consistent with the transient fire frequency data specified in NUREG/CR-6850.

The effect of an elevated transient source on the Zone of Influence of that transient would be to shift the zone of influence vertically by the distance between the assumed floor elevation and the elevated transient elevation. Such a shift would assume that the transient type/size/configuration when elevated is the same as when it is located on the floor. It is expected that the types/quantities of the transient combustible material/ignition source would be limited when assumed to be at an elevated location given limitations imposed by the temporary structure and its ability to support the transient combustible and associated ignition source.

PTN RAI FMOD 01(o) - Flamastic Credit for Fire Scenarios

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]…." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

o) Section 9.2 of the Fire Scenario Report discusses cable tray propagation and the use of Flamastic fire retardant coating in the plant. Explain how the use of this coating affected the fire modeling analysis, as well as the Fire PRA.

RESPONSE:

The flame spread parameters for IEEE-383/thermoset cables as specified in NUREG/CR-6850 section R.4.1.2 (value for XLPE cable) were used for the non-IEEE-383/thermoplastic cables when protected with Flamastic. This reduced the fire spread rate used to determine the distance applied to the initial zone of influence to account for fire spread. Cable damage was still assumed to occur at the lower temperature and heat flux thresholds associated with non-IEEE-383/thermoplastic cables.

The credit for the reduced flame spread resulted in the fire spread scenario distances being reduced from those which would have been applicable had the trays not been protected with Flamastic.

PTN RAI FMOD 01.p - Non-Control Room Panel Vent Location Impact on Zone of Influence

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]…." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used. Regarding the acceptability of the PSA approach, methods, and data in general:

p) Section 9.3 of the Fire Scenario Report discusses fire location factor. There is a definition and an acknowledgment that this factor affects the ZOI, but no specific discussion on the use of a fire location factors in certain fire areas at Turkey Point. In addition, the same section says, "For electrical panel scenarios the venting of the panel is typically at the top or away from a wall, to promote cooling, and therefore the wall or corner effects are not applicable." In the case where the cabinet venting was within the minimum distance prescribed in the Generic Fire Modeling Treatments (2-ft), describe the location factor used in the analysis. Describe whether a location factor of 2 (wall fires) or 4 (corner fires) was used throughout. If used, describe whether the Generic Fire Modeling Treatments approach was applied in those cases. If not, justify why this was not necessary.

RESPONSE:

A walkdown was performed for all panel scenarios in the PTN Fire PRA to confirm the location of the venting with respect to proximity to walls/corners. A small number of panel fire scenarios were identified for which the venting for the panel was within 2 feet of a wall or corner. For these scenarios a follow up walkdown will be performed based on use of an increased heat release rate (2 x baseline heat release rate for walls and 4 x baseline heat release rate for corners) and the corresponding targets will be added to the analysis. The results of this walkdown will be combined with the update of the analysis to remove panel factors. The impact on overall results will be provided in the RAI PRA 01.t.

PTN RAI FMOD 01.q

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]…." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

q) In Section 2.2 of the Hot Gas Layer and Multi-Compartment Analysis Report (Report 0493060006.003, Rev 2), it is stated that "secondary combustibles for a transient source were treated equally with secondary combustibles for a 464 kW panel fire." Clarify the meaning of this sentence and provide additional explanation for the treatment of secondary combustibles, given a transient ignition source.

RESPONSE:

The purpose of the statement is to indicate that the Hot Gas Layer and Multi-Compartment Analysis treated secondary combustibles impacted by a transient ignition source in the same manner as secondary combustible impacted by an electrical panel ignition source (464 kW fire). Each transient ignition source was analyzed in the Hot Gas Layer and Multi-Compartment Analysis assuming an additional heat release rate contribution from two cable trays. The methodology used for the transient time to hot gas layer was based on interpolation between heat release rates for panels with 464 kW and 237 kW. This approach, however, does not take into account the guidance provided in FAQ 08-0052 relative to the time to peak heat release rate for a transient fire. The HGL/MCA is currently being updated to incorporate the elimination of the panel factors to make the baseline analysis a non-panel factor analysis. The use of the shorter time to peak heat release rate for the transient fire will be incorporated into this update and the results will be provided in the associated RAI.

PTN RAI FMOD 01.r - Hot Gas Layer Temperatures

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

r) Section 2.3 of the Hot Gas Layer and Multi-Compartment Analysis Report describes the results of the HGL analysis and discusses the screening ZOI for a temperature of 80 °C and an additional ZOI calculated for 131 °C. Describe the basis for these two temperatures and how they relate to the Generic Treatments approach.

RESPONSE:

Section 6.1.2 of the Generic Fire Modeling Treatments report uses an 80 °C temperature threshold as an ambient temperature threshold for which the generic zones of influence from the Generic Treatments are valid. The generic zones of influence are not valid for instances where the fire can generate an enclosure temperature exceeding 80 °C. Evaluating the validity of the zone of influence using the 80 °C temperature threshold is one of the purposes of the Hot Gas Layer analysis.

The second purpose of the Hot Gas Layer analysis is to evaluate the potential for the hot gas layer temperature to exceed the cable damage temperature threshold. This analysis is used for evaluating total cable damage within an enclosure. The cable damage temperature threshold is correlated to the cable target type, which for IEEE-383 non-qualified/thermoplastic cable targets at PTN is 204 °C. If the enclosure temperature exceeds 80 °C, a zone of influence based on a 3 kW/m^2 damage threshold was used to assess the damage potential to IEEE-383 non-qualified/thermoplastic cable targets. The 3 kW/m^2 zone of influence is applicable to thermoplastic cable targets within an enclosure having a temperature up to 131°C, which corresponds to the temperature that would produce a heat flux of 2.7 kW/m^2. The combined heat flux from the ignition source and elevated enclosure temperature that defines the zone of influence extent remains constant at 5.7 kW/m^2, the damage threshold for a thermoplastic cable target. Additional details on the use of an expanded zone of influence having the 131°C temperature threshold is provided in the response to PTN RAI FMOD 01.h in the context of the modified critical heat flux.

The 3 kW/m² zone of influence and the associated higher ambient temperature were applied in locations where the 80 °C ambient temperature was exceeded at a timeframe that did not support the FPRA analysis. The larger zone of influence associated with the 3 kW/m² damage criteria would lead to an appreciably increased time to a critical hot gas layer temperature (131 °C) which, although associated with a larger zone of influence, results in a lower manual non-suppression probability that more appropriately reflected the fire risk for the scenario. The following table provides the cable target type generic zone of influence and the associated ambient temperature threshold.

Zone of influence	**Ambient Threshold Temperature**
Generic zone of influence for IEEE-383 non-qualified cable target.	An ambient temperature threshold of 80 °C is used to validate the generic zone of influence.
Generic zone of influence for a 3 kW/m² critical heat flux cable target, applicable to IEEE-383 non-qualified/thermoplastic cable targets in an elevated temperature enclosure.	An ambient temperature threshold of 131 °C is used to validate the generic zone of influence.

PTN RAI FMOD 01.s - Ignition Source Area and Height

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

s) Describe how the area and height of an ignition source was determined.

RESPONSE:

The fire height for electrical panel ignition sources was postulated 1 foot below the cabinet top per guidance from FAQ 08-0043 (Cabinet Fire Location). The electrical cabinet area is not used in the determination of the zone of influence. The generic zone of influence dimensions for electrical cabinets from the Generic Fire Modeling Treatments report was measured from the panel boundary.

The fire height for transient ignition sources was postulated at the floor level per the discussion in RAI FMOD 01.n (Transient Fires Above Floor Elevation). The ignition source zone of influence dimensions are measured from the centerline of the postulated transient fire location. For other ignition sources, the height and area of the ignition source zone of influence was measured from the ignition source enclosure boundary dimensions.

PTN RAI FMOD 01.t – Non-Cable Secondary Combustible Impact

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

t) The staff is concerned about the possibility that non-cable intervening combustibles (e.g., pipe insulation) were missed in areas of the plant. Provide information on how intervening combustibles were identified and accounted for in the fire modeling analyses.

RESPONSE:

A spreadsheet of all secondary combustibles has been created as identified per the Fire Hazards Analysis. This list was then used as a starting point for a plant wide walkdown to verify that no non-cable intervening combustibles would adversely impact the fire modeling analysis. All accessible zones at Turkey Point were subject to walkdown. During this walkdown, no secondary combustibles were identified as impacting any scenario. The following zones were inaccessible during the walkdown:

Zone	Zone Description
012	UNIT 3 RHR PUMP A ROOM
013	UNIT 3 RHR PUMP B ROOM
015	UNIT 4 RHR PUMP A ROOM
016	UNIT 4 RHR PUMP B ROOM
019	UNIT 3 WEST ELECTRICAL PENETRATION ROOM
020	UNIT 3 SOUTH ELECTRICAL PENETRATION ROOM
026	UNIT 4 NORTH ELECTRICAL PENETRATION ROOM
027	UNIT 4 WEST ELECTRICAL PENETRATION ROOM
030	UNIT 4 PIPE AND VALVE ROOM
031	UNIT 4 CONTAINMENT SPRAY PUMP ROOM
040	UNIT 3 PIPE AND VALVE ROOM
041	UNITS 3 AND 4 BORIC ACID TANKS AND PUMP ROOM
059	U4 CONTAINMENT
060	U3 CONTAINMENT

For each of the above zones, with the exception of the containment, the risk associated with a total room burnout was calculated during the fire PRA analysis, as such intervening combustibles are not an issue for these zones. The scenarios developed for containment are based on general locations within containment and the associated fire impact is not altered based on secondary combustibles.

The criteria used for this walkdown was an evaluation of exposed combustibles. Combustibles contained with a pump (oil/grease) or enclosed within a cabinet (e.g., class A combustibles in a closed cabinet) were not considered to be impacted by a fire given the enclosed nature of the associated combustibles.

PTN RAI FMOD 01.u - CSR S1 Scenario

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

u) During the site audit, NRC staff reviewed selected walkdown sheets, engineering drawings, input files and other associated documentation in order to perform independent fire modeling while on site. One of the reviewed scenarios was a transient fire in one corner of the Cable Spreading Room (Fire Zone 098, transient zone S1). A location factor equal to that of a wall was applied to this fire scenario. Provide justification for not applying the corner location factor for this fire and identify and justify any other similar cases.

RESPONSE:

All Cable Spreading Room (CSR) fire scenario ZOIs were reviewed and it was determined that the correct ZOIs were applied, with the exception of CSR Scenario 098-S1. All other corner scenarios had corner ZOIs (6'H 7'V). A walkdown of CSR Scenario 098-S1 was completed on March 29, 2013. The corner ZOI was applied to CSR Scenario 098-S1 with 7 additional targets included. The revised target list will be incorporated into the FPRA in conjunction with the removal of panel factors and the results will be provided with the associated 120 day RAIs (RAI PRA 01.t).

PTN RAI FMOD 01 .v - Transient ZOI

National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805), Section 2.4.3.3, states: "The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having authority]...." The NRC staff noted that fire modeling comprised the following:

- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times.

- The Generic Fire Modeling Treatments approach was used to determine the ZOI in all fire areas throughout plant.

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 acceptability of the fire models that were used.

Regarding the acceptability of the PSA approach, methods, and data in general:

v) During the audit, the licensee explained the use of "transient zones" in the cable spreading room (Fire Zone 098). Provide a description of this methodology to account for postulated transient fires in this fire area. In addition, identify any other fire areas that used this methodology.

RESPONSE:

The transient scenario zone of influence (ZOI) for the cable spreading room is based on a 69 kW peak Heat Release Rate (HRR) transient ignition source based on implementation of strict transient controls (see PTN RAI FMOD 01.l for a discussion of the basis for this heat release rate).

Transient fire scenarios were developed by dividing the compartment into a 10 foot by 10 foot grid, except near wall boundaries and corners where a two foot grid is used to address the wall and corner fire effects. A transient fire within 2 feet of a wall or corner has a larger zone of influence (ZOI). Figure 1 shows the Cable Spreading Room grid system used to develop the transient fire scenarios. Table 1 identifies the size of each Cable Spreading Room transient fire scenario grid.

Figure 1. Cable Spreading Room Transient Fire Scenario Grid.

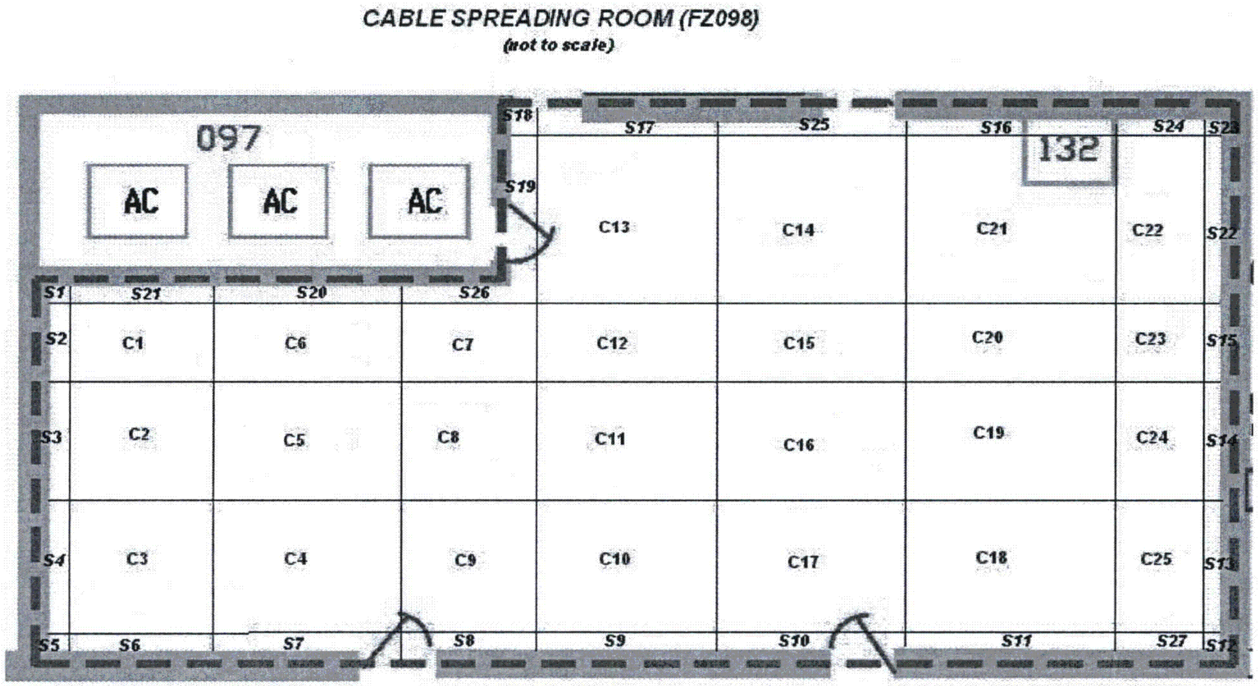

Table 1. Size of each Transient Fire Scenario Grid in the Cable Spreading Room.

Size	**Designations**
2' x 2'	S1, S5, S12, S23, S18
2' x 5'	S24, S27
2'X10'	S2, S3, S4, S6, S7, S8, S9, S10, S11, S13, S14, S15, S16, S17, S19, S20, S21, S22, S25, S26
10'X10'	C1 – C21
5'X10'	C22 – C25

Table 2 Scenario Designators From Figure 1 Without Transient Scenarios

Designator	**Note**
S22, S23, S24	No transient scenario created. The AHUs are located within 2 feet of the wall and in C22. The AHU scenario impacts cables located within the footprint.
S25	Part of S16, S17 and C14 scenarios
S26	Part of C7 scenario.
S27	Part of S11 and S12 scenarios

The grid sections identified above define a scenario which envelopes all scenarios located within the grid with the associated zone of influence applied based on all targets within the grid and all targets within the zone of influence of transients placed anywhere along the perimeter of the grid. The zone of influence used is based on the zone of influence for the 69 kW transient fire HRR for non-qualified/thermoplastic cables.

This methodology was unique to the cable spreading room given the high density of potential targets and the need for a simplified yet conservative approach for evaluating this fire area.

PTN RAI FMOD 04 - Generic Treatments Limitations

NFPA 805, Section 2.7.3.3, "Limitations of Use," states, "Acceptable engineering methods and numerical models shall only be used for applications to the extent these methods have been subject to verifications and validation. These engineering methods shall only be applied within the scope, limitations, and assumptions prescribed for that method." 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 applied appropriately as required by Section 2.7.3.3 of NFPA 805."

Regarding the limitations of use:

Identify uses, if any, of the Generic Fire Modeling Treatments (including the supplements) outside the limits of applicability of the method and for those cases explain how the use of the Generic Fire Modeling Treatments approach was justified.

RESPONSE:

As described in the response to RAI PTN PRA 01.x (F&O against FSS-A5), the Generic Fire Modeling Treatments report was developed to provide conservative ZOI and hot gas layer information for various types of ignition sources when used within the stated limitations. The supplements to the Generic Fire Modeling Treatments report were developed to address a number of limitations that prevented the application of the ZOI and tabulated hot gas layer data under various circumstances. In addition, several method enhancements have been developed to address specific configurations or conditions that have been encountered when applying the Generic Fire Modeling Treatments in the field. These enhancements address the following limitations:

- The application of the generic ZOI data in compartments in which the hot gas layer temperature exceeds 80°C (176°F);
- The application of the generic ZOI data to fire scenarios in wall and corner configurations;
- The application of the generic hot gas layer data to configurations in which secondary combustibles (cable trays) are ignited;
- The application of the generic ZOI data for panel ignition sources with panels having plan dimensions greater than 0.9 x 0.6 m (3 x 2 ft); and
- The application of the generic ZOI data to scenarios that result in flame impingement to the ceiling.

ZOIs in Elevated Temperature Enclosures

The application of the generic ZOI data in compartments in which the hot gas layer exceeds 80°C (176°F) is addressed through the use of expanded ZOIs provided in Supplement 2 to the Generic Fire Modeling Treatments. In essence, the original ZOIs described in the Generic Fire Modeling Treatments report are replaced with ZOIs derived for a lower heat flux/temperature threshold. The maximum heat flux that would be produced by the hot gas layer in the elevated temperature enclosure combined with the heat flux at the boundary of the expanded ZOI is equal to the target damage threshold heat flux or temperature. The expanded ZOIs were developed to address the use of generic ZOI data in relatively small enclosures in which the ignition source is capable of increasing the temperature above 80°C (176°F). The response to RAI FMOD 01.r (Hot Gas Layer Temperature) provides details on the temperature range through which the various expanded ZOIs are applicable.

ZOIs in Wall and Corner Locations

The application of the generic ZOI data to fires postulated in wall and corner configurations exceeds the original limitations of the Generic Fire Modeling Treatments report. However, wall and corner effects may be addressed through the use of a location factor via the 'Image' method as described in NIST-GCR-90-580. The 'Image' method is a simple means of incorporating wall and corner effects by taking advantage of the proportionality between the fire perimeter and the plume air entrainment by changing the fire area. A virtual symmetry plane bisects the increased fire area for wall configurations and two orthogonal virtual symmetry planes bisect the increased fire area for corner configurations. The fire conditions delimited by the symmetry plane represent the conditions of the confined thermal plume. The method is implemented by increasing the heat release rate by a factor of two for wall configurations or four for corner configurations. When the enclosure is explicitly included, as is the case for the hot gas layer calculations, the enclosure volume is increased by a factor of two for wall configurations and four for corner configurations via adjustments to the length and/or width. This is consistent with the definition of a symmetry plane. Report 0027-0003-008M-001, Rev. 1 (Supplement 3 to the Generic Fire Modeling Treatments report) explicitly calculates the ZOI and hot gas layer conditions in wall and corner configurations for transient ignition sources. Wall and corner effects for electrical panel fires are addressed by selecting the ZOI and hot gas layer data listed in the Generic Fire Modeling Treatments report or Supplement 2 to the Generic Fire Modeling Treatments report for heat release rates that are two or four times the specified ignition source value. Additionally, when the hot gas layer effects are assessed, the enclosure volume is increased by a factor of two or four to account for the symmetry plane through the increased fire area.

ZOIs and Hot Gas Layer Temperatures for Scenarios with Secondary Combustibles

The ZOI and hot gas layer data provided in the original Generic Fire Modeling Treatments report postulates a single ignition source fire without secondary combustibles and is thus applicable to configurations that do not involve secondary combustibles such as cable tray stacks. Supplement

2 to the Generic Fire Modeling treatments provides hot gas layer data for a single cable tray configuration having the following characteristics:

- Total cross-sectional length of 0.9 m (3 ft) as represented by two 0.45 m (18 in) wide cable trays placed side-by-side that release heat from the top and bottom or two 0.9 m (36 in) wide trays that release heat from the top;
- Heat release rate per unit area of 225 kW/m^2 (19.8 $Btu/s\text{-}ft^2$);
- Flame propagation rates of 0.3 mm/s (0.012 in/s) for thermoset/IEEE-383 qualified cables and 0.9 mm/s (0.035 in/s) for thermoplastic/non-IEEE-383 qualified cables;
- Fire propagation in two directions;
- Fire ignition at a single vertical plane located above the ignition source;
- Cable tray(s) have a base height 0.3 m (1 ft) above the base of the ignition source fire;
- Heat release rate per unit area reaches maximum value at the ignition time for any fixed location on the cable trays;
- Ignition of the cables at five minutes after the ignition source fire starts.

The hot gas layer results are considered to be conservative when applied to configurations that meet the aforementioned constraints largely because the heat release rate per unit area is not linearly ramped over a timescale equal to one-sixth the fire duration as suggested in NUREG/CR-7010, Volume 1. There are situations described in Report 0493060006.003, Rev. 2 in which the hot gas layer data reported in Supplement 2 to the Generic Fire Modeling Treatments report are applied outside their limitations, in particular for cable tray arrangements involving three or more cable trays, cable trays having a total cross-sectional width greater than 0.9 m (3 ft), cable trays that may ignite sooner than five minutes, or vertical cable tray configurations. Under these circumstances, the total heat release rate at any given time may be underestimated, which can result in an overestimate of the time to reach a particular hot gas layer temperature threshold when using the tabulated data provided in Supplement 2 to the Generic Fire Modeling Treatments report.

Additionally, because the ZOI tables listed in the original Generic Fire Modeling Treatments report are based on a single ignition source, there is the potential for the dimensions to be underestimated if secondary combustibles become involved. The response to PTN RAI FMOD 01.j (Secondary Combustible Effects on the ZOI) and PTN RAI FMOD 01.k (Secondary Combustible Flame Spread and Fire Propagation) provide additional details on the level of conservatism in the secondary combustible treatment relative to its effect on the baseline ZOI dimensions listed in the Generic Fire Modeling Treatments report

Additional scenarios will be developed for PTN specific ignition source-cable tray configurations involving three or more cable trays or configurations that fall outside the limitations of Supplement 2 the Generic Fire Modeling Treatments report using the guidance provided in NUREG/CR-6850 and NUREG/CR-7010, Volume 1 for fire propagation, flame spread, and heat release rate per unit area. Report 0493060006.003, Rev. 2 will be updated to include the hot gas layer results associated with the PTN specific ignition source-cable tray configurations. The CDF and LERF contribution from the affected scenarios will be updated accordingly in conjunction with the incorporation of the panel factor sensitivity evaluation into the base fire PRA. This update will be performed in conjunction with the update of the baseline Fire PRA to eliminate the credit for panel factors and will be reported in conjunction with the associated 120 day RAIs.

ZOIs for Large Dimension Electrical Panels

The original Generic Fire Modeling Treatment report and Supplement 2 to the Generic Fire Modeling Treatment report ZOI data was derived for panels having plan dimensions up to 0.9 x 0.6 m (3 x 2 ft). The dimensions primarily affect the extent of the horizontal component of the ZOI that is below the top of the panel. This ZOI component is calculated from an energy balance at the panel surface and the target exposure mechanism is a heated radiating vertical plane. Consequently, changes in the panel dimensions affect the dimensions of the radiating plane, which in turn affects the geometry configuration factor between the target and the radiating plane. The lower horizontal ZOI dimension is the limiting horizontal ZOI dimension and is used in Report 0493060006.004, Rev. 4 as the basis for determining the affected target set.

An approximate upper limit for the ZOI dimensions based on the conservative 0.9 x 0.6 m (3 x 2 ft) plan dimensions may be estimated by comparing against a limiting open panel configuration. In this case, the maximum heat transferred across one boundary would be given through the definition of the emissive power and a radiation area as follows:

$$\dot{Q}_{b,max} = A_b E \qquad \text{(FMOD 04–1)}$$

where $\dot{Q}_{b,max}$ is the maximum heat that can be transferred across a vertical boundary of an electrical panel (kW [Btu/s]), A_b is the area of the boundary (m² [ft²]), and E is the flame emissive power (kW/m² [Btu/s-ft²]). Assuming the maximum average flame emissive power over the panel boundary is 120 kW/m² (10.6 Btu/s-ft²) based on Section 3–10 of the *SFPE Handbook of Fire Protection Engineering* and data provided in *Combustion and Flame*, No. 139, pp. 263–277, the maximum heat that could be transferred across a vertical boundary via thermal radiation is about 235 kW (227 Btu/s) if the heat transferred across an open boundary is considered to be an upper limit on the boundary heat losses in any one direction. To link this heat loss to the postulated fire size, the radiant fraction is used, which is reasonably approximated as 0.3 for enclosure fires per Section 3–8 of the *SFPE Handbook of Fire Protection Engineering*. Dividing the maximum boundary heat loss of 235 kW (223 Btu/s) by the radiant fraction (0.3) results in the largest fire size for which the lateral ZOI dimensions would be conservative, or 783 kW (742 Btu/s). This value exceeds the severe fire heat release rate used to characterize both the multiple bundle (717 kW [680 Btu/s]) and single bundle (211 kW [200 Btu/s]) electrical panels. This result is based on a radiant fraction of 0.3; if a value at the upper end of the often cited range 0.3 – 0.4 is assumed per Section 3–8 of the *SFPE Handbook of Fire Protection Engineering*, the largest fire size for which the lateral ZOI dimensions would be conservative, or

588 kW (557 Btu/s). However, this would be based on all heat losses being directed toward the target. The internal temperature during a fully developed enclosure fire would be greater than 600°C (1,112°F), which suggest the heat losses from all boundaries, except the open boundary, would be on the order of 110 kW (104 Btu/s). This means that the maximum total energy that could radiate toward the target via thermal radiation would be about 600 kW (253 Btu/s) x 0.4 or 240 kW (227 Btu/s). This is comparable to the maximum boundary heat loss via thermal radiation (235 kW [223 Btu/s]), which indicates the conclusion applies over a wider range of radiant fractions when the additional boundary heat losses are included. There are no known applications of the panel fire ZOI dimensions to panels that have a heat release rate greater than 783 kW (742 Btu/s) and a plan size that exceeds 0.9 x 0.6 m (3 x 2 ft) within Report 0493060006.004, Rev. 4. This indicates that the panel size constraint is met for electrical panel ignition source fire scenarios.

The discussion above does not consider the flame extensions that would result if the boundary were actually open; however, the heat losses in directions other than that in which the target is located are also not considered. In the limit, the fire could be considered to be entirely open, in which case the ZOI dimensions obtained for transient fuel package fires would be nominally applicable. Based on the Table 3–2 in Generic Fire Modeling Treatments report, it is seen that the horizontal dimension of the ZOI for a 717 kW (680 Btu/s) source fire relative to a thermoplastic/non-IEEE-383 qualified cable target would be approximately 3.1 m (10.2 ft). This ZOI dimension is relative to the center of the fire, so the ZOI dimension relative to a panel edge would be about 2.3 m (7.5 ft) for a 0.9 x 0.6 x 2.1 m (3 x 2 x 7 ft) tall electrical panel under these assumptions. This is bound by the ZOI dimension of 3.3 m (10.8 ft) for a NUREG/CR-6850 Appendix E Case 4 panel fire used in Report 0493060006.004, Rev. 4 by a significant margin. The heat release rate per unit area for this configuration (1,280 kW/m^2 [113 Btu/s-ft^2]), as obtained by dividing the peak heat release rate by the plan area of the panel (717 kW/0.56 m^2 [680 Btu/s/6 m^2]), falls outside the range for which the data provided in Table 3–2 of the Generic Fire Modeling Treatments report was compiled. However, it can be seen in Figure 3–10 of the Generic Fire Modeling Treatments report that the horizontal ZOI component is a decreasing function of the heat release rate per unit area for values above 200 kW/m^2 (17.6 Btu/s-ft^2), so the estimate is applicable.

Flame Height Limitation for ZOIs

The original Generic Fire Modeling Treatment report and the corresponding supplements provide ZOI dimensions for fires that are in the open configuration. If the flame height is greater that the ceiling height, the view factors used to derive the horizontal ZOI dimensions will change. The expectation under these circumstances is that the implementation in the Generic Fire Modeling Treatments and the corresponding supplements would be conservative up to a limit. The rationale in this case would be that the that the radiant heat flux from the flame extension is projected downward while at the same time the horizontal component is reduced due to the shorter vertical flame segment. In contrast, the horizontal ZOI dimension without consideration of flame extensions is based on the maximum horizontal heat flux component from the unobstructed flame height. The condition is met if the distance over which the ceiling jet temperature or heat flux exceeds the target damage criteria is less than the horizontal ZOI dimension.

A simple application of Alpert's ceiling jet correlation as described in Section 2–2 of the *SFPE Handbook of Fire Protection Engineering* can be used estimate the transition from a conservative ZOI to a non-conservative horizontal ZOI when the flame height exceeds the ceiling height. The ceiling jet temperature, which is based on range of fire sizes and ceiling height to flame height ratios that encompass those considered, is given as follows:

$$\Delta T = 5.38\frac{\dot{Q}^{\frac{2}{3}}/H^{\frac{5}{3}}}{r/H^{\frac{2}{3}}} \qquad \text{(FMOD 04–2)}$$

where ΔT is the maximum temperature within the ceiling jet (°C) at a distance r from the centerline of the fire (m), $\dot{Q}$ is the total heat release rate of the fire (kW), and H is the height of the ceiling above the fire base (m). Report 0027-0003-008M-001, Rev. 1 provides the estimates of the minimum ceiling height above the base of a transient ignition source fire using Equation FMOD 04–2 with a resulting minimum ceiling height of 0.36 – 0.91 m (1.17 – 3.0 ft) above the fire base, depending on the particular configuration considered. There are no known applications that fall below this range within Report 0493060006.004, Rev. 4 indicating that the flame height constraint is met for transient ignition source fire scenarios.

In the case of the electrical panel fires involving thermoplastic/non-IEEE-383 qualified cables, the minimum ceiling distance as determined from Equation FMOD 04–2 is summarized in Table FMOD 04-1. The temperature differential is set to 184°C (331°F), which is deduced from a critical damage temperature of 204°C (400°F) and an initial ambient temperature of 20°C (68°F). The table indicates that the horizontal ZOI dimension for the 98th percentile panel fires is conservative provided the base of the ignition source is located more than 0.47 - 56 m (1.55 – 1.85 ft) from the ceiling. There are no known applications that fall below this range within Report 0493060006.004, Rev. 4 indicating that the flame height constraint is met for electrical panel ignition source fire scenarios.

Table FMOD 04-1 – 98th Percentile Ignition Source Fire Characteristics – Electrical Panels.

Ignition Source	Peak Heat Release Rate (kW [Btu/s])	Horizontal ZOI Dimension (m [ft])	Minimum Ceiling Height above the fire Base for which the Horizontal ZOI Dimension is Conservative (m [ft])
Single Cable Bundle Panel (Thermoplastic/non-IEEE-383 Qualified Cables)	211 (200)	2.2 (7.3)	0.47 (1.55)
Multiple Cable Bundle Panel (Thermoplastic/non-IEEE-383 Qualified Cables)	464 (440)	3.1 (10.2)	0.56 (1.85)

Enclosure Aspect Ratio Considerations

A final limitation of the Generic Fire Modeling Treatments report and Supplement 2 to the Generic Fire Modeling Treatments report relates to the maximum aspect ratio of an enclosure for which hot gas layer data is applied. The hot gas layer information is provided for enclosures having an aspect ratio up to five per NUREG-1824, Volume 5, Section 3.2. In situations where the model is applied to enclosures having a larger aspect ratio, the behavior transitions to a channel flow typical of a corridor configuration. Localized effects in the vicinity of the fire could be more severe than the average conditions throughout the enclosure length and thus a non-conservative result could be generated. NUREG-1934 describes a method to apply a fire model in a conservative manner under these conditions. This method involves the modification of the enclosure dimensions such that the application falls within the model limitation and the hot gas layer temperature result are conservative. The application of the Generic Fire Modeling Treatments hot gas layer data used in PTN enclosures with aspect ratios greater than five in Report 93060006.003, Rev. 2 will be updated using the recommended approach in NUREG-1934. The CDF and LERF contribution from the affected scenarios will be updated accordingly in conjunction with the incorporation of the panel factor sensitivity evaluation in conjunction with the response to the associated 120 day RAI.

PTN RAI FMOD 06.a - Fire Model Parameter Uncertainty
NFPA 805, Section 2.7.3.5, "Uncertainty Analysis," states, "An uncertainty analysis shall be performed to provide reasonable assurance that the performance criteria have been met."

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 FPRA development."

Regarding the uncertainty analysis for fire modeling:

a) Describe how the uncertainty associated with the fire model input parameters was accounted for in the fire modeling analyses.

RESPONSE:
Fire model uncertainty associated with the fire model input parameters was not explicitly accounted for in the fire modeling analyses conducted at PTN in support of the fire PRA. However, the uncertainty associated with specific fire modeling parameters is addressed through the use of a conservative and bounding analysis. There are three primary areas at PTN in which fire modeling parameter uncertainty is applicable:

- The MCR abandonment analysis;
- The ZOI tabulations as contained in the Generic Fire Modeling Treatments report and its applicable supplements; and
- The hot gas layer tabulations as contained in the Generic Fire Modeling Treatments report and its applicable supplements.

MCR Abandonment Calculation. The MCR abandonment calculation is structured to provide a reasonably conservative abandonment time for a given heat release rate input. The geometric description of the MCR is provided in Section 2 of the MCR abandonment calculation and includes information associated with known input parameters (i.e., the enclosure physical dimensions and construction, the volume of obstructions, the HVAC flow rates, and the door openings). A description of the fire scenarios, including the heat release rate profiles and fuel properties, is provided in Section 3 of the MCR abandonment calculation. A number of assumptions regarding the geometry, the initial conditions, and the fuel properties are made and discussed in Sections 2 and 3 of the MCR abandonment calculation and the effect of these assumptions on the predicted abandonment time is examined in a sensitivity analysis in Appendix B of the MCR abandonment calculation. These assumptions include the following:

- The use of a one-room vs. a two-room model to represent the MCR geometry;
- The assumed boundary leakage fractions;

- The fire growth rate;
- The fuel properties (soot yield, heat of combustion);
- The fire base height; and
- The initial ambient conditions;

Generally, the baseline fire scenarios are developed with the intent of skewing the assumed values conservatively if there is a basis for the selected value. Further, the assumed abandonment criteria exceed the recommended guidance provided in NUREG/CR-6850 through the use of a 50°C (122°F) occupant immersion threshold. This abandonment threshold is in most cases the cause of abandonment and provides explicit margin in each case.

The sensitivity analysis does indicate that some parameter selections can lead to a more conservative result. These would include the use of a two room model, the assumed fire growth rate, the initial ambient conditions, the fire base height, and the fuel properties. The two room model can decrease the abandonment times by about ten to twenty percent when assessed with a NUREG/CR-6850 99.9 percentile (Bin 14) fire size. The heat release rate growth profile has the greatest effect on the abandonment times and can affect the results by as much as fifty to eighty percent. However, the heat release rate growth rate is a specified parameter per NUREG/CR-6850 and NUREG/CR-6850, Supplement 1 and is provided for informational purposes.

The assumed fire base height can lead to a more conservative result when elevated slightly but a less conservative result when elevated above 1.2 m (4 ft). This is a consequence of the complex means by which abandonment is predicted (absolute hot gas layer temperature increase, visibility coupled with a hot gas layer height, and hot gas layer temperature increase coupled with the hot gas layer height). An assumption of the assumed fire base height may be conservative in one scenario but not so in another. Given that the fire base height for closed but vented panels should be located 0.3 m (1 ft) below the panel top per NUREG/CR-6850, Supplement 1, the baseline results as presented bound a scenario evaluated in accordance with existing guidance. Open panels with thermoplastic cables are correctly modeled at floor level given that the cable materials will melt and pool when ignited.

The assumed initial temperature can affect the results by up to thirty percent for a 10°C (18°F) increase in the initial conditions. Although this is a significant variation, the normal conditions within the control room are maintained approximately equal to the assumed value and the increased ambient would represent an upset condition at the start of the fire. In effect, the sensitivity analysis provides a constraint on the application of the model results in the fire PRA.

The assumed fuel properties, specifically the burning regime, can affect the results by up to fifty percent due to the increased production of soot and a change in the heat transfer rates to the enclosure boundaries. The means by which the poorly ventilated conditions were approximated is very conservative and does not take into account the potential for ventilation limited conditions to develop or the effect ventilation limited conditions on the carbon dioxide production, both of which would tend to reduce the results differential between the baseline and sensitivity cases.

Each of the sensitivity cases applies only to the 99.9th percentile heat release rates and as such contributes relatively little to the overall probability of abandonment given a severity factor of 0.001. In addition, the effect of the more restrictive 50°C (122°F) immersion threshold for abandonment skews each result conservatively and is expected to introduce a sufficient conservative bias to bound the potential variation in the abandonment results due to parameter uncertainty. Additional conservatism is provided through the selection of the most adverse baseline fuel properties and the treatment of the floor as an adiabatic surface. As part of the incorporation of the sensitivity analysis into the fire PRA, the sensitivity analysis presented in Appendix B of the MCR abandonment calculation will be revised to provide a quantitative assessment of each sensitivity parameter in terms of the overall probability of abandonment. See the response to PTN RAI FMOD 01.e (MCR Sensitivity Analysis) for additional details on the revision to the MCR abandonment calculation sensitivity analysis.

ZOI Calculations. The Generic Fire Modeling Treatments report and its associated supplements provide ZOI dimensions for various ignition sources for which fire PRA fire scenarios are developed in Report 0493060006.004, Rev. 4. The Generic Fire Modeling Treatments report summarizes the method selection for the ZOI dimensions and provides a sensitivity analysis in each case. In the case of the two dominant ignition sources in the fire PRA (transient fuel package and electrical panel), the ZOI calculation consists of a vertical plume temperature calculation and a horizontal radiant heat transfer calculation.

The vertical plume calculation uses an empirical model that requires as inputs the fire size, the ambient temperature, and fire diameter. The fire size is an input parameter specified by NUREG/CR-6850. The fire diameter and ambient temperature are the primary parameters subject to uncertainty. In this case, the fire diameter in the original Generic Fire Modeling Treatments report provides ZOI dimensions assuming a variable diameter (as characterized using the heat release rate and heat release rate per unit area). A heat release rate per unit area range between 200 kW/m^2 (17.6 Btu/s-ft^2) and 1,000 kW/m^2 (88.1 Btu/s-ft^2) is used for transient combustible materials and range up to 3,000 kW/m^2 (264 Btu/s-ft^2) for electrical panels. The baseline ambient temperature assumed in the original Generic Fire Modeling Treatments report is 20°C (68°F) with a maximum application limit of 80°C (176°F). The baseline ambient temperature selection in the Report 0027-0003-008M-001, Rev. 1 is varied from 20°C (68°F) to 80°C (176°F) and is thus not subject to assumption or uncertainty, at least within the limits of applicability.

The maximum effect of an elevated initial ambient temperature on the ZOI dimensions for transient fuel package fires is provided in Report 0027-0003-008M-001, Rev. 1. The ZOI dimension may change by about two – five percent when the ambient temperature is 40°C (104°F) and ten – twenty percent if the ambient temperature is 80°C (176°F) based on a 317 kW (300 Btu/s) transient fuel package fire in an open, wall, or corner location. In the case of a 40°C (104°F) ambient temperature, there is no material effect on the ZOI dimension used in the field given the practice of rounding to the next nearest foot increment. In the case of the 80°C (176°F) ambient temperature environment, the maximum differential between the ZOI dimensions used in the field and the actual calculated ZOI dimensions is about 0.15 m (0.5 ft). This differential is expected to be readily bound by the conservatisms that are embedded in the ZOI development. These conservatisms relative to a transient fuel package fire include the use of steady-state target damage thresholds, a fire diameter that maximizes the ZOI dimension, the use of a ZOI box rather than a cone, and the selection of the most adverse result among a range of methods.

The effect of an elevated temperature environment on the ZOI for electrical panel fires is expected to be comparable to that determined for the transient fuel packages. There are additional conservative biases that may be estimated for panel fires that can be used to show the ZOI conservatively bounds the parameter uncertainty. For example, the assumed heat release rate per unit area for the electrical panel fires for the vertical ZOI dimension is effectively 3,000 kW/m^2 (264 Btu/s-ft^2). This means that the characteristic fire dimension for the 98th percentile panel fires is on the order of 0.26 – 0.48 m (0.9 – 1.6 ft). The characteristic dimension for the electrical panels as evaluated using the NUREG/CR-6850 guidance would be based on the panel top surface area and will typically be on the order of 0.6 – 1.2 m (2 – 4 ft). This indicates a significant bias is introduced by assuming the fire plan area can occupy only a fraction of the panel top. An additional conservative bias is introduced in setting the base location of the vertical ZOI dimension. Per NUREG/CR-6850, Supplement 1, the fire base height may be set 0.3 m (1 ft) below the panel top (if the panel does not have significant openings in the top). The vertical ZOI dimensions for the electrical panels reported in the Generic Fire Modeling Treatments report use the panel top as the base height reference for the vertical ZOI dimension. This introduces a uniform 0.3 m (1 ft) bias in all vertical ZOI dimensions for the electrical panels. As such, the vertical ZOI dimension is calculated using bounding input parameters when viewed collectively.

In the case of the horizontal ZOI dimension, the maximum distance as obtained using both a solid flame model and the Point Source Model (PSM) is selected. The PSM requires as input the fire size and the fire radiant fraction, which is assumed to be 0.4. The fire size is a prescribed input per NUREG/CR-6850. Based on SFPE Handbook of Fire Protection Engineering Section 3–10, the effective radiant fraction for conservative (but not bounding) results is 0.21. A bounding result is obtained when a safety factor of two is used. By assuming a radiant fraction of 0.4, an effectively bounding result is therefore obtained. The solid flame heat flux model requires the fire size and fire diameter as input parameters. The fire size is a prescribed input per NUREG/CR-6850. The fire diameter is varied via the heat release rate per unit area parameter. In this case, the most adverse fire diameter is intermediate with a heat release rate per unit area of about 350 – 400 kW/m^2 (30.8 – 35.2 Btu/s-ft^2), depending on the specific case. The value that yields the maximum ZOI dimension is the value used in the analysis.

The electrical panel ZOIs have additional conservative margins by including an additional calculation that is more conservative than the approach suggested in NUREG/CR-6850, Supplement 1. Per NUREG/CR-6850, Supplement 1, the fire base is located 0.3 m (1 ft) below the top of the panel and is typically modeled assuming the panel boundaries do not exist (open fire). The horizontal ZOI dimensions developed in the Generic Fire Modeling Treatments report include an upper horizontal ZOI dimension that is computed in this manner and a lower ZOI dimension that assumes internal flame impingement on the panel boundary. This flame impingement imposes a 120 kW/m^2 (10.6 $Btu/s\text{-}ft^2$) heat flux on any internal boundary that radiates outward from a single side. The lower horizontal ZOI dimension is significantly larger than the upper (fire plume base horizontal dimension), typically by a factor of two (compare Tables 5–16 and 5–17 in the Generic Fire Modeling Treatments report, for example). The FPRA selects the most adverse horizontal ZOI dimension and thus incorporates this bias directly.

Based on the overall conservative bias associated with the key parameters as discussed above both the horizontal and vertical ZOI dimensions reported in the Generic Fire Modeling Treatments report and Report 0027-0003-008M-001, Rev. 1 are considered conservative with respect to parameter uncertainty.

Hot Gas Layer Tabulations. The Generic Fire Modeling Treatments report and the associated supplements containing hot gas layer data provide times at which the hot gas layer in a generic enclosure will exceed key temperature thresholds. The computations are performed using the zone computer model CFAST, version 6.0.10 and Version 6.1.1. The methodology for computing the hot gas layer tables is described in detail in Section 6.3 and Appendix B of the Generic Fire Modeling Treatments report. Essentially, CFAST is used to balance energy and mass flow through openings and the time at which the hot gas layer temperature reaches a threshold value is reported regardless of the hot gas layer height. The primary input parameters include the fire size, the enclosure geometry, the fuel properties, the opening characteristics, the boundary material properties, and the initial ambient temperature.

The fire size is a prescribed input per NUREG/CR-6850 or is specified with a particular set of input parameters and subject to the parameter constraints (cable trays). The room geometry is selected in such a way as to minimize the heat losses to the boundaries and thus varies from volume to volume. Under this assumption, the height of the enclosure necessarily varies with the volume. However, a sensitivity analysis is conducted on the room enclosure shape (Section B.4.4 of the Generic Fire Modeling Treatments report) and it is shown that minimizing the enclosure boundary surface area provides a bounding or nearly bounding result for a given enclosure volume when the length to width aspect ratio is varied from 1:1 to 1:5 in the cases considered. As the aspect ratio increases, a significant reduction in the temperature is observed indicating that spaces that deviate from a 1:1 aspect ratio have an increasing safety margin embedded in the hot gas layer temperature results.

The selection of the fuel properties is evaluated in Sections B.4.1 and B.4.2 of the Generic Fire Modeling Treatments report. Fuel properties are varied over a large range of potential values and the most adverse combination is selected to represent all fuels. In this case a relatively low soot yield material is used because it reduces the radiant heat losses from the hot gas layer to the enclosure boundaries and maximizes the hot gas layer temperature.

The opening characteristics are described in terms of a boundary fraction and are varied over a range of 0.001 – 10 percent in the baseline cases. The hot gas layer associated with the most adverse ventilation case is selected in Report 0493060006.003, Rev. 2 among the reported ventilation conditions for a given fire size and enclosure volume. The key input parameter that is set is the ventilation geometry (length, width, and base height) given a vent fraction. Section B.4.5 of the Generic Fire Modeling Treatments report provides a sensitivity analysis on the effects of various vent orientations and placements on the predicted temperature. A total of fifty-four vent configurations were examined for the baseline enclosures. It is found that the bounding case can be one of three orientations: one in which the vent width is equal to the enclosure width, located either at the ceiling or at the floor and one in which the vent height is equal to the enclosure height. All hot gas layer tables reported in the Generic Fire Modeling Treatments report and Supplement 2 to the Generic Fire Modeling Treatments report are based on the most adverse hot gas layer condition among the three vent orientations and thus represent the bounding configuration for the vent geometry.

The boundary material properties are defined as concrete having the lowest thermal diffusivity reported among available data as described in Section B.4.3 of the Generic Fire Modeling treatments report. The thermal diffusivity of the selected concrete, defined as the thermal conductivity divided by the heat capacity and density, is 5.9 x 10-7 m^2/s (6.3 x 10-6 ft^2/s) and is about thirty percent lower than the value of 8.9 x 10-7 m^2/s (9.5 x 10-6 ft^2/s) recommended in NUREG-1805. This conservatively biases the results for the boundary materials, though it is shown in Section B.4.3 that the results are not conservative if they are applied to spaces bound with thermal insulation, lightweight concrete, or gypsum wallboard.

The initial ambient temperature is assumed to be 20°C (68°F) in both the Generic Fire Modeling Treatments report and Supplement 2 to the Generic Fire Modeling Treatments report. This ambient temperature is intentionally set to be equal to the assumed initial temperature for which the ZOIs are computed in the Generic Fire Modeling Treatments report. Although this is not a conservative and bounding assumption, the ZOI dimensions are adjusted or limited via the modified critical heat flux. In addition, conservative assumptions with regard to the enclosure geometry, fuel properties, and vent placement are expected to bound the variation in the results that is possible with different initial ambient temperatures.

Finally, a significant conservatism embedded in the CFAST model results is the specification of an adiabatic floor. Radiant heat losses from both the fire and the hot gas layer to the floor are not credited with reducing the hot gas layer temperature. This assumption is expected to conservatively bias the temperature predictions.

Based on the overall conservative bias associated with the CFAST model parameters (collectively), the hot gas layer tables reported in the Generic Fire Modeling Treatments report and in Supplement 2 to the Generic Fire Modeling Treatments report are considered conservative with respect to uncertainty in the parameter values.

PTN RAI FMOD 06.b - Fire Model "Model" Uncertainty
NFPA 805, Section 2.7.3.5, "Uncertainty Analysis," states, "An uncertainty analysis shall be performed to provide reasonable assurance that the performance criteria have been met."

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 FPRA development."

Regarding the uncertainty analysis for fire modeling:

b) Describe how the "model" uncertainty was accounted for in the fire modeling analyses.

RESPONSE:
Fire model "model" uncertainty was not explicitly accounted for in the fire modeling analyses conducted at PTN in support of the fire PRA. However, the uncertainty associated with fire modeling "model" uncertainty is addressed through the use of a conservative and bounding analysis. There are three primary areas at PTN in which fire modeling "model" uncertainty is applicable:

- The MCR abandonment analysis;
- The ZOI tabulations as contained in the Generic Fire Modeling Treatments report and its applicable supplements; and
- The hot gas layer tabulations as contained in the Generic Fire Modeling Treatments report and its applicable supplements.

MCR Abandonment Calculation. The MCR abandonment calculation is structured to provide a reasonably conservative abandonment time for a given heat release rate input. The geometric description of the MCR is provided in Section 2 of the MCR abandonment calculation and includes information associated with known input parameters (i.e., the enclosure physical dimensions and construction, the volume of obstructions, the HVAC flow rates, and the door openings). A description of the fire scenarios, including the heat release rate profiles and fuel properties, is provided in Section 3 of the MCR abandonment calculation. Generally, the baseline fire scenarios are developed with the intent of skewing the assumed values conservatively if there is a basis for the selected value. Further, the assumed abandonment criteria exceed the recommended guidance provided in NUREG/CR-6850 through the use of a 50°C (122°F) occupant immersion threshold. This abandonment threshold is in most cases the cause of abandonment and provides explicit margin in each case.

The control room abandonment times provided in Report 0020-0010-001, Rev. 0 are computed using the fire model CFAST, Version 6.0.10 using minimum abandonment time as predicted using the visibility-hot gas layer height threshold, the temperature threshold, and the temperature-hot gas layer height threshold. Per NUREG-1934, model and completeness uncertainty are related and specific parameters that may be used to quantify both uncertainties together are provided in Table 4-1 of NUREG-1934. In cases where the abandonment times are determined exclusively from the visibility parameter, it may be shown that model and completeness uncertainty are not applicable by calculating the probability that a value will be exceeded. This probability may be determined from the following equation:

$$P(x > x_c) = \frac{1}{2}\operatorname{erfc}\left(\frac{x_c - \mu}{\sigma\sqrt{2}}\right) \qquad \text{(FMOD 06–1)}$$

where P is the probability, x is a parameter value, x_c is a threshold parameter value, μ mean 'true' predicted value of the parameter, σ is the standard deviation of the model prediction for the parameter of interest. The mean value is determined from the model bias as follows:

$$\mu = \frac{M}{\delta} \qquad \text{(FMOD 06–2)}$$

where M is the model prediction and δ is the model bias. The standard deviation is given by the following equation:

$$\sigma = \frac{\tilde{\sigma}M}{\delta} \qquad \text{(FMOD 06–3)}$$

where $\tilde{\sigma}$ is the normalized standard deviation (normalized variance). The parameter that drives the visibility is the optical density, which is proportional to the smoke concentration. The CFAST model bias and normalized standard deviation for the smoke concentration predictions are 2.65 and 0.63, respectively. This means that given a model optical density prediction of 3 m^{-1} (0.9 ft^{-1}), a mean 'true' value is 1.13 m^{-1} (0.34 ft^{-1}). The probability that given an optical density prediction of 3 m^{-1} (0.9 ft^{-1}), the actual value will exceed as computed from Equation FMOD 06–1 is 0.0044, which is close to zero. This result is a consequence of the large conservative bias in the in the prediction of the smoke concentration.

A similar computation may be performed for the cases in which abandonment is predicted by the 50°C (122°F) temperature threshold. In this case, the comparison metric is the NUREG/CR-6850 temperature threshold for abandonment, or 95°C (200°F). The CFAST model bias and normalized standard deviation for the hot gas layer temperature are 1.04 and 0.12, respectively. The probability that the hot gas layer temperature is 95°C (200°F) given a prediction of 50°C (122°F) is about zero.

The results also bound the case in which the cause of abandonment changes from visibility to temperature or temperature to visibility by noting that the differential between the predicted and the upset value are larger. This is readily explained by considering a situation in which a temperature of 50°C (122°F) is predicted to cause control room abandonment, meaning that the optical density is less than 3 m^{-1} (0.9 ft^{-1}). The probability that the optical density would be greater than 3 m^{-1} (0.9 ft^{-1}) under this condition is necessarily lower than 0.0044 as previously computed because the differential between the predicted value and the upset condition is non-zero.

There are no scenarios listed in Report 0020-0010-001, Rev. 0 in which the control room abandonment is predicted to be caused by the 95°C (200°F) temperature threshold. Consequently, it is concluded that model and completeness uncertainty either would not contribute to the risk uncertainty or are bounded by the conservatisms in the analysis, depending on the condition causing abandonment for a given fire scenario.

A discussion of the uncertainty analysis will be provided in the revised control room abandonment calculation that will directly incorporate the results of the sensitivity analysis (PTN RAI FMOD 01.e (MCR Sensitivity Analysis)) and the additional scenarios associated with the panels located near a wall (PTN RAI 01.f (Control Room Panel Vent Location with Respect to a Wall or Corner)). The uncertainty analysis will address changes to the baseline cases that may result.

ZOI Calculations. The ZOI computations rely on a plume centerline temperature, an open source fire radiant heat flux computation, and a radiant heat flux computation from a heated panel. The plume centerline temperature computation is shown in NUREG-1934 and NUREG-1824, Volume 3 to have a non-conservative bias and a relatively large standard deviation. However, the application considered did not explicitly account for the hot gas layer temperature changes, which are the expected source of the bias and variation. Similar plume correlations used by CFAST and MAGIC show a conservative bias and smaller variation. The application of the plume correlations is limited in the Generic Fire Modeling Treatments report and in Report 0027-0003-008M-001, Rev. 1 to 80°C (122°F) or less through the use of the modified critical heat flux, which is intended to adapt the models for elevated internal temperatures. Further, as discussed in the response to PTN RAI FMOD 06.a (Fire Model Parameter Uncertainty), the vertical plume ZOI dimension may have as much as a 0.3 m (1 ft) conservative bias embedded based on the assumed diameters and the base elevations relative to NUREG/CR-6850 and NUREG/CR-6850, Supplement 1 guidelines.

Additional conservative bias is introduced through the steady-state treatment of a transient fuel package fire. Based on Report 0027-0003-008M-001, Rev. 1, the fire duration for a transient fuel package that conforms to the fuel package fire tests listed in Table G-7 of NUREG/CR-6850 is about twelve minutes. Per NUREG/CR 6850 Table H-6, the failure temperature for this exposure duration is about 275°C (525°F). The probability that the temperature exceeds 275°C (525°F) given a predicted value of 204° (400°F) may as computed using Equations FMOD 06–1, FMOD 06–2, and FMOD 06–3 with the bias and normalized variance for the thermal plume for MAGIC, which uses the same plume model (Heskestad Plume). The model bias and normalized variance for the radiant heat flux models are listed in NUREG-1934 as 2.02 and 0.59, respectively. The corresponding probability the temperature exceeds 275°C (525°F) is 5.64 x 10-9. Similarly, if the CFAST thermal plume bias and variance are used for the McCaffrey Plume (1.25 and 0.28, respectively), the probability that the temperature exceeds 275°C (525°F) is about 0.0044. In either case, the probability is sufficiently low and is not expected to propagate significant non-conservative uncertainty into the risk analysis.

The horizontal ZOI dimensions are computed using a radiant heat flux model with the radiant fraction set to about two times the value recommended in the *SFPE Handbook of Fire Protection Engineering*, Section 3–10. Effectively, the radiant heat flux has a bias of two explicitly embedded in the calculation. The probability that the heat flux at a fixed location would exceed 5.7 kW/m^2 (0.5 Btu/s-ft^2) given a prediction of 2.35 kW/m^2 (0.25 Btu/s-ft^2) (i.e., removed conservative bias) may be computed using Equations FMOD 06–1, FMOD 06–2, and FMOD 06–3 with the bias and normalized variance for the radiant heat flux models, which are 2.02 and 0.59. The resulting probability is about 1.9 x 10-11, which is essentially zero. In the case of the electrical panel fires, an additional margin is provided through the use of a conservative model beyond that required in NUREG/CR-6850 and NUREG/CR-6850, Supplement 1 for portions of the ZOI below the panel. Because Report 0493060006.004, Rev. 4 uses the most adverse horizontal ZOI dimension above or below the panel, this additional modeling introduces a second conservative factor that is on the order of two as described in the response PTN RAI FMOD 06.a (Fire Model Parameter Uncertainty).

Consequently, it is concluded that model and completeness uncertainty either would not contribute to the risk uncertainty or are bounded by the conservatisms in the analysis, depending on the ZOI dimension considered.

Hot Gas Layer Tabulations. The hot gas layer tables are computed using the zone computer model CFAST, Version 6.0.10 and 6.1.1 in the Generic Fire Modeling Treatments report and Supplement 2 to the Generic Fire Modeling Treatments report. As described in the response to PTN RAI FMOD 06.a (Fire Model Parameter Uncertainty), there are a significant number of parameters that are conservatively biased in the model, including the fuel properties, the combustion properties, the boundary properties, the adiabatic floor surface, and the vent configuration. In addition, for a given CFAST geometry, Report 0493060006.003, Rev. 2 selects the most adverse scenario among a ventilation range between 0.001 and 10 percent of the boundary area. The approximate effect of each of these parameters (except for the adiabatic floor surface) on the temperature results are provided in Appendix B of the Generic Fire Modeling Treatments report. If a baseline case is defined as one in which the probability the temperature exceeds the critical value of 204°C (400°F), application of Equations FMOD 06–1, FMOD 06–2, and FMOD 06–3 may be used to determine the baseline case enclosure temperature. The corresponding baseline temperature in this case is 176°C (315°F) and the probability that the temperature would exceed 204°C (400°F) is about 0.019, which is not expected to propagate significant uncertainty into the risk model. Appendix B may be used to demonstrate that the results are conservatively biased at least to this extent relative to a case evaluated using inputs as recommended in NUREG/CR-6850 and NUREG-1805. Figure B4-7 and B4-8 in the Generic Fire Modeling Treatments report demonstrates that the effect of changing the thermal diffusivity of the boundary materials on the steady state temperature is roughly proportional to the change in the thermal diffusivity at least when centered on a value of 5.9 x 10-7 m^2/s (6.3 x 10-6 ft^2/s). Given that this value is about thirty percent lower than the thermal diffusivity recommended in NUREG-1805 (see PTN RAI FMOD 06.a (Fire Model Parameter Uncertainty)) for normal weight concrete, a comparable test case would have a temperature reduction of about 60°C (58°F). This sensitivity alone is comparable to the temperature change necessary to reduce the model and completeness uncertainty to less than two percent. Although the thermal diffusivity assumed is much lower than the value recommended by NUREG-1805, the model sensitivity to similar changes (decreases) show sensitivity within the range considered. When all conservatively biased input parameters are considered together, it is expected that the collective effect on the predicted temperature will result in a low probability of exceeding a threshold value at a tabulated time.

Consequently, it is concluded that fire model "model" uncertainty would not contribute significantly to the risk uncertainty since it is sufficiently bound by the conservatisms in the CFAST hot gas layer analyses.

Given that this value is about thirty percent lower than the thermal diffusivity recommended in NUREG-1805 (see PTN RAI FMOD 06.a (Fire Model Parameter Uncertainty)) for normal weight concrete, a comparable test case would have a temperature reduction of about 60°C (58°F). This sensitivity alone is comparable to the temperature change necessary to reduce the model and completeness uncertainty to less than two percent. Although the thermal diffusivity assumed is much lower than the value recommended by NUREG-1805, the model sensitivity to similar changes (decreases) show sensitivity within the range considered. When all conservatively biased input parameters are considered together, it is expected that the collective effect on the predicted temperature will result in a low probability of exceeding a threshold value at a tabulated time.

Consequently, it is concluded that fire model "model" uncertainty would not contribute significantly to the risk uncertainty since it is sufficiently bound by the conservatisms in the CFAST hot gas layer analyses.

PTN RAI FMOD 06.c - Fire Model "Completeness" Uncertainty

NFPA 805, Section 2.7.3.5, "Uncertainty Analysis," states, "An uncertainty analysis shall be performed to provide reasonable assurance that the performance criteria have been met."

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 FPRA development."

Regarding the uncertainty analysis for fire modeling:

c) Describe how the "completeness" uncertainty was accounted for in the fire modeling analyses.

RESPONSE:

Fire model "completeness" uncertainty was not explicitly accounted for in the fire modeling analyses conducted at PTN in support of the fire PRA. However, the fire modeling applications at PTN are conservative where applied within the specified limitations (see responses to PTN RAI PRA 01.x (F&O 10-14 against FSS-A5) and PTN RAI FMOD 04 (Generic Treatments Limitations)), and this conservatism is expected to bound the "completeness" uncertainty associated with the fire model application. Per NUREG-1934, the "model" uncertainty and the "completeness" uncertainty are related and may be combined into a single source of uncertainty. The response to PTN RAI FMOD 06.b (Fire Model "Model" Uncertainty) provides additional details on the conservative aspects of the fire modeling applications at PTN relative to the potential fire model "model" uncertainty.

PTN Monitoring Program RAI 01

Describe the process that will be used to identify systems, structures, and components (SSCs) for inclusion in the NFPA 805 monitoring program, and 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. The response should include how performance monitoring groups will be established and screened.

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.

Describe how the NFPA 805 monitoring program will address programmatic elements that fail to meet performance goals (examples include discrepancies in programmatic areas such as the combustibles control program).

Describe how the guidance in EPRI Technical Report 1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features," if used, will be integrated into the NFPA 805 monitoring program.

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.

RESPONSE:

PTN will use the process as approved in FAQ 10-0059, NFPA 805 Monitoring, Revision 5. Specific answers are provided below:

The six categories of SSCs and programmatic elements as defined in FAQ 10-0059 will establish the overall scope of the NFPA 805 monitoring program. The method by which these SSC's (not the programmatic elements) will be monitored will be dependent upon their risk significance and whether they are already functionally monitored by the Maintenance Rule. There is currently no direct correlation of risk significance to individual SSC component or equipment identifier. Performance Monitoring Groups (PMGs) will be established to correlate SSCs with common fire protection functions such as detection, suppression, water supply, etc. and their locations (fire area, fire zone) so that risk significance can be determined for screening purposes. SSCs not currently modeled within the scope of the Fire PRA are by definition not risk significant. The screening will be conducted as described in LAR section 4.6.2, Phase 2 using compartment CDF and LERF values with the value of RAW derived from the PMG functional contribution to compartment risk for those SSCs for which it cannot be determined directly. For those SSCs already considered within scope of the Maintenance Rule, a review will be conducted to ensure the credited NFPA 805 function(s) are bounded by the function(s) currently being monitored under the Maintenance Rule.

LAR section 4.6.2, Phase 3 Risk Target Value Determination provides a description of the process that will be used to assign availability, reliability, and performance goals to HSS SSCs within the scope of the monitoring program. SSCs that do not meet the screening criteria in Phase 2 do not specifically require assignment of availability, reliability, and performance goals. Target values for reliability and availability for the fire protection systems and features are established at the component level, program level, or functionally through the use of the pseudo system or 'performance monitoring group' concept. The actual action level is determined based on the number of component, program or functional failures within a sufficiently bounding time period (~2-3 operating cycles). In addition, the EPRI Technical Report (TR) 1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features" will be used as input for establishing reliability targets, action levels, and monitoring frequency. See Implementation Item 1 in Table S-3 of Attachment S. Since the HSS NSCA equipment have been identified using the Maintenance Rule guidelines, the associated equipment specific performance criteria will be established as in the Maintenance Rule, provided the criteria are consistent with Fire PRA assumptions. When establishing the action level threshold for reliability and availability, the action level will be no lower than the Fire PRA assumptions.

Programmatic elements such as fire brigade performance, fire watches, combustible controls, etc., will be qualitatively evaluated using the existing program health process. Guidance for action thresholds is contained in procedure PI-AA-205, Condition Evaluation and Corrective Action. The LAR Section 4.6.2 Phase 4, Phase 4 Monitoring Implementation, 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 goals of programmatic elements.

EPRI TR 1006756 will be used as input for establishing reliability targets, action levels, and monitoring frequency. The frequency at which inspections, testing and maintenance of the fire protection systems and features is performed will be evaluated using Section 11 which contains the following guidance to ensure that reliability levels established are consistent with Fire PRA and Maintenance Rule, "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."

LAR Section 4.6.2 Phase 4 provides a description of how periodic assessments of the monitoring program will be performed including consideration of internal and external operating experience. A periodic assessment will be performed (e.g., at a frequency of approximately every two to three operating cycles and coordinated with the NRC Triennial Inspection), taking into account, where practical, industry wide operating experience. This will be conducted as part of other established assessment activities. Issues that will be addressed include:

- Review systems with performance criteria. Do performance criteria still effectively monitor the functions of the system? Do the criteria still monitor the effectiveness of the fire protection and NSCA systems?

- Have the supporting analyses been revised such that the performance criteria are no longer applicable or new fire protection and NSCA SSCs, programmatic elements and/ or functions need to be in scope?
- Based on the performance during the assessment period, are there any trends in system performance that should be addressed that are not being addressed?

PTN RAI PROG 04 - Training for Change Evaluation Process

Describe how the Turkey Point training program will be revised to support the NFPA 805 change evaluation process, including who will be trained and how the training will be implemented (e.g., classroom, computer-based, reading program).

RESPONSE:

The response to PTN RAI Programmatic 03 outlined changes to the fire protection program and provided identification of how training was to be handled under the transition. The change evaluation process will incorporate FAQ 12-0061 when it is approved. This will be used to revise existing procedures and/or create new procedures for the change evaluation process. PTN RAI Programmatic 02 indentified the anticipated procedure changes.

As stated in PTN RAI Programmatic 03 all new procedures or procedure revisions require an assessment of training impact and completion of training prior to issuance per procedure AD-AA-100-1004. The type of training and the recipients of such training are identified as part of that process. In addition to this, due to the complex nature of this change, a change management plan has been developed to support the transition to NFPA 805. That change management plan consists of two parts, the first is a fleet level plan (AR 1623193) and the second is a site level plan (AR 1670987). These plans also require review of training requirements.

Based on the current development of the transition process the following training is anticipated for the change evaluation process (screening is included since that is the start of the process)

Module
Applicability Screening of Changes for Operations/Maintenance/Work Control etc.
Applicability Screening of Changes for Engineering
FP Modification Review Engineering Qualification Card
Change Evaluation Qualification Card Development

PTN RAI PROG 05 - Configuration Management and Change Control Procedures

Describe how the various Turkey Point configuration management and change control procedures will be implemented together to ensure compliance with NFPA 805 change evaluation and configuration control requirements.

RESPONSE:

As stated in the response to PTN RAI Programmatic 02 changes will be made to various procedures to ensure that the NFPA 805 fire protection program is maintained in accordance with NFPA 805 requirements. All the required procedure changes will be coordinated such that the configuration control requirements for NFPA 805 will be met. Specifically, the change control process defined in FAQ 12-0061 (when approved) will be adopted. This provides for screening all changes that affect the fire protection program and for the creation of fire risk change evaluations for changes that do not screen out in the screening process. The current configuration control processes will be revised to incorporate any changes required by FAQ 12-0061 and any other changes required to meet the requirements of NFPA 805.

As stated in PTN RAI Programmatic 02 the following procedures are anticipated to be revised in addition to the screen/change evaluation procedure.

- EN-AA-100, Engineering Design Control
- EN-AA-205-1100, Design Change Package
- EN-AA-105-1000 PRA Configuration Control and Model Maintenance
- EN-AA-104-1002, Fire Protection Configuration Control (New procedure)

Turkey Point RAI PROG 06 – Combustible Controls

Describe how the combustible loading program will be administered to ensure that fire PRA assumptions regarding combustible loading are met.

RESPONSE:

No specific assumptions are made with respect to combustible loading in the fire PRA. However, for transient combustibles, a reduced heat release rate is applied for those areas where strict transient controls are implemented.

Strict, mandatory administrative controls are being implemented in several areas at Turkey Point that will limit both the size and frequency of transient fires in these areas. The justification for the use of a 69 kW HRR for these areas comes from the significantly reduced fire size expected given the zero transient control. This type of transient control is a newly imposed criterion that will require a monitoring program to address future adherence to the requirements. Additional bases for the use of the 69 kW HRR are provided below:

- PTN is implementing additional administrative controls such as a fire watch for conditions in which transients are stored in these areas.
- Areas that have transient administrative controls will not have stock piles of paper, cardboard, scrap wood or trash stored in these areas.
- The transient fire heat release rate distribution specified in NUREG/CR 6850 (Reference 5) as a 317 kW (300 Btu/s) 98th percentile peak heat release rate fire is considered to be generically applicable to nuclear power plants. The PTN plant does not differ in any significant manner with respect to its transient combustible controls to warrant a significant increase or decrease in the applicable heat release rate profile. However, for areas that have been designated as "no transient combustible areas", to address the potential for violation of these controls, a 69 kW (65 Btu/s) 98th percentile peak heat release rate fire was applied. This heat release rate is considered appropriate given the unlikely event that transients are stored in these areas contrary to the controls imposed. The 69 kW (65 Btu/s) heat release rate was defined based on the heat release rate specified in NUREG/CR-6850 for a motor fire given that the most likely transient fire in a zone with limited transients would be associated with temporary cabling since this configuration would provide both the ignition source (energized temporary cabling) and combustible (cable insulation). The motor configuration would resemble such a transient fire. Monitoring of the controls and evaluation of their effectiveness will provide a basis for assessing the appropriateness of this HRR as will the monitoring of other transient fires at PTN and industry wide with respect to the use of the nominal 317 kW (300 Btu/s) peak heat release rate transient fire.
- A letter dated September 27, 2011, from NEI to NRC, B. Bradley to D. Harrison, "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," allows a lower heat release rate to be chosen for transient fires to screen for specific fire based on "the specific attributes and

considerations applicable to that location." The letter suggests 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.". The use of this method was endorsed by the June 21, 2012 letter from the NRC to NEI (ML12171A583), with minor exceptions unrelated to the PTN treatment.

PTN RAI PROG 07 - Process and Plans to Comply with NFPA 805 Section 2.7.3

Describe Turkey Point's process and plans for conducting future NFPA 805 analyses in accordance with each of the requirements of NFPA 805 Section 2.7.3, Compliance with Quality Requirements.

RESPONSE:

Currently fire protection is classified as "quality related" by EN-AA-203-1102 "Safety Classification". Under NFPA 805 fire protection will continue to be classified as "quality related". Engineering Design Control (ENG-QI-1.0) requires that all safety related and quality related engineering products be independently verified and be prepared by a competent engineer. The qualification requirements for engineers are maintained through JB ENG-002. ENG-QI-1.5, "Calculations" requires that all calculations be verified. The above referenced documents will be revised as necessary to capture any additional requirements in NFPA 805 Section 2.7.3 not already covered by the existing procedures.

PTN RAI RR 03

For areas where containment/confinement is not available, verify that the administrative controls ensure that there is no offsite release, or that the offsite release will not result in doses in excess of the limits in 10 CFR 20.

RESPONSE:

PTN performed a bounding analysis for the RCA-Outdoors/Yard compartment. Calculations using the methodology defined in the Turkey Point Offsite Dose Calculation Manual were performed. The worst-case source term was determined to be the largest curie containing Sea-Land trailer of dry active waste (DAW) shipped in 2012. The calculation assumed that the Sea-Land trailer, stored in the Radiological Control Area prior to shipment offsite, caught on fire and the radioactive contents were washed into the Cooling Canal System. The analysis determined that no release rate or dose limits were exceeded due to a fire of this container.

The analysis also evaluated the impact of airborne releases due to a fire of the same trailer of DAW. The results of the analysis determined that if the contents of the trailer were to go airborne and drift with the wind to an area outside the site boundary no dose limits would be exceeded.