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June 28, 2013

Serial: BSEP 13-0066

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

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Docket Nos. 50-325 and 50-324
Response to Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805 (NRC TAC Nos. ME9623 and ME9624)

References:

1. Letter from Michael J. Annacone (Carolina Power & Light Company) to U.S. Nuclear Regulatory Commission (Serial: BSEP 12-0106), *License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)*, dated September 25, 2012, ADAMS Accession Number ML12285A428

2. Letter from Michael J. Annacone (Carolina Power & Light Company) to U.S. Nuclear Regulatory Commission (Serial: BSEP 12-0140), *Additional Information Supporting License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)*, dated December 17, 2012, ADAMS Accession Number ML12362A284

3. Letter from Christopher Gratton (USNRC) to Michael J. Annacone (Carolina Power & Light Company), *Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805 (TAC Nos. ME9623 and ME9624)*, dated May 15, 2013, ADAMS Accession Number ML13123A231

Ladies and Gentlemen:

By letter dated September 25, 2012 (i.e., Reference 1), as supplemented by letter dated December 17, 2012 (i.e., Reference 2), Duke Energy Progress, Inc., formerly known as Carolina Power & Light Company, submitted a license amendment request to adopt a new risk-informed performance-based (RI-PB) fire protection licensing basis for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2.

During the week of April 8 through April 12, 2013, the NRC conducted an audit at BSEP to support development of questions regarding the license amendment request. On May 15, 2013 (i.e., Reference 3), the NRC provided a set of requests for additional information (RAIs) regarding the license amendment request. That letter divided the RAIs into 60-day, 90-day, and

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120-day responses. In subsequent telephone calls with the NRC Project Manager for BSEP, the following modifications were agreed to regarding the RAI response schedule shown in the May 15, 2013, letter:

- The 60-day RAI responses will be submitted by July 1, 2013 (i.e., 60 days following the May 2, 2013, clarification call that was conducted with the NRC). Probabilistic Risk Assessment (PRA) RAIs 1A, 1B, 1C, 1D, 1F, 1G, 1I, 1K, 1N, 1O, 1P, 1Q, 1R, 4, 5, 9, 10, 17, and 18, which were included in the set of 60-day RAIs, will be addressed in a separate submittal due by July 15, 2013 (i.e., 60 days following the date of the letter).
- The 90-day RAI responses will be submitted by July 31, 2013 (i.e., 90 days following the May 2, 2013, clarification call). Fire Protection Engineering RAI 1, which was included in the set of 60-day RAIs, will be addressed as part of the 90-day RAI responses.
- The 120-day RAI responses will be submitted by August 30, 2013 (i.e., 120 days following the May 2, 2013, clarification call). PRA RAI 1H will be addressed as part of the 120-day RAI responses, rather than with the 60-day RAI responses.

A tabulation of the individual RAIs and the planned response submittal dates is provided in Enclosure 1. Duke Energy's response to the 60-day RAIs are provided in Enclosure 2. A list of regulatory commitments contained in this letter are provided in Enclosure 3.

Please refer any questions regarding this submittal to Mr. Lee Grzeck, Manager – Regulatory Affairs, at (910) 457-2487.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on June 28, 2013.

Sincerely,

George T. Hamrick

George T. Hamrick

Enclosures:
1. Revised Response Schedule to NFPA 805 Request for Additional Information
2. Response to Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805
3. List of Regulatory Commitments

WRM/wrm

cc (with enclosures):

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Revised Response Schedule to NFPA 805 Request for Additional Information

Revised Response Schedule		
Section Title	**Question Number(s)**	**Submittal Date**
60-Day Response - Non-PRA		
Programmatic	1, 2, 3, 4, 5, 6, 7	July 1, 2013
Safe Shutdown Analysis	3, 4, 6, 7, 8, 10, 12	
Fire Modeling	1A, 1E, 1F, 1G, 1H, 2A, 2B, 5A, 5B	
60-Day Response – PRA		
Probabilistic Risk Assessment	1A, 1B, 1C, 1D, 1F, 1G, 1I, 1K, 1N, 1O, 1P, 1Q, 1R, 4, 5, 9, 10, 17, 18	July 15, 2013
90 Day Response		
Radiation Release	1, 2, 3	July 31, 2013
Fire Protection Engineering	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21	
Safe Shutdown Analysis	1, 2, 5, 9, 11, 13, 14	
Probabilistic Risk Assessment	1J, 1M, 2, 3, 6, 7, 11, 12, 13, 14, 15, 16	
Fire Modeling	1B, 2C, 5C	
120 Day Response		
Fire Protection Engineering	2	August 30, 2013
Safe Shutdown Analysis	15	
Probabilistic Risk Assessment	1E, 1H, 1L, 8	
Fire Modeling	1C, 1D, 1I, 2D, 3, 4, 6	

Response to Request for Additional Information Regarding Voluntary Risk Initiative National Fire Protection Association Standard 805

By letter dated September 25, 2012, as supplemented by letter dated December 17, 2012, Duke Energy Progress, Inc., formerly known as Carolina Power & Light Company, submitted a license amendment request (LAR) to adopt a new risk-informed performance-based (RI-PB) fire protection licensing basis for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2.

During the week of April 8 through April 12, 2013, the NRC conducted an audit at BSEP to support development of questions regarding the license amendment request. On May 15, 2013, the NRC provided a set of requests for additional information (RAIs) regarding the license amendment request. That letter divided the RAIs into 60-day, 90-day, and 120-day responses. In subsequent telephone calls with the NRC Project Manager for BSEP, the following modifications were agreed to regarding the RAI response schedule shown in the May 15, 2013, letter:

- The 60-day RAI responses will be submitted by July 1, 2013 (i.e., 60 days following the May 2, 2013, clarification call that was conducted with the NRC). Probabilistic Risk Assessment (PRA) RAIs 1A, 1B, 1C, 1D, 1F, 1G, 1I, 1K, 1N, 1O, 1P, 1Q, 1R, 4, 5, 9, 10, 17, and 18, which were included in the set of 60-day RAIs, will be addressed in a separate submittal due by July 15, 2013 (i.e., 60 days following the date of the letter).
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Duke Energy's response to the 60-day RAIs are provided below.

Programmatic Requests for Additional Information

Programmatic RAI 1

Describe the specific documents that will comprise the post transition NFPA 805 fire protection program licensing basis.

Describe whether documents, analyses, designs, and engineering reviews prepared to support the NFPA 805 fire protection program are managed as controlled documents under the document control process.

Response

The Fire Protection licensing basis documents under NFPA 805 consist of the following:

- The Transition Report/LAR
- The NFPA 805 Safety Evaluation
- The revised License Condition
- The revised Updated Final Safety Analysis Report (UFSAR)

The Fire Protection Program Design Basis Documents (DBDs) will contain, or reference, sub-tier documents that form part of the fire protection program. The DBDs, as described in NFPA 805 Section 2.7.1.2, are the Fire Safety Analysis (FSA) calculations provided for each plant fire area. Also included is the NFPA 805 Code Compliance Calculation, which will maintain certain supporting elements of the LAR such as Tables B-1, B-2, and E-1. These and other supporting calculations are developed under fleet procedure EGR-NGGC-0017, *Preparation and Control of Design Analyses and Calculations*, and are maintained as design documents/controlled documents as described in the procedure.

Programmatic RAI 2

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

Response

BSEP and Nuclear Generation Group fleet engineering personnel (i.e., design, programs, and systems engineering) are provided training commensurate with the job responsibility through the Institute of Nuclear Power Operations (INPO) accredited Engineering Support Personnel (ESP) training program. This is provided in either ESP Continuing Training or Work Group Specific Continuing Training. Specific qualification for performance of the FIR-NGGC-0010, *Fire Protection Program Change Process*, is documented using Training Guide (i.e., Qualification Card) ESG0102N, *Fire Protection Plant Change Impact Review*.

Programmatic RAI 3

Describe how the various configuration control and change control procedures are implemented together to ensure compliance with NFPA 805 change evaluation and configuration control requirements.

Response

Configuration control is and will be maintained going forward, in accordance with existing procedures and processes, which satisfy the NFPA 805 requirements. Procedure FIR-NGGC-0010, *Fire Protection Program Change Process*, provides review of configuration, process, and procedure changes to ensure applicable requirements of NFPA 805 Fire Protection Program (i.e., Fundamental Elements, Nuclear Safety Capability Assessment (NSCA), Non-Power Operations (NPO), Radioactive Release and Fire Probabilistic Risk Assessment (FPRA)) are maintained.

Programmatic RAI 4

Describe how the combustibles loading program will be administered to ensure that the Fire Probabilistic Risk Assessment assumptions regarding combustibles loading are met.

Response

Fleet procedure FIR-NGGC-0009, NFPA 805 *Transient Combustibles and Ignition Source Controls Program*, provides administrative controls in accordance with NFPA 805 Chapter 3 requirements, in support of applicable assumptions contained in the Fire Probabilistic Risk Assessment, and evaluations contained in applicable Fire Safety Analyses (FSAs).

Programmatic RAI 5

LAR Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," does not indicate whether future NFPA 805 analyses will be conducted in accordance with the requirements of NFPA 805, Section 2.7.3. Indicate whether future NFPA 805 analysis will be conducted in accordance with NFPA 805, Section 2.7.3.

Response

As stated in Section 4.7.3 of the BSEP LAR:

> CP&L will maintain the existing fire protection quality assurance program.
>
> During the transition to 10 CFR 50.48(c), BSEP performed work in accordance with the quality requirements of Section 2.7.3 of NFPA 805.

Additionally, any future NFPA 805 analyses will be conducted in accordance with the Quality Requirements described in NFPA 805, Section 2.7.3, under the design controls in place and required by the Fire Protection portions of the NGGM-PM-0007, *Quality Assurance Program Manual*.

Programmatic RAI 6

NEI 04-02 Section 4.6 indicates that the LAR should contain a "discussion of the changes to Updated Final Safety Analysis Report (UFSAR) necessitated by the license amendment and a statement that the changes will be made in accordance with 10 CFR 50.71(e)." LAR Section 5.4 indicates that after approval of the LAR, the UFSAR will be revised consistent with NEI-04-02; however, there is no description of the changes that need to be made to the current UFSAR. Describe the changes that will to be made to the current UFSAR as a result of implementing

NFPA 805. Alternatively, indicate whether the UFSAR will be updated following the guidance provided in Frequently Asked Question (FAQ) 12-0062 (ADAMS Accession No. ML121980557).

Response

Duke Energy will revise applicable portions of the UFSAR related to Fire Protection under NFPA 805, using the guidance contained in FAQ 12-0062. This will occur during the implementation phase described in LAR Section 5.5. Changes to the UFSAR are controlled under procedure REG-NGGC-0101, *Final Safety Analysis Report Revisions.*

Programmatic RAI 7

Describe how the plant specific requirements and configuration are incorporated when corporate or fleet wide procedures are implemented at the Brunswick plant.

Response

Review and approval of corporate or fleet-wide procedures applied to BSEP are controlled under PRO-NGGC-0204, *Procedure Review and Approval.* Site-specific impact and technical reviews are completed under this process to ensure each individual plant's requirements and configurations are incorporated and maintained.

Safe Shutdown Analysis Requests for Additional Information

SSA RAI 3

Attachment S, Table S-1 Item #10 of the LAR currently lists a modification to "address valve pressure boundary issues due to fire induced spurious actuations." The Table S-1 states "evaluate and modify valves, as necessary, to address pressure boundary concerns due to fire induced spurious actuations. Perform a study for the extent of condition for valves of concern." Attachment S, Table S-2, Implementation Item #8, of the LAR addresses a study to evaluate the extent of condition related to spurious operation of pressure boundary valves. Describe how these components are included in the nuclear safety capability assessment (NSCA) and how they are subsequently treated in the fire probabilistic risk assessment (FPRA). Describe the scope, methods, and implications for impact to NSCA and FPRA of this study.

Response

Motor-operated valves in the safe shutdown equipment list were evaluated for loss of function and pressure boundary failure following spurious operation prior to any transfer to a remote operating station, if applicable. The NSCA identified functional failures of the valves as variances from the deterministic requirements (VFDRs) and they were resolved using the risk-informed performance-based approach in the FPRA.

Potential pressure boundary failures were evaluated at the system level using the NSCA on a fire area-by-fire area basis rather than in the FPRA. Any fire affected valve whose pressure boundary failure would conflict with the ability to achieve and maintain safe and stable conditions was subjected to a weak link analysis and modification, if appropriate. The screening of valves subject to spurious operation caused by fire induced cable damage only used the insights of the FPRA and the results of the NSCA as inputs to the study.

The modification study focuses on those valves subject to the weak link analysis with negative structural margin due to stall thrust. Available options to resolve those valves with issues include:

- Protect the target cable(s) with appropriately rated Electrical Raceway Fire Barrier System (ERFBS),
- Replace the target cable(s) with a fire rated cable,
- Reroute the target cable(s) outside of the fire area or the zone of influence of any ignition source,
- Ensure that the target cables are in dedicated conduit, thereby removing the possibility of inter-cable hot shorts,
- De-energize the valve during normal plant operation,
- Replace the motor, operator, or alter the gear ratio to reduce the stall thrust,
- Replace the valve with a stronger design, or
- Install stronger weak link pressure boundary subcomponents in the valve.

Based on the resolution chosen, the NSCA will be updated accordingly.

SSA RAI 4

Attachment B, Table B-2, Section 3.1.1.9, of the LAR, (72-hour coping), indicates that the alternate shutdown methodology ensures cold shutdown can be achieved in 72 hours, including repairs. However, the cold shutdown actions including repairs are not identified as variances from deterministic requirements (VFDRs). It also states that the analysis may be modified in the future because National Fire Protection Association Standard 805 "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, (NFPA 805) does not have a cold shutdown requirement. Section 4.2.1.2 of the LAR indicates that based on the criteria discussed in the NCSA calculation for safe shutdown, the NFPA 805 licensing basis is to achieve and maintain hot shutdown conditions following any fire occurring prior to establishing cold shutdown. This appears to include cold shutdown as part of the "safe and stable" plant condition being achieved, which would require actions and repairs necessary to be addressed as VFDRs. Describe the plant mode that the operator is attempting to achieve and maintain for safe and stable. NFPA 805 requires the plant to achieve and maintain safe and stable conditions. Provide additional information that would justify not identifying VFDRs for an analysis that "ensures cold shutdown can be achieved in 72 hours."

Response

The NSCA has shown that there are no fire scenarios for BSEP that would require that the plant achieve cold shutdown to meet any nuclear safety performance goals, so the continuation of Reactor Coolant System (RCS) cooldown beyond hot shutdown conditions is not a prerequisite for establishing safe and stable conditions. Notably, options following the establishment of hot shutdown may include achieving cold shutdown conditions at some unspecified time for reasons of operational convenience or as a result of decreasing decay heat. Since achieving and maintaining cold shutdown within 72 hours, or any other specific time frame, is not a licensing commitment under Section 4.2.3 of NFPA 805, any recovery actions that may be needed are not identified as VFDRs. For BSEP, the operator is attempting to achieve safe and stable conditions in hot shutdown (i.e., RCS > 212° F with the reactor shutdown) by inserting control rods, establishing either high pressure injection, using High Pressure Coolant Injection (HPCI) or Reactor Core Isolation Cooling (RCIC), or low pressure injection through the use of Core Spray or Residual Heat Removal (RHR) in Low Pressure Coolant Injection (LPCI) Mode. Long term decay heat removal to the ultimate heat sink is assured by aligning the Service Water System to support suppression pool cooling. Also, the operator will establish a reliable AC power source originating either on or off-site.

Attachment B, Table B-2, Section 3.1.1.9, of the LAR will be revised to clarify the BSEP position concerning the requirements of Section 3.1.1.9 of NEI 00-01 and the safe and stable conditions required by NFPA 805. The updated Attachment B of the LAR will be provided in conjunction with the 120-day set of RAI responses.

SSA RAI 6

Attachment B, Table B-2, Section 3.5.2.1, of the LAR for current transformer open circuit potential of secondary fires, indicates that analysis of open circuits on high voltage (e.g., 4.16 kilo-volt (kV) ammeter current transformers was completed, and the final disposition of this potential fire scenario is assessed as part of the analysis. Section 4.2.1.1 of the LAR states that the evaluation concludes that this failure mode is unlikely for control transformers (CTs) that could pose a threat to safe shutdown equipment. Describe a more specific description and justification of this conclusion, and include the aspects of secondary fires that may be created and subsequently impact the NSCA. Provide the analysis method and provide the outcome for damage to the safe shutdown (SSD) equipment where the CT is mounted. If fire models were performed to satisfy resolution of fire area failures, then provide verification and validation (V&V) information in Attachment J of the LAR.

Response

For the NSCA, the following determinations were made concerning secondary CT fires:

1. Secondary fires due to open circuits on the secondary windings of CTs with a turns ratio of ≤ 1200:5 were not considered plausible (i.e., NUREG/CR-7150, *Joint Assessment of Cable Damage and Quantification of Effects from Fire (JACQUE-FIRE)*).
2. For CTs > 1200:5, secondary fires are unlikely and any damage would be confined to the affected switchgear containing the CT. For all potential fires on high ratio CTs, the adverse affects will be limited to internal CT damage and no further adverse effects are expected to occur as a result of the open circuit condition. These conclusions are consistent with those of NUREG/CR-7150.
3. For safe shutdown equipment, secondary CT cables were identified as required, so any potential damage resulted in an assumed failure of the switchgear/component.

Since the criteria above were used to successfully resolve issue of CT fires on a fire area basis, fire modeling and any associated V&V activities were not required.

SSA RAI 7

For breaker fuse coordination, describe whether cable length was considered as additional impedance in the study necessary to meet maximum available short circuit current. Alternating current (AC) and DC coordination procedure (EGR-NGGC-0106) indicates that the impedance length of the cable can be 10 feet or 10 percent (%) of the cable length (whichever is less), or longer where justified. If this qualification was used, describe how this length was factored into the potential impact to the FPRA. For establishing targets in the zone of influence (ZOI) describe how cable lengths were considered and provide any justifications required for the FPRA.

Response

Cable length impedance was credited in the fault current calculations where needed to demonstrate coordination with upstream power supply breakers in the FPRA. The identification of potential ignition sources for which coordination could not be assumed first required establishing the minimum length of cable that provided adequate impedance to coordinate the circuit with the greatest potential fault current. Added conservatism was provided by applying this length to all of the load cables on the power supply. Then, a controlled database containing both the cable to raceway relationships and physical raceway data identified those raceways which contained power cables within the minimum length criteria. Available fire zone to raceway correlations in conjunction with source-target walkdown data ultimately provided a conservative list of all possible ignition sources within these fire zones for which the power supply was assumed to not coordinate. Finally, these power supplies were added to FPRA scenarios where the identified cable routing is a target in the ZOI. In cases of hot gas layer, loss of the power supply was added to FPRA scenarios if the credited cable length is within the compartment being considered for hot gas layer.

SSA RAI 8

The LAR did not appear to include table entries for ERFBS by fire area. Provide a list of fire areas that rely on ERFBS for compliance with NFPA 805. Additionally provide the reason(s) for relying on the ERFBS.

Response

ERFBS was credited for defense-in-depth, but not for risk reduction, in Fire Area DG-8. There are no fire areas where installed ERFBS constitute a VFDR. The required systems table in Attachment C will be updated to note that ERFBS was credited for defense-in-depth in Fire Area DG-8, including a descriptive basis for retaining it under the NFPA 805 licensing basis. The discussion in Attachment C under "Fire Area Comments" in the B-3 Table for Fire Area DG-1, that suggests that fire resistant wraps are credited, will be deleted since it refers to historical pre-transition information that is no longer applicable. An updated Attachment C of the LAR will be provided in conjunction with the 120-day RAI responses.

SSA RAI 10

Attachment C, Fire Areas RB1-1 and RB2-1 of the LAR are evaluated using both deterministic (4.2.3) and performance-based (4.2.4) methods in the same fire areas. Provide additional explanation to provide a better understanding of the approach in these areas. These areas are also identified as having recovery actions (RAs). NFPA 805 excludes the ability to classify an area as deterministically compliant with RAs. Justify the use of RAs in what appears to be deterministically compliant areas. Provide only one strategy for each fire area. Include any other fire areas which are concurrently represented as compliant with both deterministic and performance-based strategies.

Response

BSEP does not credit recovery actions in any fire areas that meet the deterministic requirements of NFPA 805, Section 4.2.3.

The post transition licensing basis for both Fire Areas RB1-1, Unit 1 and RB2-1, Unit 2 is *NFPA 805, 4.2.4 Risk Informed Performance Based Approach with Deterministic Methods for Simplifying Assumptions* for the fire affected unit. Accordingly, Attachment C of the LAR will be clarified to show a single post-transition licensing basis for RB1-1, Unit 1 and RB2-1, Unit 2. An updated Attachment C of the LAR will be provided in conjunction with the 120-day RAI responses. Because the fire impact on each unit at a multiple unit facility may be different due to the scope of equipment in a particular fire area, the NFPA 805 fire area compliance basis may be different for the other unit (e.g., RB1-1, Unit 2 and RB2-1, Unit 1 may still be deterministic under Section 4.2.3).

SSA RAI 12

Attachment G of the LAR under the heading, "Results of Step 4," contains an incomplete reference to the feasibility assessment as follows, "...contained in Change Package BNP-." Provide the complete reference.

Response

The complete reference is "Change Package BNP-0246."

Fire Modeling Requests for Additional Information

Fire Modeling RAI 1A

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 jurisdiction] ..." The NRC staff noted that fire modeling comprised the following:

- The Generic Fire Modeling Treatments (GFMTs) approach was used to determine the ZOI for transient and oil spill fires in all fire areas throughout plant
- Fire Dynamics Tools (FDT's) were used for ZOI calculations of cabinet and cable tray fires throughout the plant
- The Consolidated Fire Growth and Smoke Transport (CFAST) model was used to calculate control room abandonment times
- Fire Dynamics Simulator used for various fire hazard calculations

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

Specifically regarding the acceptability of CFAST for the MCR abandonment times study:

a. Attachment 13 to BNP-PSA-083, Revision 2 presents a compilation of fire brigade response times from drills performed between 2002 and 2010. Of the 56 drills for which fire brigade response time data are given, 5 are for the Control Building. The response times for these drills were 20, 21, 25, 19, and 17 minutes. On page 18 of BNP-PSA-083, it is stated that the drill times are reduced by a factor of two. During the audit, it was discussed that the reduced drill times were used as the basis for the assumption in the MCR abandonment times study that the fire brigade is expected to arrive within 15 minutes. Describe the uncertainty associated with the 15-minute assumption, discuss possible adverse effects of not meeting this assumption on the results of the FPRA and explain how possible adverse effects will be mitigated.

Response

As described in Enclosure A to Attachment 16, Main Control Room Treatment, of BNP-PSA-080, *BNP Fire PRA – Quantification*, the 15-minute assumption for the arrival of the fire brigade is used in the main control room (MCR) abandonment study to define different conditions under which to evaluate the effect of opening the MCR door. This 15-minute assumption bounds the nominal fire brigade response time of 10 and 11 minutes, based on the historical fire brigade drill times and a 50% correction factor.

The correction factor considers several aspects of the drill that cause drill response times to be greater than actual response times during actual fire events. It is industry and BSEP practice that fire brigade drills incorporate a degree of training while performing an overall evaluation of the fire brigade, firefighting equipment performance, and plant administrative controls. Fire brigade drills may vary in types of response, speed of response, and use of equipment. A level of proficiency and safety is desired above simply speed of completion during drills. Another factor affecting response times during drills is delays required for compliance with security, administrative controls, radiological controls, and other barriers. During actual fire events, access/egress routes and administrative procedures are expedited for the fire brigade, further decreasing response time. Industry experience also indicates fire brigade response will quicken based on the human behavioral stimuli provided by an actual event (i.e., excitement). Finally, the time required for drill controllers to verbally describe and the fire brigade to visualize the fire conditions adds considerable time to the drill process that would not be present during an actual event.

To that extent, the nominal fire brigade response time supports the 15-minute assumption in the MCR abandonment study. Section 2.1.4 of Enclosure A to Attachment 16 of BNP-PSA-080 indicates which set of MCR abandonment results to assume based on the fire brigade arrival time. In particular, if the fire brigade arrival time is longer than 15 minutes, the results that correspond to the boundary door being always closed should be assumed. Likewise, if the fire brigade arrival time is shorter than 15 minutes, the results corresponding to the cases in which the door is opened at 15 minutes should not be credited. A sensitivity study showing this is presented in Attachment 14, Updated Risk of Recovery Actions Due to Control Room Abandonment, Section B.9, of BNP-PSA-082, *BNP Fire PRA – NFPA 805 Transition Support.*

Fire Modeling RAI 1E

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

e. Explain how the effect of the increased HRR from intervening combustibles (cable trays) on the ZOI was accounted for, or provide justification for ignoring this effect.

Response

To ensure that intervening combustibles, including non-cable intervening combustibles and cables that are not targets in the Fire PRA, are properly accounted for in the Fire Modeling analysis supporting the FPRA, two walk down project instructions are followed:

- FPIP-0200, Revision 9, *Fire PRA Walkdown Instructions*, provides specific guidance on dealing with intervening combustibles. The guidance consists of identifying the intervening combustibles within the zone of influence and capturing them in the walkdown forms. For the case of cable trays above ignition sources, all the raceways above the ignition source and up to the ceiling should be included.

- FPIP-0208, Revision 5, *Scoping Fire Modeling*, provides guidance to consider cable trays above the ignition sources up to the enclosure ceiling to prevent missing the contribution from these cable trays to the heat release rate.

The practical implications of the guidance listed in the project instructions above are that the BSE FPRA includes the contribution from two types of fire scenarios from the perspective of this RAI. These fire scenarios are:

- Those fire scenarios affecting the ignition source only. That is, there is no fire propagation outside the ignition source. No propagation outside the ignition source is due to either no intervening combustibles within the zone of influence, or credit to passive fire protection features such as solid bottom trays.

- Those fire scenarios where fire propagates throughout the zone of influence. If during walk downs, intervening combustibles (i.e., cable trays) were identified within the zone of influence, the heat release rate contribution from these combustibles was included as part of the heat release rate profile characterizing the fire scenario. The zone of influence extends to the ceiling of the physical analysis unit.

The process for determining the heat release rate associated with intervening combustibles (e.g., those cable trays within the zone of influence of an ignition source) is summarized in Section 3.2.6.2 of FPRA Calculation BNP-PSA-080. The heat release rate for the cable trays that are identified during walkdowns is calculated assuming:

1. A cable tray width of 2 feet (i.e., 0.61 m). Typical cable tray widths range from 6 inches to 3 feet wide. A 2 foot wide tray was selected to be representative for all BSEP fire zones. This is consistent with the average cable tray size as presented in NUREG/CR-6850, Section R.4.2.1.
2. Initial cable tray burning length of approximately 3 feet (i.e., 1 m). This value is representative of the fire diameter for the ignition source, which is also the length of the first tray burning in the stack.
3. A heat release rate per unit area of 180 kW/m2. This heat release rate value is slightly higher than the one recommended in NUREG/CR-7010, Cable Heat Release, Ignition, and Spread in Tray Installations During Fire (CHRISTIFIRE) Phase 1: Horizontal Trays, for thermoset/qualified cables of 150 kW/m2.
4. A vertical space between cable trays of 6 inches (i.e., 0.16 m).

Using the values listed above, the heat release rate for the cable trays is calculated as the surface area of the tray multiplied by the heat release rate per unit area. The angle of 35° described in Appendix R of NUREG/CR-6850 is used for determining the length of the cable trays in the stack above the ignition source so that the appropriate burning surface for each tray is determined.

Consequently, an additional screening process will be completed to identify ignition sources where propagating fires may result in additional risk-contributing fire scenarios. The screening process will consist of the following steps:

- Identify and screen those ignition sources where the postulated fire progresses to a "hot gas layer" scenario in a relatively short period of time (i.e., a time comparable with fire propagation throughout the zone of influence). A hot gas layer scenario is one where the full fire zone is failed when the temperature in the enclosure reaches the temperature damage threshold for the cables. Since these ignition sources already progress to full zone damage at a relatively short period of time, there is no need to evaluate the risk contribution of targets damaged by expanding zone of influences. There are a number of reasons why an ignition source will not generate hot gas layer scenarios. Some of those reasons include sealed cabinets that do not propagate fires, scenarios with solid bottom cable trays, and ignition sources with no intervening combustibles within the zone of influence. These ignition sources can be screened.
- Screen out fire scenarios where the Conditional Core Damage Probability (CCDP) (Conditional Large Early Release Probability (CLERP)) for the zone of influence scenario is 1.0. For these scenarios, propagation outside of the zone of influence is irrelevant as the CCDP (CLERP) is already 1.0.

- The fire scenarios where the ignition frequency for the "zone of influence" scenario is less than 1.0E-8 will be screened. That is, assuming a CCDP (CLERP) value of 1.0, these scenarios will present a very low risk contribution. It is therefore concluded that the hot gas layer scenario, which will be a progression of the zone of influence scenario, is expected to have an even lower frequency due to additional credit for suppression activities.
- Screen fire scenarios where the multiplication of the fire ignition frequency for the zone of influence times the CCDP (CLERP) associated with the hot gas layer scenario results in a CDF lower than 1.0E-8. That is, the ignition frequency for the zone of influence scenario times the CCDP (CLERP) of a hot gas layer scenario produces a bounding CDF value that can be used as an indicator of a propagating scenario with a relatively small risk contribution. This is the case because the propagating scenario should have a lower ignition frequency than the zone of influence one, and a CCDP (CLERP) equal or lower than the one calculated for the hot gas layer scenario.

The five additional screening steps described above will produce a list of ignition sources that are not expected to produce hot gas layer scenarios, but are able to propagate to intervening combustibles identified within the zone of influence. A bounding approach will be implemented to conservatively estimate the risk contribution (e.g., CDF, LERF) of fire scenarios consisting of targets failing outside of the original zone of influence. This approach will consist of:

1. Assigning to the fire scenario the CCDP (CLERP) associated with full damage to the fire zone. This CCDP (CLERP) is bounding as it results from failing ALL targets assigned to the fire zone, not just the additional targets that would be damaged as the fire grows out of the zone of influence. As a conservative practice, the highest CCDP from the ones calculated for both Unit 1 and Unit 2 will be selected.
2. Assigning to the fire scenario the ignition frequency associated with a similar ignition source (i.e., ignition source classified in the same fire ignition frequency bin from Chapter 6 in NUREG/CR-6850) in the fire zone that produces a hot gas layer scenario. In practice, the highest ignition frequency for the hot gas layer scenario will be selected from all the ignition sources producing such scenario in the fire zone. As a conservative practice, the highest ignition frequency from the ones calculated for both Unit 1 and Unit 2 will be selected. The ignition frequency for the hot gas layer scenarios is considered a good representation of the frequency for propagating scenarios because propagating scenarios outside the zone of influence in most cases will receive the same credit for fire suppression activities protecting targets outside the zone of influence as in hot gas layer scenarios. This credit for suppression is based on the time necessary for fire to propagate within the zone of influence, and continue burning affecting additional targets.
3. Screen from the analysis scenarios with CDF lower than 1.0E-9, as their risk contribution is negligible.

The three steps listed above will produce risk values representing a bounding risk contribution from fires propagating outside the zone of influence and damaging additional targets. This risk estimate is bounding as the CCDP (CLERP) is associated with full zone damage, and the ignition frequency is the maximum frequency calculated for hot gas layer scenarios in the same fire zone from similar ignition sources.

The sensitivity analyses for identifying impact on CDF, ΔCDF, LERF and ΔLERF is under development as some 90-day and 120-day RAIs will influence the quantification process. The results of this sensitivity analyses will be provided together with other sensitivities at the 120-day RAI responses.

Fire Modeling RAI 1F

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

f. Explain how wall and corner effects in the HGL calculations were accounted for, or provide a justification if these effects were not considered.

Response

The wall and corner effects impact the FPRA in two specific technical areas:

- Generally, the hot gas layer analysis determines the heat release rate required in individual fire zones for generating a hot gas layer scenario. The heat release rate values are used for screening the hot gas layer scenarios by comparing it with the heat release rates from individual ignition source and secondary combustible combinations. Fires along walls or in corners may require lower heat release rates to generate higher temperatures compared with fires in the open.
- The individual scenarios where the fire may propagate from the ignition sources to intervening combustibles. Wall and corner effects will increase the size of the zone of influence, which, in turn, will result in additional cable trays that could be damaged/ignited by the ignition source.

The following Sections describe in detail how the wall and corner effects are addressed in the FPRA with respect to the two above listed technical areas.

<u>Hot Gas Layer Analysis</u>

The hot gas layer analysis is described in BNP-MECH-HGL-0001, *Hot Gas Layer Calculation*. This calculation documents a process for determining the heat release rate required for generating a hot gas layer crediting the "soak time." The "soak time" is the term used in the calculation when referring to the lag time between the gas temperature surrounding a target cable and the internal cable temperature. The analysis is based on the concept that a higher heat release rate is required within a pre-defined scenario duration (e.g., 30 minutes) to fail the cables crediting the soak time, versus the heat release rate needed to simply increase the room temperature to the target damage criteria at some point within the same time period. The heat release rate necessary to raise the temperature of a cable to the critical damage level is calculated using the McCaffrey, Quintiere, and Harkleroad (MQH) or Beyler correlations described in NUREG-1805, *Fire Dynamics Tools (FDTs): Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Program.*

The analysis described above results in a percentage increase that is applied to the heat release rate necessary to raise the gas temperature to target damage level. The resulting percentages are:

- Rooms with open door (i.e., MQH room temperature model) - 14.9% for thermoset cables

- Rooms with closed doors (i.e., Beyler room temperature model) - 16.8% for thermoset cables

Consider, as an example, a physical analysis unit requiring 500 kW to raise the temperature of the room to the thermoset damage criteria of 330° C in 30 minutes. Using the percentage listed above, a heat release rate value of 500 x 1.149 = 575 kW is necessary for the scenario duration to damage the cables crediting the soak time.

The approach does not explicitly consider wall and corner effects. Specifically, the analysis does not consider potentially higher hot gas layer temperatures resulting from ignition sources located along walls or inside corners. Conceptually, consideration for these effects would result in lower heat release rates that would be needed to increase the temperature of the room to the cable damage criteria. However, there are two sources of conservatism that overcome the lack of treatment for wall and corner effects.

1. First, the analysis is based on the engineering calculations documented in NUREG-1805 (i.e., the MQH and Beyler models). As stated in Chapter 4 of NUREG-1934, *Nuclear Power Plant Fire Modeling Application Guide (NPP FIRE MAG) – Final Report*, there is inherent temperature over-predictions resulting in conservative screening heat release rate estimates. Specifically, the estimated percentages to increase heat release rate are conservative as they are lower than the heat release rates necessary to overcome the over-predictions by the MQH and Beyler models. Given that these models tend to over predict temperatures by 44% or more (From Table 4-1 in NUREG-1934), Equation 4-16 in NUREG-1934 can be used for determining the "real" heat release rate that would be necessary to reach the temperature predictions by these models. Accordingly,

$$0.44 = \frac{2}{3}\frac{\Delta\dot{Q}}{\dot{Q}}$$

   where the term $\Delta\dot{Q}/\dot{Q}$ is the percentage increase in the heat release rate necessary to reach the 44% over-predicted temperature. Solving for $\Delta\dot{Q}/\dot{Q}$, the value is 66%. In other words, the heat release rate value resulting from an analysis using the room temperature models mentioned earlier would need to be increased by 66% so that the over-predicted temperatures are observed in the room.

2. Second, the hot gas layer analysis has been developed reducing the room height for each physical analysis unit by 6 feet. In practice, the height reduction has the effect of reducing the volume for the physical analysis unit, which in turn results in lower heat release rates than those that would be needed to raise the room temperature to damaging levels.

Using Fire Compartment FC212 (CB-07) as an example, this physical analysis unit has some ignition sources in corners and along walls. Per BNP-MECH-HGL-0001, the floor area for this zone is 945 square feet and the height is 14.2 feet.

- The hot gas layer screening heat release rate value is 1587 kW. This value was calculated assuming a ceiling height of 14.2 – 6 = 8.2 ft. The Beyler hot gas layer model for closed rooms suggests a heat release rate necessary for cable damage of 1359 kW, which is multiplied by 1.168 to account for the heat soak time. Therefore, 1359 kW x 1.168 = 1587 kW.

- Considering a fire located in a corner, with the adjusted ceiling height of 8.2 ft, the heat release rate is estimated to be 968 kW. Considering the 66% heat release rate increase to that would be needed to reach the critical temperature accounting for the model uncertainty, the heat release rate that would actually be necessary is 968 kW x 1.66 = 1,607 kW.
- The heat release rate value calculated in a similar way for the actual room height of 14.2 feet is 2004 kW.
- Considering a fire located in a corner, with the adjusted ceiling height of 14.2 feet, the heat release rate is estimated to be 1,085 kW. Considering the 66% heat release rate increase to that would be needed to reach the critical temperature accounting for the model uncertainty, the heat release rate that would actually be necessary is 1,085 kW x 1.66 = 1,801 kW.

Since the corner fires bound the heat release rate associated with fires along walls, it is concluded that both sources of conservatism bound the lack of explicit treatment of wall and corner effects in the determination of screening hot gas layer values. In the example above, the resulting value used in the analysis of 1587 kW is lower than any value estimated for corner configurations and corrected for the over-predictions associated with the room temperature models. This lower heat release rate value ensures that wall and corner scenarios will not be inappropriately screened for hot gas layer scenarios.

Individual Fire Scenarios

For the case of individual fire scenarios, wall and corner effects are considered in the development of the zone of influence that is used for determining which cable trays are ignited by the ignition source. Corresponding zone of influences for wall and corner fires are documented in FPIP-0200, *Fire PRA Walk down Instructions*, and FPIP-0208, *Scoping Fire Modeling*. Accordingly, cable trays identified in the zone of influence for ignition sources located along walls and inside corners are considered ignited and the heat release rate contribution from cable fires is added to the ignition source to determine if a hot gas layer scenario can develop.

Summary

The wall and corner effects impact the FPRA in two specific areas: in the calculation of heat release rate screening values and the determination of which cable trays are within the zone of influence of ignition sources along walls or in corners. The BSEP FPRA addresses the wall and corner effects in both of the areas. That is:

- Screening heat release rate values are low enough so that fires starting along walls and in corners would not inappropriately screen out for hot gas layer scenarios, and
- The zone of influence for fires in corners and along walls is appropriately expanded so that the cable trays within the zone of influence are considered as intervening combustibles in the calculation of heat release rates.

Fire Modeling RAI 1G

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

g, The FPRA Walkdown Instructions indicate that generally a 3' x 3' footprint was assumed for transient combustibles, and that the vertical ZOI was measured from the floor (see page 8 of FPIP-200, Rev. 8). Actual transient fires may have a smaller area and their base may be elevated above the floor. Provide justification for the transient fire areas and elevations that were assumed during the walkdowns. Explain how deviations from these assumptions (i.e., smaller actual transient fire area and/or higher transient fire base elevation) affect the risk (CDF, ΔCDF, LERF and ΔLERF).

Response

Two factors that affect the zone of influence assigned to the transient fires are fire diameter and fire elevation.

The practical implementation of the project instructions, as shown on page 8 of the current revision of FPIP-200 (i.e., FPIP-200, Revision 9) is as follows. The footprint of 3 foot by 3 foot is set as a minimum floor area spatial place holder for where a transient fire can be located. Larger footprints are used when applicable, but the minimum area is 3 foot by 3 foot.

During the plant walkdowns conducted during the development phases of the FPRA, the applicable floor area for the transient scenario is recorded. This floor area represents the portion of the floor where a transient fire has the potential of affecting a common set of targets. There are many scenarios where the recorded floor area is larger than the 3 foot by 3 foot minimum as evidenced in Attachment 6 of BNP-PSA-086, *Fire Scenario Data* (i.e., walk down data tables). Consider, as an example, the following transient ignition sources:

- Source 9627, with a footprint of 204 inches by 36 inches
- Source 9643, with a footprint of 180 inches by 60 inches

The above listed ignition sources are only two examples among many transient fires with corresponding floor areas larger than the 3 foot by 3 foot footprint. The floor area recorded during walk downs is used for determining the floor area ratio (i.e., geometry factor), which apportions the transient fire ignition frequency assigned to the physical analysis unit to specific fire scenarios.

The diameter used in the fire modeling calculation for determining the vertical zone of influence was approximately 1 foot. Notice that this value is not based on the floor area selected during the walkdowns. The minimum vertical distance used as a zone of influence for transient fires is 8 feet (i.e., see HNP-M/MECH-1129, *Zone of Influence Calculation*, Table 4-1, for thermoset for the 317 kW case), based on:

- an open fire configuration (i.e., fires away from walls and corners),
- a fire diameter of approximately 1 foot (i.e., see HNP-M/MECH-1129, Attachment 4, page 5 of 16, D = 0.34 m ~ 1 foot), and
- the 98th percentile value for transient fires of 317 kW (i.e., from Appendix G in NUREG/CR-6850).

This relatively small diameter is intended to be conservative, as larger diameters will result in smaller vertical zone of influences. If a 3 foot by 3 foot footprint was used, the vertical zone of influence would decrease to 5.7 feet (i.e., from solving the 09_PLUME_TEMPERATURE_CALCULATION FDT tool available in NUREG-1805 with a 317 kW fire, an area of the combustible fuel of 9 square feet and a vertical distance above the target of 5.7 feet, which results in a 328° C plume temperature). A 3 foot by 3 foot footprint is equivalent to a fire diameter of approximately 3.3 feet. Therefore, the selection of fire diameter value of 1 foot for the zone of influence calculation is equivalent to placing the base of the transient fire 2.3 feet off the ground. Under this approach, the impact on CDF, ΔCDF, LERF and ΔLERF is minimal as elevated fires with diameters of up to 3.3 feet can be postulated up to 2.3 feet above the ground without impacting the current transient fire scenario selection scheme.

Transient fires are assumed on the floor to present the location of small trash receptacles and combustible materials brought into the zone on a temporary basis. This assumption is supported by FIR-NGGC-0009, *NFPA 805 Transient Combustibles and Ignition Source Controls Program*, Revision 4. FIR-NGGC-0009, Section 9.1.13 specifies that adequate clearance, free of combustible material, shall be maintained around energized electrical equipment. In addition, Section 9.2.1.3 lists distances of 6 feet and 8 feet as clearances for conduit and cable trays. These distances are fully consistent with the zone of influence used for Fire PRA for selecting transient fire scenarios. The Fire PRA is supported by plant operations as governed by the combustible and ignition source control program through FIR-NGGC-0009.

Fire Modeling RAI 1H

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

h. Address how it was assured that cables not credited in the PRA and non-target and non-cable intervening combustibles were not missed in all areas of the plant. Provide information on how intervening combustibles were identified and accounted for in the fire modeling analyses.

Response

To ensure that intervening combustibles, including non-cable intervening combustibles and cables that are not targets in the fire PRA, are properly accounted for in the fire modeling analysis supporting the FPRA, two walkdown project instructions are followed:

- FPIP-0200, Revision 9, *Fire PRA Walkdown Instructions*. This procedure provides specific guidance on dealing with intervening combustibles. The guidance consists of identifying the intervening combustibles within the zone of influence and capturing them in the walkdown forms. For the case of cable trays above ignition sources, all the raceways above the ignition source and up to the ceiling should be included.

- FPIP-0208, Revision 5, *Scoping Fire Modeling*. This procedure provides guidance to consider cable trays above the ignition sources up to the enclosure ceiling to prevent missing the contribution from these cable trays to the heat release rate.

The practical implications of the guidance listed in the project instructions above are that the BSEP FPRA includes the contribution from two types of fire scenarios from the perspective of this RAI. These fire scenarios are:

- Those fire scenarios affecting the ignition source only. That is, there is no fire propagation outside the ignition source. No propagation outside the ignition source is due to either no intervening combustibles within the zone of influence, or credit to passive fire protection features such as solid bottom trays.

- Those fire scenarios where fire propagates throughout the zone of influence. If during walkdowns, intervening combustibles (i.e., cable trays) were identified within the zone of influence, the heat release rate contribution from these combustibles was included as part of the heat release rate profile characterizing the fire scenario. The zone of influence extends to the ceiling of the physical analysis unit.

The process for determining the heat release rate associated with intervening combustibles (e.g., those cable trays within the zone of influence of an ignition source) is summarized in Section 3.2.6.2 of FPRA Calculation BNP-PSA-080. The heat release rate for the cable trays that are identified during walkdowns is calculated assuming:

1. A cable tray width of 2 feet (i.e., 0.61 m). Typical cable tray widths range from 6 inches to 3 feet wide. A 2 foot wide tray was selected to be representative for all BSEP fire zones. This is consistent with the average cable tray size presented in NUREG/CR-6850, Section R.4.2.1.

2. Initial cable tray burning length of approximately 3 feet (i.e., 1 m). This value is representative of the fire diameter for the ignition source, which is also the length of the first tray burning in the stack.

3. A heat release rate per unit area of 180 kW/m^2. This heat release rate value is slightly higher than the one recommended in NUREG/CR-7010 for thermoset/qualified cables of 150 kW/m^2.

4. A vertical space between cable trays of 6 inches (0.16 m).

Using the values listed above, the heat release rate for the cable trays is calculated as the surface area of the tray multiplied by the heat release rate per unit area. The angle of 35° described in Appendix R of NUREG/CR-6850 is used for determining the length of the cable trays in the stack above the ignition source so that the appropriate burning surface for each tray is determined.

Fire Modeling RAI 2A and 2B

NFPA 805, Section 2.5, requires damage thresholds be established to support the performance-based approach. Thermal impact(s) must be considered in determining the potential for thermal damage of structures, systems, or components. Appropriate temperature and critical heat flux criteria must be used in the analysis.

Section 3.1.1.b of the HGL Calculation (BNP-MECH-HGL-001, Rev. 1), states that "BNP predominantly has thermoset cables so the damage criteria associated with thermoset cables has been used in this analysis."

Provide the following information:

a. Describe how installed cabling in the power block was characterized, specifically with regard to the critical damage threshold temperatures and critical heat flux for thermoset and thermoplastic cables as described in NUREG/CR-6850. If thermoplastic cables are present, explain how raceways with a mixture of thermoset and thermoplastic cables were treated in terms of damage thresholds.

b. Section 2.0 of the GFMTs document provides a discussion of damage criteria for different types of targets. Section 2.1 of the GFMTs document states: "Damage to IEEE [Institute of Electrical and Electronics Engineers] 383 qualified cables is quantified as either an imposed incident heat flux of 11.4 kW/m^2 (1 Btu/s-ft^2) or an immersion temperature of 329 °C (625 °F) per Nuclear Regulatory Guidance [NRC, 2005, NUREG 6850, 2005]." Section 2.2 of the GFMTs document states: "Damage to non-IEEE-383 qualified cables is quantified as either an imposed incident heat flux of 5.7 kW/m2 (0.5 Btu/s-ft^2) or an immersion temperature of 204 °C (400 °F) per Nuclear Regulatory Guidance [NRC, 2005, NUREG 6850, 2005]."

   The above statements imply that in the GFMTs document, IEEE-383 qualified cables are assumed to be equivalent in terms of damage thresholds to "thermoset" cables as defined in Table 8-2 of NUREG/CR-6850. In addition, non-IEEE-383 qualified cables are assumed to be equivalent to "thermoplastic" cables as defined in Table 8-2 of NUREG/CR 6850. These assumptions may or may not be correct. An IEEE-383 qualified cable may or may not meet the criteria for a "thermoset cable" as defined in NUREG/CR-6850. It is also possible that a non-IEEE-383 qualified cable actually meets the NUREG/CR-6850 criteria for a "thermoset" cable.

   For those areas that are assumed to have thermoset damage criteria, confirm that the cables are actually thermoset and that the potential confusion about IEEE-383/thermoset is not applicable.

Response

The BSEP FPRA assumes thermoset damage criteria for cables. The Brunswick Cable Management System (BCAMS) database contains accurate cable information, status, and routing of plant cables. It should be noted that BCAMS is a highly controlled database that has been used to capture and track cable information and routing since the construction of BSEP. As described in change package BNP-0131, this database was used for identifying the percentage (i.e., slightly over 96%) of cable in the plant that is considered thermoset for fire PRA purposes. Specifically, the information in the database was used for determining if the cables can be characterized with the damage criteria for thermoset cables listed in Appendix H of NUREG/CR-6850.

Cables in the database were classified as thermoset if the insulation and jacket was of the following materials:

- EP, EPR, EPDM (ethylene propylene)
- HY, HYP, CSPE(DuPont Hypalon / chlorosulfonated polyethylene)
- NEO, NE (Neoprene / polychloroprene)
- FR-XLPE, (fire retardant cross-linked polyethylene)

- XLP, XLPE (cross-linked polyethylene)
- XLPO (cross-linked polyolefin)
- SR (Silicon Rubber)

The above listed materials are also listed as having damage temperatures above 300°C in Table H-4 of NUREG/CR-6850. Therefore, the classification of these cables as thermoset for damage criteria purposes (i.e., using the value of 300°C) is appropriate. That is, these cables are not only qualified (i.e., meet the IEEE-383 qualification test), but also have damage thresholds consistent with thermoset materials as described in Appendix H of NUREG/CR-6850.

Based on the percentage of thermoset cables associated being slightly over 96%, the amount of Thermoplastic cable is minimal, which supports the assumption of thermoset damage criteria for cable targets in the FPRA, even if a given raceway contains Thermoplastic cables.

Fire Modeling RAI 5A

NFPA 805, Section 2.7.3.4, "Qualification of Users," states: "Cognizant personnel who use and apply engineering analysis and numerical models (e.g., fire modeling techniques) shall be competent in that field and experienced in the application of these methods as they relate to nuclear power plants, nuclear power plant tire protection, and power plant operations."

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

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

Duril1g the transition to 10 CFR 50.48(c), work was performed in accordance with the quality requirements of Section 2.7.3 of NFPA 805. Personnel who used and applied engineering analysis and numerical methods (e.g., fire modeling) in support of compliance with 10 CFR 50.48(c) are competent and experienced as required by NFPA 805 Section 2.7.3.4.

Post-transition, for personnel performing fire modeling or FPRA development and evaluation, Carolina Power & Light has developed and maintains qualification requirements for individuals assigned various tasks. Position-Specific Guides have been developed to identify and document required training and mentoring to ensure individuals are appropriately qualified per the requirements of NFPA 805 Section 2.7.3.4 to perform assigned work. The following Training Guides have been developed and implemented.

ESG0089N - Fire Probabilistic Safety Assessment Engineer (Quantification)

ESG0093N - Fire Probabilistic Safety Assessment Engineer (Initial Development)

ESG0094N - Fire Probabilistic Safety Assessment Engineer (Data Development), and

ESG0105N - Basic Fire Modeling

Regarding qualifications of users of engineering analyses and numerical models:

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

Response

Duke Energy considers the following to be appropriate qualifications for fire protection engineers and contractors to perform and review fire modeling analyses using fire modeling tools and methods:

1. Complete or demonstrate equivalency to the following qualification program, as applicable to the task.

    - ESG0089N - Fire Probabilistic Safety Assessment Engineer (Quantification)
    - ESG0093N - Fire Probabilistic Safety Assessment Engineer (Initial Development)
    - ESG0094N - Fire Probabilistic Safety Assessment Engineer (Data Development)
    - ESG0102N - Fire Protection Plant Change Impact Review
    - ESG0104N - Fire Protection Engineer
    - ESG0105N - Basic Fire Modeling

2. Complete reading assignments of project instructions (i.e., calculation procedures) for the relevant tasks that will be performed. This requirement also includes completing independent studies for relevant industry methodology and/or guidance documents, such as NUREG/CR-6850, NUREG-1934, NUREG-1805, and other applicable fire modeling user's guide documents.

3. Education on the subject of combustion, fire dynamics and/or fire modeling. Examples of education activities meeting this requirement includes

    - Academic training in fire analysis (e.g., fire modeling, fire dynamics)
    - Demonstration of comprehension and proficiency in fire modeling

For the specific case of Duke Energy contractors, the contractor's quality assurance process ensures that the personnel performing the fire modeling are qualified and trained. The contractor's qualifications are maintained by the contracting company quality assurance manager, who ensures that the education credentials, appropriate quality assurance training, and reading assignments are completed before the tasks are performed.

Fire Modeling RAI 5B

Regarding qualifications of users of engineering analyses and numerical models:

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

Response

Fire modeling calculations are required to be performed by a fire protection engineer who meets the qualification requirements of Section 2.7.3.4 of NFPA 805. The qualification process is based on the following programs, which provides the minimum training necessary to perform calculations and analyses:

- ESG0102N - Fire Protection Plant Change Impact Review
- ESG0104N - Fire Protection Engineer
- ESG0105N - Basic Fire Modeling

The requirement in NFPA 805 listed above will continue to be met and adhered to through Duke Energy procedures and project management of contractor support staff. For personnel performing fire modeling or fire PRA development and evaluation, Duke Energy maintains project instructions to be used by individuals assigned to these tasks. This ensures consistency in the end products. These instructions were developed by personnel with intimate knowledge and experience in the task subject matter. The task instructions were developed to identify and document required training and mentoring to ensure individuals are appropriately qualified per the requirements in NFPA 805 to perform the assigned work.

During and following transition, the existing engineering staff will continue to be knowledgeable in fire modeling techniques, including interpreting and maintaining the fire analyses. If new fire modeling personnel are needed in the future, their credentials will also be reviewed and approved by Duke Energy management to ensure qualifications and equivalency with the qualification program described in response to RAI 5A.

List of Regulatory Commitments

The following table identifies the actions in this document to which the Brunswick Steam Electric Plant has committed. Statements in this submittal, with the exception of those in the table below, are provided for information purposes and are not considered commitments. Please direct questions regarding these commitments to Mr. Lee Grzeck, Manager - Regulatory Affairs, at (910) 457-2487.

Commitment	Completion Date
Duke Energy will revise applicable portions of the UFSAR related to Fire Protection under NFPA 805, using the guidance contained in FAQ 12-0062.	This will occur during the implementation phase described in NFPA 805 LAR Section 5.5.