October 28, 2015

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3R-C
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3 - ISSUANCE OF AMENDMENTS REGARDING TRANSITION TO A RISK-INFORMED, PERFORMANCE-BASED FIRE PROTECTION PROGRAM IN ACCORDANCE WITH 10 CFR 50.48(c) (CAC NOS. MF1185, MF1186, AND MF1187)

Dear Mr. Shea:

The Nuclear Regulatory Commission (NRC or the Commission) has issued the enclosed Amendment Nos. 290, 315, and 273, to Renewed Facility Operating License (RFOL) Nos. DPR-33, DPR-52, and DPR-68, for the Browns Ferry Nuclear Plant, Units 1, 2, and 3, respectively. These amendments are in response to Tennessee Valley Authority's (the licensee) application dated March 27, 2013, as supplemented by letters dated May 16, 2013; November 22, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 14, 2014; August 26, 2014; August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2015.

The amendments modify the RFOLs and Technical Specifications to incorporate a new fire protection licensing basis in accordance with Title 10 of the *Code of Federal Regulations* Section 50.48(c). The amendments authorize the transition of the licensee's fire protection program to a risk-informed, performance-based program based on the 2001 Edition of National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants." This standard describes how to use performance-based methods, such as fire modeling, and risk-informed methods, such as fire probabilistic risk assessment, to demonstrate compliance with nuclear safety performance criteria.

The NRC staff's safety evaluation (SE) of the amendments is enclosed. We have previously sent the SE in draft form to your staff to ascertain that it contains no proprietary information. Your staff confirmed that the SE contains no proprietary information.

A Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA/ AHon for

Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, and 50-296

Enclosures:
1. Amendment No. 290 to DPR-33
2. Amendment No. 315 to DPR-52
3. Amendment No. 273 to DPR-68
4. Safety Evaluation

cc w/enclosures: Distribution via Listserv

A Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA/ AHon for

Farideh E. Saba, Senior Project Manager
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OFFICE	DORL/LPL2-2/PM	DORL/LPL2-2/LA	DRA/AFPB/BC*	DRA/APLA/BC*
NAME	FSaba	BClayton (LRonewicz for)	AKlein	SRosenberg
DATE	8/18/15	10/21/15	7/13/15	7/13/15
OFFICE	DSS/STSB/BC	OGC – NLO	DORL/LPL2-2/BC	DORL/LPL2-2/PM
NAME	RElliott (MChernoff for)	SUttal	SHelton	FSaba (AHon for)
DATE	10/20/15	10/15/15	10/28/15	10/28/15

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TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-259

BROWNS FERRY NUCLEAR PLANT UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 290
Renewed License No. DPR-33

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated March 27, 2013, as supplemented by letters dated May 16, 2013; November 22, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 14, 2014; August 26, 2014, August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2015, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Renewed Operating License and Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-33 is hereby amended as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 290, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented according to the schedule in the revised License Condition (13).

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Shana R. Helton, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Facility Operating
License and Technical Specifications

Date of Issuance: October 28, 2015

ATTACHMENT TO LICENSE AMENDMENT NO. 290

RENEWED FACILITY OPERATING LICENSE NO. DPR-33

DOCKET NO. 50-259

Replace the following pages of Renewed Facility Operating License No. DPR-33 with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3	3
5	5
--	5a
--	5b

Replace the following page of Appendix A, Technical Specifications, with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

REMOVE	INSERT
5.0-7	5.0-7

(3) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use at any time any byproduct, source, and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use in amounts as required any byproduct, source, or special nuclear material without restriction to chemical or physical form for sample analysis or equipment and instrument calibration or associated with radioactive apparatus or components;

(5) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 3458 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 290, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

For Surveillance Requirements (SRs) that are new in Amendment 234 to Facility Operating License DPR-33, the first performance is due at the end of the first surveillance interval that begins at implementation of the Amendment 234. For SRs that existed prior to Amendment 234, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the surveillance was last performed prior to implementation of Amendment 234.

(8) Deleted.

(9) Deleted.

(10) Deleted.

(11)(a) The licensee shall fully implement and maintain in effect all provisions of the Commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provisions of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822) and to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans, which contains Safeguards Information protected under 10 CFR 73.21, is entitled: "Browns Ferry Nuclear Plant Physical Security Plan, Training and Qualification Plan, and Contingency Plan," submitted by letter dated April 28, 2006.

(b) The licensee shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The licensee CSP was approved by License Amendment No. 279, as amended by changes approved by License Amendment No. 286.

(12) Deleted.

(13) TVA Browns Ferry Nuclear Plant shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the license amendment request dated March 27, 2013, as supplemented by letters dated May 16, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2015, as approved in the Safety Evaluation dated October 28, 2015. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

Risk-Informed Changes that May Be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at the plant. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

(a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

(b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than 1×10^{-7}/year (yr) for CDF and less than 1×10^{-8}/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Other Changes that May Be Made Without Prior NRC Approval

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program.

Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3 element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

- Fire Alarm and Detection Systems (Section 3.8);
- Automatic and Manual Water-Based Fire Suppression Systems (Section 3.9);
- Gaseous Fire Suppression Systems (Section 3.10); and
- Passive Fire Protection Features (Section 3.11).

This License Condition does not apply to any demonstration of equivalency under Section 1.7 of NFPA 805.

2. Fire Protection Program Changes that Have No More than Minimal Risk Impact

   Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC Safety Evaluation dated October 28, 2015, to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by (2) below, risk-informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in (2) above.

2. The licensee shall implement the following modifications to its facility, as described in Table S-2, "Plant Modifications," of Tennessee Valley Authority letter CNL-15-191, dated September 8, 2015, to complete the transition to full compliance with 10 CFR 50.48(c) no later than the end of the second refueling outage (for each unit) following issuance of the license amendment. The licensee shall maintain appropriate compensatory measures in place until completion of these modifications.

3. The licensee shall complete the implementation items as listed in Table S-3, "Implementation Items," of Tennessee Valley Authority letters CNL-15-191, dated September 8, 2015, and CNL-15-224, dated October 20, 2015, within 240 days after issuance of the license amendment unless that date falls within a scheduled refueling outage, then implementation will occur within 60 days after startup from that scheduled refueling outage. Implementation items 32 and 33 are associated with modifications and will be completed after all procedure updates, modifications, and training are complete.

(14) The licensee shall maintain the Augmented Quality Program for the Standby Liquid Control System to provide quality control elements to ensure component reliability for the required alternative source term function defined in the Updated Final Safety Analyses Report (UFSAR).

(15) The licensee is required to confirm that the conclusions made in TVA's letter dated September 17, 2004, for the turbine building remain acceptable using seismic demand accelerations based on dynamic seismic analysis prior to the restart of Unit 1.

(16) Upon implementation of Amendment No. 275, adopting TSTF-448, Revision 3, the determination of control room envelope (CRE) unfiltered air inleakage as required by SR 3.7.3.4, in accordance with TS 5.5.13.c(i), the assessment of the CRE habitability as required by TS 5.5.13.c(ii), and the measure of CRE pressure as required by TS 5.5.13.d, shall be considered met.

5.0 ADMINISTRATIVE CONTROLS

5.4 Procedures

5.4.1 Written procedures shall be established, implemented, and maintained covering the following activities:

a. The applicable procedures recommended in Regulatory Guide 1.33, Revision 2, Appendix A, February 1978;

b. The emergency operating instructions required to implement the requirements of NUREG-0737 and to NUREG-0737, Supplement 1, as stated in Generic Letter 82-33;

c. Quality assurance for effluent and environmental monitoring;

d. (Deleted); and

e. All programs specified in Specification 5.5.

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-260

BROWNS FERRY NUCLEAR PLANT, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 315
Renewed License No. DPR-52

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated March 27, 2013, as supplemented by letters dated May 16, 2013; November 22, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 14, 2014; August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2015, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission’s regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Renewed Operating License and Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-52 is hereby amended as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 315, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented according to the schedule in the revised License Condition (14).

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Shana R. Helton, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Facility Operating
License and Technical Specifications

Date of Issuance: October 28, 2015

ATTACHMENT TO LICENSE AMENDMENT NO. 315

RENEWED FACILITY OPERATING LICENSE NO. DPR-52

DOCKET NO. 50-260

Replace the following pages of Renewed Facility Operating License No. DPR-52 with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3	3
5	5
--	5a
--	5b

Replace the following page of Appendix A, Technical Specifications, with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

REMOVE	INSERT
5.0-7	5.0-7

sealed sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use in amounts as required any byproduct, source, or special nuclear material without restriction to chemical or physical form for sample analysis or equipment and instrument calibration or associated with radioactive apparatus or components;

(5) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 0 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 3458 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 315, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

For Surveillance Requirements (SRs) that are new in Amendment 253 to Facility Operating License DPR-52, the first performance is due at the end of the first surveillance interval that begins at implementation of the Amendment 253. For SRs that existed prior to Amendment 253, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the surveillance was last performed prior to implementation of Amendment 253.

(3) The licensee is authorized to relocate certain requirements included in Appendix A and the former Appendix B to licensee-controlled documents. Implementation of this amendment shall include the relocation of these requirements to the appropriate documents, as described in the licensee's

(8) Deleted.

(9) Deleted.

(10) Deleted.

(11)(a) The licensee shall fully implement and maintain in effect all provisions of the commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provisions of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822) and to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans, which contains Safeguards Information protected under 10 CFR 73.21, is entitled: "Browns Ferry Nuclear Plant Physical Security Plan, Training and Qualification Plan, and Contingency Plan," submitted by letter dated April 28, 2006.

(b) The licensee shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The licensee CSP was approved by License Amendment No. 306, as amended by changes approved by License Amendment 312.

(12) Deleted.

(13) Deleted.

(14) TVA Browns Ferry Nuclear Plant shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the license amendment request dated March 27, 2013, as supplemented by letters dated May 16, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2015, as approved in the Safety Evaluation dated October 28, 2015. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

Risk-Informed Changes that May Be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at the plant. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

(a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

(b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than $1x10^{-7}$/year (yr) for CDF and less than $1x10^{-8}$/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Other Changes that May Be Made Without Prior NRC Approval

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program.

   Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3 element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

   The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

   - Fire Alarm and Detection Systems (Section 3.8);

- Automatic and Manual Water-Based Fire Suppression Systems (Section 3.9);
- Gaseous Fire Suppression Systems (Section 3.10); and
- Passive Fire Protection Features (Section 3.11).

This License Condition does not apply to any demonstration of equivalency under Section 1.7 of NFPA 805.

2. Fire Protection Program Changes that Have No More than Minimal Risk Impact

Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC Safety Evaluation dated October 28, 2015, to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by (2) below, risk-informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in (2) above.

2. The licensee shall implement the following modifications to its facility, as described in Table S-2, “Plant Modifications,” of Tennessee Valley Authority letter CNL-15-191, dated September 8, 2015, to complete the transition to full compliance with 10 CFR 50.48(c) no later than the end of the second refueling outage (for each unit) following issuance of the license amendment. The licensee shall maintain appropriate compensatory measures in place until completion of these modifications.

3. The licensee shall complete the implementation items as listed in Table S-3, “Implementation Items,” of Tennessee Valley Authority letters CNL-15-191, dated September 8, 2015, and CNL-15-224, dated October 20, 2015, within 240 days after issuance of the license amendment unless that date falls within a scheduled refueling outage, then implementation will occur within 60 days after startup from that scheduled refueling outage. Implementation items 32 and 33 are associated with modifications and will be completed after all procedure updates, modifications, and training are complete.

(15) The licensee shall maintain the Augmented Quality Program for the Standby Liquid Control System to provide quality control elements to ensure component reliability for the required alternative source term function defined in the Updated Final Safety Analysis Report (UFSAR).

(16) Upon complementation of Amendment No. 302, adopting TSTF-448, Revision 3, the determination of control room envelope (CRE) unfiltered air inleakage as required by SR 3. 7.3.4, in accordance with TS 5.5.13.c(i), the assessment of the CRE habitability as required by TS 5.5.13.c(ii), and the measure of CRE pressure as required by TS 5.5.13.d, shall be considered met.

5.0 ADMINISTRATIVE CONTROLS

5.4 Procedures

5.4.1 Written procedures shall be established, implemented, and maintained covering the following activities:

a. The applicable procedures recommended in Regulatory Guide 1.33, Revision 2, Appendix A, February 1978;

b. The emergency operating instructions required to implement the requirements of NUREG-0737 and to NUREG-0737, Supplement 1, as stated in Generic Letter 82-33;

c. Quality assurance for effluent and environmental monitoring;

d. (Deleted); and

e. All programs specified in Specification 5.5.

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-296

BROWNS FERRY NUCLEAR PLANT, UNIT 3

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 273
Renewed License No. DPR-68

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated March 27, 2013, as supplemented by letters dated May 16, 2013; November 22, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 14, 2014; August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2105, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Renewed Operating License and Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-68 is hereby amended as follows:

   (2) <u>Technical Specifications</u>

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 273, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented according to the schedule in the revised License Condition (7).

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Shana R. Helton, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Facility Operating
License and Technical Specifications

Date of Issuance: October 28, 2015

ATTACHMENT TO LICENSE AMENDMENT NO. 273

RENEWED FACILITY OPERATING LICENSE NO. DPR-68

DOCKET NO. 50-296

Replace the following pages of Renewed Facility Operating License No. DPR-68 with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3	3
4	4
--	4a
--	4b
5	5

Replace the following page of Appendix A, Technical Specifications, with the attached revised page. The revised page is identified by amendment number and contains marginal lines indicating the areas of change.

REMOVE	INSERT
5.0-7	5.0-7

(3) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use at any time any byproduct, source, and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use in amounts as required any byproduct, source, or special nuclear material without restriction to chemical or physical form for sample analysis or equipment and instrument calibration or associated with radioactive apparatus or components;

(5) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) <u>Maximum Power Level</u>

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 3458 megawatts thermal.

(2) <u>Technical Specifications</u>

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 273, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

For Surveillance Requirements (SRs) that are new in Amendment 212 to Facility Operating License DPR-68, the first performance is due at the end of the first surveillance interval that begins at implementation of the Amendment 212. For SRs that existed prior to Amendment 212, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the surveillance was last performed prior to implementation of Amendment 212.

(3) The licensee is authorized to relocate certain requirements included in Appendix A and the former Appendix B to licensee-controlled documents. Implementation of this amendment shall include the relocation of these requirements to the appropriate documents, as described in the licensee's application dated September 6, 1996; as supplemented May 1, August 14, November 5 and 14, December 3, 4, 11, 22, 23, 29, and 30, 1997; January 23, March 12, April 16, 20, and 28, May 7, 14, 19, and 27, and June 2, 5, 10 and 19, 1998; evaluated in the NRC staff's Safety Evaluation enclosed with this amendment. This amendment is effective immediately and shall be implemented within 90 days of the date of this amendment.

(4) Deleted.

(5) Classroom and simulator training on all power uprate related changes that affect operator performance will be conducted prior to operating at uprated conditions. Simulator changes that are consistent with power uprate conditions will be made and simulator fidelity will be validated in accordance with ANSI/ANS 3.5-1985. Training and the plant simulator will be modified, as necessary, to incorporate changes identified during startup testing. This amendment is effective immediately.

(6)(a) The licensee shall fully implement and maintain in effect all provisions of the Commission-approved physical security, training and qualification, and safeguards contingency plans including amendments made pursuant to provisions of the Miscellaneous Amendments and Search Requirements revisions to 10 CFR 73.55 (51 FR 27817 and 27822) and to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The combined set of plans, which contains Safeguards Information protected under 10 CFR 73.21, is entitled: "Browns Ferry Nuclear Plant Physical Security Plan, Training and Qualification Plan, and Contingency Plan," Revision 4, submitted by letter dated April 28, 2006.

(b) The licensee shall fully implement and maintain in effect all provisions of the Commission-approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The licensee CSP was approved by License Amendment No. 265, as amended by changes approved by License Amendment No. 271.

(7) TVA Browns Ferry Nuclear Plant shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the license amendment request dated March 27, 2013, as supplemented by letters dated May 16, 2013; December 20, 2013; January 10, 2014; January 14, 2014; February 13, 2014; March 14, 2014; May 30, 2014; June 13, 2014; July 10, 2014; August 29, 2014; September 16, 2014; October 6, 2014; December 17, 2014; March 26, 2015; April 9, 2015; June 19, 2015; August 18, 2015; September 8, 2015; and October 20, 2015, as approved in the Safety Evaluation dated October 28, 2015. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee

may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

Risk-Informed Changes that May Be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at the plant. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

(a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

(b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than $1x10^{-7}$/year (yr) for CDF and less than $1x10^{-8}$/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Other Changes that May Be Made Without Prior NRC Approval

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program.

   Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3 element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the alternative is “adequate for the hazard.” Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

- Fire Alarm and Detection Systems (Section 3.8);
- Automatic and Manual Water-Based Fire Suppression Systems (Section 3.9);
- Gaseous Fire Suppression Systems (Section 3.10); and
- Passive Fire Protection Features (Section 3.11).

This License Condition does not apply to any demonstration of equivalency under Section 1.7 of NFPA 805.

2. Fire Protection Program Changes that Have No More than Minimal Risk Impact

   Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC Safety Evaluation dated October 28, 2015, to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by (2) below, risk-informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in (2) above.

2. The licensee shall implement the following modifications to its facility, as described in Table S-2, “Plant Modifications,” of Tennessee Valley Authority letter CNL-15-191, dated September 8, 2015, to complete the transition to full compliance with 10 CFR 50.48(c) no later than the end of the second refueling outage (for each unit) following issuance of the license amendment. The licensee shall maintain appropriate compensatory measures in place until completion of these modifications.

3. The licensee shall complete the implementation items as listed in Table S-3, “Implementation Items,” of Tennessee Valley Authority letters CNL-15-191, dated September 8, 2015, and CNL-15-224, dated October 20, 2015, within 240 days after issuance of the license amendment unless that date falls within a scheduled refueling outage, then implementation will occur within 60 days after startup from that scheduled refueling outage. Implementation items 32 and 33 are associated with modifications and will be completed after all procedure updates, modifications, and training are complete.

(8) Deleted.

(9) The licensee shall maintain the Augmented Quality Program for the Standby Liquid Control System to provide quality control elements to ensure component reliability for the required alternative source term function defined in the Updated Final Safety Analyses Report (UFSAR).

(10) Mitigation Strategy License Condition

Develop and maintain strategies for addressing large fires and explosions and that include the following key areas:

(a) Fire fighting response strategy with the following elements:
   1. Pre-defined coordinated fire response strategy and guidance
   2. Assessment of mutual aid fire fighting assets
   3. Designated staging areas for equipment and materials
   4. Command and control
   5. Training of response personnel

(b) Operations to mitigate fuel damage considering the following:
   1. Protection and use of personnel assets
   2. Communications
   3. Minimizing fire spread
   4. Procedures for implementing integrated fire response strategy
   5. Identification of readily-available pre-staged equipment
   6. Training on integrated fire response strategy
   7. Spent fuel pool mitigation measures

(c) Actions to minimize release to include consideration of:
   1. Water spray scrubbing
   2. Dose to onsite responders

(11) The licensee shall implement and maintain all Actions required by Attachment 2 to NRC Order EA-06-137, issued June 20, 2006, except the last action that requires incorporation of the strategies into the site security plan, contingency plan, emergency plan and/or guard training and qualification plan, as appropriate.

(12) Upon completion of Amendment No. 261, adopting TSTF-448, Revision 3, the determination of control room envelope (CRE) unfiltered air inleakage as required by SR 3.7.3.4, in accordance with TS 5.S.13.c(i), the assessment of the CRE habitability as required by TS 5.S.13.c(ii), and the measurement of the CRE pressure as required by TS 5.S.13.d. shall be considered met.

5.0 ADMINISTRATIVE CONTROLS

5.4 Procedures

5.4.1 Written procedures shall be established, implemented, and maintained covering the following activities:

a. The applicable procedures recommended in Regulatory Guide 1.33, Revision 2, Appendix A, February 1978;

b. The emergency operating instructions required to implement the requirements of NUREG-0737 and to NUREG-0737, Supplement 1, as stated in Generic Letter 82-33;

c. Quality assurance for effluent and environmental monitoring;

d. (Deleted); and

e. All programs specified in Specification 5.5.

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TRANSITION TO A RISK-INFORMED, PERFORMANCE-BASED

FIRE PROTECTION PROGRAM IN ACCORDANCE WITH 10 CFR 50.48(c)

AMENDMENT NOS. 290, 315, AND 273 TO RENEWED FACILITY OPERATING

LICENSE NOS. DPR-33, DPR-52, AND DPR-68

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3

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1.0 INTRODUCTION

1.1 Background

The U.S. Nuclear Regulatory Commission (NRC or the Commission) started developing fire protection requirements in the 1970's. In 1976, the NRC published comprehensive fire protection guidelines in the form of Branch Technical Position (BTP) Auxiliary and Power Conversion Systems Branch (APCSB) 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants" (Reference 1), and Appendix A to BTP APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976" (Reference 2). Subsequently, the NRC performed fire protection reviews for the operating reactors and documented the results in safety evaluations (SEs), or supplements to SEs.

In 1980, to resolve issues identified in those reports, the NRC amended its regulations for fire protection in operating nuclear power plants (NPPs) and published its Final Rule, Fire Protection Program for Operating Nuclear Power Plants, in the *Federal Register* (FR) on November 19, 1980 (45 FR 76602), adding Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.48, "Fire Protection," and Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," to 10 CFR Part 50.

Section 50.48(a)(1) of 10 CFR requires that each holder of an operating license, and holders of a combined operating license issued under 10 CFR Part 52, have a fire protection plan that satisfies General Design Criterion (GDC) 3 of Appendix A to 10 CFR Part 50 and states that the fire protection plan must describe the overall fire protection program (FPP); identify the positions responsible for the program and the authority delegated to those positions; outline the plans for fire protection, fire detection and suppression capability, and limitation of fire damage.

Section 50.48(a)(2) of 10 CFR states that the fire protection plan must describe the specific features necessary to implement the program described in paragraph (a)(1), including administrative controls and personnel requirements; automatic and manual fire detection and suppression systems; and the means to limit fire damage to structures, systems, and components (SSCs) to ensure the capability to safely shut down the plant. Section 50.48(a)(3) of 10 CFR requires that the licensee retain the fire protection plan and each change to the plan as a record until the Commission terminates the license and that the licensee retain each superseded revision of the procedures for 3 years.

In the 1990's, the NRC worked with the National Fire Protection Association (NFPA) and industry to develop a risk-informed (RI), performance-based (PB) consensus standard for fire protection. In 2001, the NFPA Standards Council issued NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants" (Reference 3), which describes a methodology for establishing fundamental FPP design requirements and elements, determining required fire protection systems and features, applying PB requirements, and administering fire protection for existing light-water reactors during operation, decommissioning, and permanent shutdown. It provides for the establishment of a minimum set of fire protection requirements but allows PB or deterministic approaches to be used to meet performance criteria.

NRC Regulatory Guide (RG) 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," Revision 1 (Reference 4), states, in part:

> On March 26, 1998, the staff sent to the Commission SECY-98-058, "Development of a Risk-Informed, Performance-Based Regulation for Fire Protection at Nuclear Power Plants" (Reference 5), in which it proposed to work with NFPA and the industry to develop a risk-informed, performance-based consensus standard for nuclear power plant fire protection. This consensus standard could be endorsed in a future rulemaking as an alternative set of fire protection requirements to the existing regulations in 10 CFR 50.48. In SECY-00-0009, "Rulemaking Plan, Reactor Fire Protection Risk-Informed, Performance-Based Rulemaking," dated January 13, 2000 (Reference 6), the NRC staff requested and received Commission approval to proceed with a rulemaking to permit reactor licensees to adopt NFPA 805 as an alternative to existing fire protection requirements. On February 9, 2001, the NFPA Standards Council approved the 2001 Edition of NFPA 805 as an American National Standard for performance-based fire protection for light-water nuclear power plants.

A licensee that elects to adopt NFPA 805 must meet the performance goals, objectives, and criteria that are itemized in Chapter 1 of NFPA 805 through the implementation of PB or deterministic approaches. The goals include ensuring that reactivity control, inventory and pressure control, decay heat removal, vital auxiliaries, and process monitoring are achieved and maintained. The licensee then must establish plant fire protection requirements using the methodology in Chapter 2 of NFPA 805, such that the minimum FPP elements and design criteria contained in Chapter 3 of NFPA 805 are satisfied. Next, a licensee identifies fire areas and fire hazards through a plant-wide analysis and then applies either a PB or a deterministic approach to meet the performance criteria. As part of a PB approach, the licensee will use engineering evaluations, probabilistic safety assessments (PSAs), and fire modeling (FM) calculations to show that the criteria are met. Chapter 4 of NFPA 805 establishes the methodology to determine the fire protection systems and features required to achieve the performance criteria. It also specifies that at least one success path to achieve the nuclear safety performance criteria (NSPC) shall be maintained free of fire damage by a single fire.

RG 1.205 also states, in part:

> Effective July 16, 2004, the Commission amended its fire protection requirements in 10 CFR 50.48 to add 10 CFR 50.48(c), which incorporates by reference the 2001 Edition of NFPA 805, with certain exceptions, and allows licensees to apply for a license amendment to comply with the 2001 Edition of NFPA 805 (69 FR [*Federal Register*] 33536). NFPA has issued subsequent Editions of NFPA 805, but the regulation does not endorse them.

Throughout this SE, where the NRC staff states that the licensee's FPP element is in compliance with (or meets the requirements of) NFPA 805, the NRC staff is referring to the 2001 edition of NFPA 805 with the exceptions, modifications, and supplements described in 10 CFR 50.48(c)(2).

RG 1.205 also states, in part:

> In parallel with the Commission's efforts to issue a rule incorporating the risk-informed, performance-based fire protection provisions of NFPA 805, NEI [Nuclear Energy Institute] published implementing guidance for the specific provisions of NFPA 805 and 10 CFR 50.48(c) in NEI 04-02 ["Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)]." [(Reference 7)]

RG 1.205 provides the NRC staff's position on NEI 04-02, Revision 2, and offers additional information and guidance to supplement the NEI document and assist licensees in meeting the NRC's regulations in 10 CFR 50.48(c) related to adopting a risk-informed, performance-based (RI/PB) FPP. RG 1.205 endorses the guidance of NEI 04-02, Revision 2, subject to certain exceptions, as providing methods acceptable to the staff for adopting an FPP consistent with the 2001 Edition of NFPA 805 and 10 CFR 50.48(c).

Accordingly, Tennessee Valley Authority (TVA or the licensee) requested license amendments to allow it to establish and maintain the Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3 FPP in accordance with 10 CFR 50.48(c) and change the Renewed Facility Operating Licenses (RFOLs) and Technical Specifications (TSs) accordingly.

1.2 Requested Licensing Action

By letter dated March 27, 2013 (Reference 8), as supplemented by letters dated May 16, 2013 (Reference 9); November 22, 2013 (Reference 10); December 20, 2013 (Reference 11); January 10, 2014 (Reference 12); January 14, 2014 (Reference 13); February 13, 2014 (Reference 14); March 14, 2014 (Reference 15); May 30, 2014 (Reference 16); June 13, 2014 (Reference 17); July 10, 2014 (Reference 18); August 14, 2014 (Reference 19); August 26, 2014 (Reference 20)August 29, 2014 (Reference 21); September 16, 2014 (Reference 22);

October 6, 2014 (Reference 23); December 17, 2014 (Reference 24); March 26, 2015 (Reference 25); April 9, 2015 (Reference 26); June 19, 2015 (Reference 27), August 18, 2015 (Reference 28), September 8, 2015 (Reference 29), and October 20, 2015 (Reference 30), the licensee submitted an application for license amendments (also called license amendment request (LAR)) to transition the FPP from 10 CFR 50.48(b) to 10 CFR 50.48(c), NFPA 805. The supplemental letters were in response to the NRC staff's requests for additional information (RAIs) dated November 19, 2013 (Reference 31); May 20, 2014 (Reference 32); May 21, 2014 (Reference 33); July 31, 2014 (Reference 34); November 18, 2014 (Reference 35); February 21, 2015 (Reference 36), and May 29, 2015 (Reference 37). The licensee's supplemental letters dated December 20, 2013; January 10, January 14, February 13, March 14, May 30, June 13, July 10, August 14, August 26, August 29, September 16, October 6, and December 17, 2014; and March 27, April 9, June 19, August 18, September 8, and October 20, 2015, provided additional information that clarified the application, did not expand the overall scope of the application as originally noticed, and did not change the staff's original proposed opportunity for a hearing on the initial application as published in the FR on August 13, 2013 (78 FR 49302).

The licensee requested amendments to the BFN RFOLs and TSs to establish and maintain an RI/PB FPP in accordance with the requirements of 10 CFR 50.48(c).

Specifically, the licensee requested to transition BFN from the existing deterministic fire protection licensing basis established in accordance with all provisions of the approved FPP as described in the final safety analysis report (FSAR), as approved in the SEs dated December 8, 1988 (Reference 38); March 31, 1993 (Reference 39); April 1, 1993 (Reference 40); November 2, 1995 (Reference 41); April 25, 2007 (Reference 42); and supplement dated November 3, 1989 (Reference 43), to an RI/PB FPP in accordance with 10 CFR 50.48(c) that uses risk information, in part, to demonstrate compliance with the fire protection and nuclear safety goals, objectives, and performance criteria of NFPA 805. As such, the proposed FPP at BFN is referred to as RI/PB FPP throughout this SE.

In its LAR, the licensee provided a description of the revised FPP for which it is requesting NRC approval to implement, a description of the FPP that it will implement under 10 CFR 50.48(a) and (c), and the results of the evaluations and analyses required by NFPA 805.

This SE documents the NRC staff's evaluation of the licensee's LAR and the NRC staff's conclusion that:

1. The licensee has identified any orders, license conditions, and the TSs that must be revised or superseded, and that any necessary revisions are adequate, as required by 10 CFR 50.48(c)(3)(i);

2. The licensee has completed its implementation of the methodology in Chapter 2, "Methodology," of NFPA 805 (including all required evaluations and analyses), and the NRC staff has approved the licensee's modified FPP, which reflects the decision to comply with NFPA 805, as required by 10 CFR 50.48(a); and

3. The licensee will modify its FPP, as described in the LAR, in accordance with the implementation schedule set forth in this SE and the accompanying license condition, as required by 10 CFR 50.48(c)(3)(ii).

The licensee proposed a new fire protection license condition reflecting the new RI/PB FPP licensing basis, as well as revisions to the TSs that address this change to the current FPP licensing basis. SE Sections 2.4.2 and 4.0 discuss in detail the proposed license condition, and SE Section 2.4.3 discusses the proposed TS changes.

2.0 REGULATORY EVALUATION

Section 50.48 of 10 CFR, "Fire protection," provides the NRC requirements for NPP fire protection. Section 50.48 includes specific requirements for requesting approval for an RI/PB FPP program based on the provisions of NFPA 805 (Reference 3). Paragraph 50.48(c)(3)(i) of 10 CFR states, in part:

> A licensee may maintain a fire protection program that complies with NFPA 805 as an alternative to complying with paragraph (b) of this section [10 CFR 50.48(b)] for plants licensed to operate before January 1, 1979, or the fire protection license conditions for plants licensed to operate after January 1, 1979. The licensee shall submit a request to comply with NFPA 805 in the form of an application for license amendment under [10 CFR] 50.90. The application must identify any orders and license conditions that must be revised or superseded, and contain any necessary revisions to the plant's technical specifications and the bases thereof.

In addition, 10 CFR 50.48(c)(3)(ii) states:

> The licensee shall complete its implementation of the methodology in Chapter 2 of NFPA 805 (including all required evaluations and analyses) and, upon completion, modify the fire protection plan required by paragraph (a) of this section to reflect the licensee's decision to comply with NFPA 805, before changing its fire protection program or nuclear power plant as permitted by NFPA 805.

The intent of 10 CFR 50.48(c)(3)(ii) is given in the statement of considerations for the "Final Rule, Voluntary Fire Protection Requirements for Light Water Reactors; Adoption of NFPA 805 as a Risk-Informed, Performance-Based Alternative" (69 FR 33536-33548; June 16, 2004), which states:

> This paragraph requires licensees to complete all of the Chapter 2 methodology (including evaluations and analyses) and to modify their fire protection plan before making changes to the fire protection program or to the plant configuration. This process ensures that the transition to an NFPA 805 configuration is conducted in a complete, controlled, integrated, and organized manner. This requirement also precludes licensees from implementing NFPA 805 on a partial or selective basis (e.g., in some fire areas and not others, or truncating the methodology within a given fire area).

As stated in 10 CFR 50.48(c)(3)(i), the Director of the Office of Nuclear Reactor Regulation (NRR), or a designee of the Director, may approve the application if the Director or designee determines that the licensee has identified orders, license conditions, and the TSs that must be revised or superseded, and that any necessary revisions are adequate.

The regulations also allow for flexibility that was not included in the NFPA 805 standard. Licensees who choose to adopt 10 CFR 50.48(c), but wish to use the PB methods permitted elsewhere in the standard to meet the fire protection requirements of NFPA 805, Chapter 3, “Fundamental Fire Protection Program and Design Elements,” must submit an LAR in accordance with 10 CFR 50.48(c)(2)(vii). This regulation further provides as follows:

> The Director of the Office of Nuclear Reactor Regulation, or a designee of the Director, may approve the application if the Director or designee determines that the performance-based approach;
>
> (A) Satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release;
>
> (B) Maintains safety margins; and
>
> (C) Maintains fire protection defense-in-depth (DID) (fire prevention, fire detection, fire suppression, mitigation, and post-fire safe shutdown (SSD) capability).

Alternatively, licensees may choose to use RI or PB alternatives to comply with NFPA 805 by submitting an LAR in accordance with 10 CFR 50.48(c)(4), which states:

> The Director of the Office of Nuclear Reactor Regulation, or designee of the Director, may approve the application if the Director or designee determines that the proposed alternatives:
>
> (i) Satisfy the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release;
>
> (ii) Maintain safety margins; and
>
> (iii) Maintain fire protection DID (fire prevention, fire detection, fire suppression, mitigation, and post-fire SSD capability).

In addition to the conditions outlined by the rule that requires licensees to submit an LAR for NRC review and approval in order to adopt an RI/PB FPP, a licensee may also submit additional elements of its FPP for which it wishes to receive specific NRC review and approval, as set forth in Regulatory Position (RP) C.2.2.1 of RG 1.205, Revision 1 (Reference 4). Inclusion of these elements in the NFPA 805 LAR is meant to alleviate uncertainty in portions of the current FPP licensing bases as a result of the lack of specific NRC approval of these elements. RGs are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission. Accordingly, any submittal addressing these additional FPP elements needs to include sufficient detail to allow the NRC staff to assess whether the licensee's treatment of these elements meets the 10 CFR 50.48(c) requirements.

The purpose of the FPP established by NFPA 805 is to provide assurance, through a DID philosophy, that the NRC's fire protection objectives are satisfied. NFPA 805 Section 1.2, "Defense-in-Depth," states:

> Protecting the safety of the public, the environment, and plant personnel from a plant fire and its potential effect on safe reactor operations is paramount to this standard. The fire protection standard shall be based on the concept of defense-in-depth. Defense-in-depth shall be achieved when an adequate balance of each of the following elements is provided:
>
> (1) Preventing fires from starting;
>
> (2) Rapidly detecting and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage; and
>
> (3) Providing an adequate level of fire protection for SSCs important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

In addition, in accordance with GDC 3, "Fire protection," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, fire protection systems must be designed such that their failure or inadvertent operation does not significantly impair the ability of SSCs important to safety to perform their intended safety functions.

2.1 Other Applicable Regulations

The following regulations address fire protection:

- GDC 3, "Fire protection," to 10 CFR Part 50, Appendix A, states:

  > Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to assure that their

> rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.

- GDC 5, "Sharing of structures, systems, and components," to 10 CFR Part 50, Appendix A, states:

  > Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

- 10 CFR 50.48(a)(1) requires that each holder of an operating license have a fire protection plan that satisfies GDC 3 of Appendix A to 10 CFR Part 50.

- 10 CFR 50.48(c) incorporates NFPA 805 (2001 Edition) by reference, with certain exceptions, modifications, and supplementation. This regulation establishes the requirements for using an RI/PB FPP in conformance with NFPA 805 as an alternative to the requirements associated with 10 CFR 50.48(b) and Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," to 10 CFR Part 50, or the specific plant fire protection license condition.

- 10 CFR Part 20, "Standards for protection against radiation," establishes the radiation protection limits used as NFPA 805 radioactive release performance criteria, as specified in NFPA 805, Section 1.5.2, "Radioactive Release Performance Criteria."

2.2 Applicable Guidance

The NRC staff review also relied on the following additional codes, RGs, and standards:

- RG 1.205, Revision 1, issued December 2009 (Reference 4), which provides guidance for use in complying with the requirements that the NRC has promulgated for RI/PB FPPs that comply with 10 CFR 50.48 and the referenced 2001 Edition of the NFPA standard. It endorses portions of NEI 04-02, Revision 2, where it has been found to provide methods acceptable to the NRC for implementing NFPA 805 and complying with 10 CFR 50.48(c). The RPs in Section C of RG 1.205 include clarification of the guidance provided in NEI 04-02, as well as NRC exceptions to the guidance. RG 1.205 sets forth RPs, emphasizes certain issues, clarifies the requirements of 10 CFR 50.48(c) and NFPA 805, clarifies the guidance in NEI 04-02, and modifies the NEI 04-02 guidance where required. Should a conflict occur between NEI 04-02 and this RG, the RPs in RG 1.205 govern. This RG also indicates that Chapter 3 of NEI 00-01, "Guidance for Post-Fire Safe Shutdown Circuit Analysis," Revision 2, issued May 2009, when used in conjunction with NFPA 805 and the RG, provides one acceptable approach to circuit analysis for a plant implementing an FPP under 10 CFR 50.48(c).

- The 2001 edition of NFPA 805 (Reference 3), which specifies the minimum fire protection requirements for existing light water NPPs during all phases of plant operations, including shutdown, degraded conditions, and decommissioning. NFPA 805 was developed to provide a comprehensive RI/PB standard for fire protection. The NFPA 805 Technical Committee on Nuclear Facilities is composed of nuclear plant licensees, the NRC, insurers, equipment manufacturers, and subject matter experts. The standard was developed in accordance with NFPA processes, and consisted of a number of technical meetings and reviews of draft documents by committee and industry representatives. The scope of NFPA 805 includes goals related to nuclear safety, radioactive release, life safety, and plant damage/business interruption. The standard addresses fire protection requirements for nuclear plants during all plant operating modes and conditions, including shutdown and decommissioning, which had not been explicitly addressed by previous requirements and guidelines. NFPA 805 became effective on February 9, 2001.

- NEI 04-02, “Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)” (Reference 7), which provides guidance for implementing the requirements of 10 CFR 50.48(c), and represents methods for implementing in whole or in part an RI/PB FPP. This implementing guidance for NFPA 805 has two primary purposes: (1) provide direction and clarification for adopting NFPA 805 as an acceptable approach to fire protection, consistent with 10 CFR 50.48(c); and (2) provide additional supplemental technical guidance and methods for using NFPA 805 and its appendices to demonstrate compliance with fire protection requirements. Although there is a significant amount of detail in NFPA 805 and its appendices, clarification and additional guidance for select issues help ensure consistency and effective utilization of the standard. The NEI 04-02 guidance focuses attention on the RI/PB fire protection goals, objectives, and performance criteria contained in NFPA 805 and the RI/PB tools considered acceptable for demonstrating compliance. Revision 2 of NEI 04-02 incorporates guidance from RG 1.205 and approved Frequently Asked Questions (FAQs).

- NEI 00-01, “Guidance for Post Fire Safe Shutdown Circuit Analysis,” Revision 2 (Reference 44), provides a deterministic methodology for performing post-fire safe shutdown analysis (SSA). In addition, NEI 00-01 includes information on RI methods (when allowed within a plant’s license basis) that may be used in conjunction with the deterministic methods for resolving circuit failure issues related to multiple spurious operations (MSOs). The RI method is intended for application by licensees to determine the risk significance of identified circuit failure issues related to MSOs. RG 1.205 indicates that Chapter 3 of NEI 00-01, Revision 2, when used in conjunction with NFPA 805 and RG 1.205, provides one acceptable approach to circuit analysis for a plant implementing an FPP under 10 CFR 50.48(c).

- RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 2, issued May 2011 (Reference 45), which provides the NRC staff's recommendations for using risk information in support of licensee-initiated licensing basis changes to a NPP that require such review and approval. The guidance provided does not preclude other approaches for requesting licensing basis changes. Rather, RG 1.174 is intended to improve consistency in regulatory decisions in areas in which the results of risk analyses are used to help justify regulatory action. As such, the RG provides general guidance concerning one approach that the NRC has determined to be acceptable for analyzing issues associated with proposed changes to a plant's licensing basis and for assessing the impact of such proposed changes on the risk associated with plant design and operation.

- RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 2, issued March 2009 (Reference 46), which provides guidance to licensees for use in determining the technical adequacy of the base probabilistic risk assessment (PRA) used in an RI regulatory activity, and endorses standards and industry peer review guidance. The RG provides guidance in four areas:

  1. A definition of a technically acceptable PRA;

  2. The NRC's position on PRA consensus standards and industry PRA peer review program documents;

  3. Demonstration that the baseline PRA (in total or specific pieces) used in regulatory applications is technically adequate; and

  4. Documentation to support a regulatory submittal.

  It does not provide guidance on how the base PRA is revised for a specific application or how the PRA results are used in application-specific decision-making processes.

- American Society of Mechanical Engineers (ASME)/American Nuclear Society (ANS) RA-Sa-2009, "Addenda to ASME/ANS RA-S-2008, Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications" (Reference 47), which provides guidance PRAs used to support RI decisions for commercial light water reactor NPPs and prescribes a method for applying these requirements for specific applications. The standard gives guidance for a Level 1 PRA of internal and external hazards for all plant operating modes. In addition, the standard provides guidance for a limited Level 2 PRA sufficient to evaluate large early release frequency (LERF). The only hazards explicitly excluded from the scope are accidents resulting from purposeful human-induced security threats (e.g., sabotage). The standard applies to PRAs used to support applications of RI decisionmaking related to design, licensing, procurement, construction, operation, and maintenance.

- RG 1.189, “Fire Protection for Operating Nuclear Power Plants,” Revision 2, issued October 2009 (Reference 48), which provides guidance to licensees on the proper content and quality of engineering equivalency evaluations used to support the FPP. The NRC staff developed the RG to provide a comprehensive fire protection guidance document and to identify the scope and depth of fire protection that the staff would consider acceptable for NPPs.

- NUREG-0800, Section 9.5.1.2, “Risk-Informed, Performance-Based Fire Protection Program,” Revision 0, issued December 2009 (Reference 49), which provides the NRC staff with guidance for evaluating LARs that seek to implement an RI/PB FPP in accordance with 10 CFR 50.48(c).

- NUREG-0800, Section 19.1, “Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities,” Revision 3, issued September 2012 (Reference 50), which provides the NRC staff with guidance for evaluating the technical adequacy of a licensee’s PRA results when used to request RI changes to the licensing basis.

- NUREG-0800, Section 19.2, “Review of Risk Information Used to Support Permanent Plant-Specific Changes to the Licensing Basis: General Guidance,” Revision 0, issued June 2007 (Reference 51), which provides the NRC staff with guidance for evaluating the risk information used by a licensee to support permanent, RI changes to the licensing basis for the plant.

- NUREG/CR-6850, “EPRI [Electric Power Research Institute]/NRC-RES [Office of Nuclear Regulatory Research] Fire PRA Methodology for Nuclear Power Facilities,” Volumes 1 and 2 and Supplement 1 (Reference 52) (Reference 53) (Reference 54), which presents a compendium of methods, data, and tools to perform a fire probabilistic risk assessment (FPRA) and develop associated insights. In order to address the need for improved methods, RES and EPRI embarked upon a program to develop state-of-art FPRA methodology. Both RES and EPRI have provided specialists in fire risk analysis, FM, electrical engineering, human reliability analysis (HRA), and systems engineering for methods development. A formal technical issue resolution process was developed to direct the deliberative process between RES and EPRI. The process ensures that divergent technical views are fully considered, yet encourages consensus at many points during the deliberation. Significantly, the process provides that each party maintain its own point of view if consensus is not reached. Consensus was reached on all technical issues documented in NUREG/CR-6850. The methodology documented in this report reflects the current state-of-the-art in FPRA. These methods are expected to form a basis for RI analyses related to the plant FPP. Volume 1, the Executive Summary, provides general background and overview information, including both programmatic and technical, and project insights and conclusions. Volume 2 provides the detailed discussion of the recommended approach, methods, data, and tools for conduct of an FPRA. Supplement 1 provides clarifications and additional information on recommended approaches, methods, and data for conduct of an FPRA.

- Memorandum from Richard P. Correia, RES, to Joseph G. Giitter, NRR, titled "Interim Technical Guidance on Fire-Induced Circuit Failure Mode Likelihood Analysis," dated June 14, 2013 (Reference 55) notes that, based on new experimental information documented in NUREG/CR-6931, "Cable Response to Live Fire (CAROLFIRE)," issued April 2008 (Reference 56), and NUREG/CR- 7100, "Direct Current Electrical Shorting in Response to Exposure Fire (DESIREE-Fire): Test Results," issued April 2012 (Reference 57), the reduction in hot short probabilities for circuits provided with control power transformers (CPTs) identified in NUREG/CR-6850 cannot be repeated in experiments, and therefore, may be too high and should be reduced.

- NUREG-1805, "Fire Dynamics Tools (FDTs): Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program" (Reference 58), which provides quantitative methods, known as "Fire Dynamics Tools (FDTs)," to assist regional fire protection inspectors in performing fire hazard analysis. The FDTs are intended to assist fire protection inspectors in performing RI evaluations of credible fires that may cause critical damage to essential SSD equipment, as required by the new reactor oversight process defined in the NRC's inspection manual.

- NUREG-1824, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," Volumes 1 through 7 (Reference 59), which provides technical documentation regarding the predictive capabilities of a specific set of fire models for the analysis of fire hazards in NPP scenarios. This report is the result of a collaborative program with the EPRI and the National Institute of Standards and Technology (NIST). The selected models are:

  1. FDTs developed by the NRC (Volume 3),

  2. Fire-Induced Vulnerability Evaluation Methodology (FIVE), Revision 1, developed by EPRI (Volume 4),

  3. The zone model Consolidated Model of Fire and Smoke Transport (CFAST), developed by NIST (Volume 5),

  4. The zone model MAGIC developed by Electricite de France (Volume 6), and

  5. The computational fluid dynamics model fire dynamics simulator (FDS) developed by NIST (Volume 7).

In addition to the fire model volumes, Volume 1 is the comprehensive main report and Volume 2 is a description of the experiments and associated experimental uncertainty used in developing this report.

- NUREG/CR-7010, "Cable Heat Release, Ignition, and Spread in Tray Installations during Fire (CHRISTIFIRE), Volume 1: Horizontal Trays" (Reference 60), which describes Phase 1 of the CHRISTIFIRE testing program conducted by NIST. The overall goal of this multiyear program is to quantify the burning characteristics of grouped electrical cables installed in cable trays. This first phase of the program focuses on horizontal tray configurations. CHRISTIFIRE addresses the burning behavior of a cable in a fire beyond the point of electrical failure. The data obtained from this project can be used for the development of fire models to calculate the heat release rate (HRR) and flame spread of a cable fire.

- NUREG-1855, Volume 1, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making" (Reference 61), which provides guidance on how to treat uncertainties associated with PRA in RI decisionmaking. The objectives of this guidance include fostering an understanding of the uncertainties associated with PRA and their impact on the results of PRA and providing a pragmatic approach to addressing these uncertainties in the context of the decisionmaking. To meet the objective of the NUREG, it is necessary to understand the role that PRA results play in the context of the decision process. To define this context, NUREG-1855 provides an overview of the RI decision-making process itself.

- NUREG-1921, "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines – Final Report" (Reference 62), which presents the state-of-the-art in fire HRA practice. This report was developed jointly between RES and EPRI to develop the methodology and supporting guidelines for estimating human error probabilities (HEPs) for human failure events following the fire-induced initiating events of an FPRA. The report builds on existing HRA methods, and is intended primarily for practitioners conducting a fire HRA to support an FPRA.

- NUREG-1934, "Nuclear Power Plant Fire Modeling Analysis Guidelines (NPP FIRE MAG)" (Reference 63), which describes the implications of the verification and validation (V&V) results from NUREG-1824 for fire model users. The features and limitations of the fire models documented in NUREG-1824 are discussed relative to their use to support NPP fire hazard analyses. The report also provides information to assist fire model users in applying this technology in the NPP environment.

- NUREG/CR-6595, "An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events" (Reference 64), which provides a simplified approach for using PRA to estimate the frequency of containment failure and bypass events that result in radioactive releases to the environment with the potential for causing early fatalities. The approach uses LERF as a measure of the risk of early fatality and provides guidance for estimating LERF under low power and shutdown conditions.

- Generic Letter (GL) 2006-03, “Potentially Nonconforming Hemyc and MT Fire Barrier Configurations” (Reference 65), which requested that licensees evaluate their facilities to confirm compliance with the existing applicable regulatory requirements in light of the information provided in this GL and, if appropriate, take additional actions.

- Branch Technical Position (BTP) Chemical Engineering Branch (CMEB) 9.5-1, “Guidelines for Fire Protection for Nuclear Power Plants,” Revision 2, July 1981 (Reference 66), provides the NRC staff with guidance for implementing a deterministic FPP in accordance with 10 CFR 50, Section 50.48 and Appendix R.

- NFPA 13, “Standard for the Installation of Sprinkler Systems” (Reference 67), is the industry benchmark for design and installation of automatic fire sprinkler systems. NFPA 13 addresses sprinkler system design approaches, system installation, acceptance testing, and component options.

- NFPA 14, “Standard for the Installation of Standpipe and Hose Systems” (Reference 68), provides the minimum requirements for the installation of standpipes and hose systems to ensure that systems will work as intended to deliver adequate and reliable water supplies in a fire emergency. NFPA 14 covers all system components and hardware, including piping, fittings, valves, and pressure-regulation devices, as well as system requirements; installation requirements; design; plans and calculations; water supply; and system acceptance.

- Regulatory Issue Summary (RIS) 2004-03, Revision 1, “Risk-Informed Approach for Post-Fire Safe-Shutdown Circuit Inspections,” dated December 29, 2004 (Reference 69), informed the industry that the NRC has RI its inspection procedure for post-fire SSD circuit analysis inspections to concentrate inspections on circuit failures that have a relatively high likelihood of occurrence. The RIS describes three categories, or bins, of circuit failure likelihood and the inspection process used to assess circuit configurations in each of the three bins. This RIS also describes the process the NRC will use to implement the Reactor Oversight Process (ROP) for post-fire SSD circuit inspection findings.

- IN 84-09, Revision 1, “Lessons Learned from NRC Inspections of Fire Protection Safe Shutdown Systems (10 CFR 50, Appendix R),” dated March 7, 1984 (Reference 70), provides the industry with supplemental guidance on meeting the fire protection SSD requirements in 10 CFR 50, Appendix R. IN 84-09 includes supplemental guidance on establishing fire areas, fire barrier testing and configuration, protection of equipment necessary to achieve hot shutdown (HSD), performing reassessments for conformance with Appendix R, identification of SSD systems and components, assessing combustibility of electrical cable insulation, detection and automatic suppression, instrumentation and procedures necessary for alternative shutdown, fire protection features for cold shutdown (CSD) systems, and configuration of reactor coolant pump (RCP) oil collection systems.

- RG 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," Revision 4, issued March, 2012 (Reference 71), which provides methods that the NRC staff considers acceptable for use in implementing requirements regarding the sumps and suppression pools that provide water sources for emergency core cooling, containment heat removal, or containment atmosphere cleanup systems. RG 1.82 also provides guidelines for evaluating the adequacy and the availability of the sump or suppression pool for long-term recirculation cooling following a loss-of-coolant accident (LOCA).

2.3 Frequently Asked Questions

In the LAR, the licensee proposed to use a number of documents commonly known as FAQs. The following table provides the set of FAQs the licensee used that the NRC staff referenced in the preparation of this SE, as well as the SE sections to which each FAQ was referenced.

Table 2.3-1: Frequently Asked Questions

FAQ #	FAQ Title and Summary	Reference	SE Section
07-0030	"Establishing Recovery Actions" • This FAQ provides an acceptable process for determining the RAs for NFPA 805, Chapter 4 compliance. The process includes: ▪ Differentiation between RAs and activities in the main control room or at primary control station(s). ▪ Determination of which RAs are required by the NFPA 805 FPP. ▪ Evaluate the additional risk presented by the use of RAs. ▪ Evaluate the feasibility of the identified RAs. ▪ Evaluate the reliability of the identified RAs.	(Reference 72)	3.2.5 3.2.6.3 3.4.4 3.5.1.6 3.5.1.7
07-0038	"Lessons Learned on Multiple Spurious Operations (MSOs)" • This FAQ reflects an acceptable process for the treatment of MSOs during transition to NFPA 805: ▪ Step 1 – Identify potential MSO combinations of concern. ▪ Step 2 – Expert panel assesses plant-specific vulnerabilities and reviews MSOs of concern. ▪ Step 3 – Update the FPRA and Nuclear Safety Capability Assessment (NSCA) to include MSOs of concern. ▪ Step 4 – Evaluate for NFPA 805 compliance. ▪ Step 5 – Document the results.	(Reference 73)	3.2.4 3.2.7

FAQ #	FAQ Title and Summary	Reference	SE Section
07-0039	“Incorporation of Pilot Plant Lessons Learned – Table B-2” • This FAQ provides additional detail for the comparison of the licensee’s SSD strategy to the endorsed industry guidance, NEI 00-01 “Guidance for Post-Fire Safe Shutdown Circuit Analysis,” Revision 1 (Reference 74). In short, the process has the licensees: ▪ Assemble industry and plant-specific documentation; ▪ Determine which sections of the guidance are applicable; ▪ Compare the existing SSD methodology to the applicable guidance; and ▪ Document any discrepancies.	(Reference 75)	3.2.1
07-0040	“Non-Power Operations (NPOs) Clarifications” • This FAQ clarifies an acceptable NFPA 805 NPO program. The process includes: ▪ Selecting NPOs equipment and cabling. ▪ Evaluation of NPOs Higher Risk Evolutions (HRE). ▪ Analyzing NPO key safety functions (KSFs). ▪ Identifying plant areas to protect or “pinch points” during NPOs HREs and actions to be taken if KSFs are lost.	(Reference 76)	3.5.3 3.5.3.1 3.5.3.3 3.5.4
08-0046	“Incipient Fire Detection Systems” • This FAQ provides guidance for modeling non-suppression probability when an incipient fire detection system is installed in electrical cabinets outside the Main Control Room.	(Reference 77)	3.2.6.1 3.2.7
08-0049	“Cable Tray Fire Propagation” • This FAQ provides clarification regarding guidance on cable fire propagation for use in developing FPRAs.	(Reference 78)	3.4.2.3.2
08-0052	“Transient Fires - Growth Rates and Control Room Non-Suppression” • This FAQ clarifies and updates the treatment of transient fires in terms of both manual suppression and time-dependent fire growth modeling.	(Reference 79)	3.4.2.3.2

FAQ #	FAQ Title and Summary	Reference	SE Section
08-0054	"Compliance with Chapter 4 of NFPA 805" • This FAQ provides an acceptable process to demonstrate Chapter 4 compliance for transition: ▪ Step 1 – Assemble documentation ▪ Step 2 – Document Fulfillment of NSPC ▪ Step 3 – Variance From Deterministic Requirements (VFDR) Identification, Characterization, and Resolution Considerations ▪ Step 4 – Performance-Based Evaluations ▪ Step 5 – Final VFDR Evaluation ▪ Step 6 – Document Required Fire Protection Systems and Features	(Reference 80)	3.4.3 3.4.6 3.5.1.4
09-0056	"Radioactive Release Transition" • This FAQ provides an acceptable level of detail and content for the radioactive release section of the LAR. It includes: ▪ Justification of the compartmentation, if the radioactive release review is not performed on a fire area basis. ▪ Pre-fire plan and fire brigade training review results. ▪ Results from the review of engineering controls for gaseous and liquid effluents.	(Reference 81)	3.6.1
10-0059	"Monitoring Program" • This FAQ provides clarification regarding the implementation of an NFPA 805 monitoring program for transition. It includes: ▪ Monitoring program analysis units; ▪ Screening of low safety SSCs; ▪ Action level thresholds; and ▪ The use of existing monitoring programs.	(Reference 82)	3.1.1.1 3.7.1
12-0061	"NFPA 805 Change Process" • This FAQ summarizes an acceptable process for licensees to make changes to the FPP after implementing a 10 CFR 50.48(c) compliant FPP through the standard license condition described in Regulatory Guide (RG) 1.205.	(Reference 83)	2.6.1
13-0005	"Cable Fires Special Cases: Self-Ignited and Caused by Welding and Cutting" • This FAQ provides additional guidance for detailed FPRA/FM concerning self-ignited cable fires and cable fires caused by welding and cutting.	(Reference 84)	3.4.2.2

FAQ #	FAQ Title and Summary	Reference	SE Section
13-0006	"Modeling Junction Box Scenarios in a Fire PRA" • This FAQ provides a definition for junction boxes that allow the characterization and quantification of junction box fire scenarios in plant physical access units (PAUs) requiring detailed FPRA/FM analysis and also describes a process for quantifying the risk associated with junction box fire scenarios in such plant locations.	(Reference 85)	3.4.2.2

2.4 Orders, License Conditions, and Technical Specifications

Paragraph 50.48(c)(3)(i) of 10 CFR states, in part, that the LAR, "… must identify any orders and license conditions that must be revised or superseded, and contain any necessary revisions to the plant's technical specifications and the bases thereof."

2.4.1 Orders

The NRC staff reviewed LAR Section 5.2.3, "Orders and Exemptions," and LAR Attachment O, "Orders and Exemptions," with regard to NRC-issued orders pertinent to BFN that are being revised or superseded by the NFPA 805 transition process. The LAR stated that the licensee conducted a review of its docketed correspondence to determine if there were any orders or exemptions that needed to be superseded or revised. The LAR also stated that the licensee conducted a review to ensure that compliance with the physical protection requirements, security orders, and adherence to those commitments applicable to BFN are maintained. The licensee discussed the affected orders and exemptions in LAR Attachment O.

The licensee requested that five exemptions be rescinded and that two of the five exemptions be transitioned to the NFPA 805 FPP. The licensee also determined that no orders need to be superseded or revised to implement an FPP at BFN that comply with 10 CFR 50.48(c).

The licensee's review included an assessment of docketed correspondence files and electronic searches, including the NRC's Agencywide Documents Access and Management System (ADAMS). The review was performed to ensure that compliance with the physical protection requirements, security orders, and adherence to commitments applicable to BFN are maintained. The NRC staff accepts the licensee's determination that five exemptions should be rescinded and that two of the five exemptions are being transitioned to NFPA 805 as listed in LAR Attachment K, "Existing Licensing Action Transition," and that no orders need to be superseded or revised to implement NFPA 805. (See SE Section 2.5 for the NRC staff's detailed evaluation of the exemptions being rescinded.)

The licensee also performed a specific review of the license amendments that incorporated the mitigation strategies required by Section B.5.b of Commission Order EA-02-026 (subsequently incorporated into 10 CFR 50.54(hh)(2)) to ensure that any changes being made in order to comply with 10 CFR 50.48(c) do not invalidate existing commitments applicable to BFN. The licensee's review of this order and the related license amendment demonstrated that changes to the FPP during transition to NFPA 805 will not affect the mitigation measures required by

Commission Order EA-02-026. The NRC staff concludes that the licensee's determination in regard to Commission Order EA-02-026 is acceptable.

2.4.2 License Conditions

The NRC staff reviewed LAR Section 5.2.1, "License Condition Changes," and LAR Attachment M, "License Condition Changes," regarding changes the licensee seeks to make to the BFN fire protection license condition in order to adopt NFPA 805, as required by 10 CFR 50.48(c)(3).

The NRC staff reviewed the revised license condition, which supersedes the current BFN fire protection License Conditions 2.C.(13), 2.C.(14), and 2.C.(7) for consistency with the content guidance outlined by RP C.3.1 of RG 1.205, Revision 1, and with the proposed plant modifications identified in the LAR.

The revised license condition provides a structure and detailed criteria to allow self-approval for RI/PB, as well as other types of changes to the FPP. The structure and detailed criteria result in a process that meets the requirements in NFPA 805, Sections 2.4, "Engineering Analyses"; 2.4.3, "Fire Risk Evaluations"; and 2.4.4, "Plant Change Evaluation." These sections establish the requirements for the content and quality of the engineering evaluations to be used for approval of changes.

The revised license condition also defines the limitations imposed on the licensee during the transition phase of plant operations when the physical plant configuration does not fully match the configuration represented in the fire risk analysis. The limitations on self-approval are required because NFPA 805 requires that the risk analyses be based on the as-built, as-operated, and maintained plant, and reflect the operating experience at the plant. Until the proposed implementation items and plant modifications are completed, the risk analysis is not based on the as-built, as-operated, and maintained plant.

Overall, the licensee's proposed revised license condition allows self-approval for FPP changes that meet the requirements of NFPA 805 with regard to engineering analyses, fire risk evaluations (FREs), and plant change evaluations (PCEs). The NRC staff's evaluation of the self-approval process for FPP changes (post-transition) is contained in SE Section 2.6. The license condition also references the plant-specific modification and associated implementation item schedules that must be accomplished at BFN to complete transition to NFPA 805 and comply with 10 CFR 50.48(c). In addition, the license condition includes a requirement that appropriate compensatory measures remain in place until the specified plant modifications are completed. These modification and implementation schedules are identical to those identified elsewhere in the LAR, as discussed by the NRC staff in SE Sections 2.7.1 and 2.7.2, and reviewed in SE Section 3.0.

SE Section 4.0 provides the NRC staff's review of the proposed BFN FPP license condition.

2.4.3 Technical Specifications

The NRC staff reviewed LAR Section 5.2.2, "Technical Specifications," and LAR Attachment N, "Technical Specification Changes," with regard to proposed changes to the BFN TSs that are being revised or superseded during the NFPA 805 transition process. According to the LAR, the licensee conducted a review of the BFN TSs to determine which, if any, TS sections will be impacted by the transition to an RI/PB FPP based on 10 CFR 50.48(c). The licensee identified changes to the TSs needed for adoption of the new fire protection licensing basis and provided applicable justification listed in LAR Attachment N. The licensee identified one change to the TS that involved deleting TS 5.4.1.d, which requires that procedures be established, implemented, and maintained for FPP implementation.

Specifically, the licensee stated that deleting TS 5.4.1.d is acceptable for adoption of the new fire protection licensing basis since the requirement for establishing, implementing, and maintaining fire protection procedures is contained in 10 CFR 50.48(a) and (c), as specifically outlined in NFPA 805, Section 3.2.3, “Procedures,” and that inherent in the NFPA 805, Section 3.2.3 requirement to establish the fire protection procedures is that they be implemented and maintained. The regulations in 10 CFR 50.48(c) approve the incorporation of NFPA 805 by reference and NFPA 805, Section 3.2.3, “Procedures,” states that, “Procedures shall be established for implementation of the fire protection program.”

Based on the information provided by the licensee, the NRC staff concludes that the proposed change to the TS is acceptable because TS 5.4.1.d is an administrative control (i.e., a procedure the licensee puts in place to establish, implement, and maintain the FPP as required by the licensee’s fire protection license condition; 10 CFR 50.48(a) and (c); and NFPA 805, Section 3.2.3, and would be redundant to the NFPA 805 requirement to establish FPP procedures. NFPA 805 requires the licensee to establish FPP procedures, and 10 CFR 50.48(a) and (c) would become the fire protection licensing basis of BFN. In addition, failure by the licensee to establish FPP procedures would result in non-compliance with 10 CFR 50.48(c)(1), which is the licensee’s fire protection licensing basis. Changes to fire protection administrative controls are controlled by the proposed fire protection license condition (see SE Section 4.0.)

2.4.4 Safety Analysis Report

The NRC staff reviewed LAR Section 5.4, “Revision to the SAR,” which states that after the approval of the LAR, in accordance with 10 CFR 50.71(e), the BFN updated final safety analysis report (UFSAR) will be revised. The LAR further states that the content will be consistent with NEI 04-02.

The NRC staff concludes that the licensee’s method to update the SAR is acceptable because the licensee will update the SAR after approval of the LAR in accordance with 10 CFR 50.71(e), and the content will be consistent with the guidance contained in NEI 04-02.

2.5 Rescission of Exemptions

Since the BFN units were licensed to operate on December 20, 1973; June 28, 1974; and July 2, 1976, the BFN FPP is based on compliance with 10 CFR 50.48(a) and (b) (Appendix R), and the BFN fire protection license conditions.

The NRC staff reviewed LAR Section 5.2.3, "Orders and Exemptions"; LAR Attachment O; and LAR Attachment K with regard to previously-approved exemptions to Appendix R to 10 CFR Part 50, which the transition to an FPP licensing basis in conformance with NFPA 805 will supersede. These exemptions will no longer be required, since upon approval of the RI/PB FPP in accordance with NFPA 805, Appendix R will not be part of the licensing basis for BFN.

The licensee requested and received NRC approval for five exemptions from 10 CFR Part 50, Appendix R. These exemptions were discussed in detail in LAR Attachment K. The licensee requested that the exemptions be rescinded and that two of the five exemptions be transitioned to the new licensing basis under 10 CFR 50.48(a) and (c), as previously approved (NFPA 805, Section 2.2.7) and compliant with the new regulation.

Disposition of Appendix R exemptions may follow two different paths during transition to NFPA 805:

- The exemption was found to be unnecessary because the underlying condition has been evaluated using RI/PB methods (FM and/or FRE) and found to be acceptable and no further actions are necessary by the licensee; and

- The exemption was found to be appropriate as a qualitative engineering evaluation that meets the deterministic requirements of NFPA 805 and is carried forward as part of the engineering analyses supporting NFPA 805 transition.

The following exemptions are rescinded as requested by the LAR, and the underlying condition has either been evaluated using RI/PB methods, evaluated using an existing engineering equivalency evaluation (EEEE), or found to be deterministically compliant, and found to be acceptable with no further actions:

- Exemption from the requirements of Appendix R, Section III.G.3, for Fixed Fire Suppression in the Main Control Rooms.

- Exemption from the requirements of Appendix R, Section III.G.3, for Fixed Suppression and Detection in the Control Building Areas that Require Alternative Shutdown.

- Exemption from the requirements of Appendix R, Section III.L, for No Core Uncovery.

The following exemptions are rescinded, but the engineering evaluation of the underlying condition will be used as a qualitative engineering evaluation for transition to NFPA 805 (see SE Section 3.5.1.3):

- Exemption from the requirements of Appendix R, Section III.G.2.b, for Automatic Fire Suppression Systems in the residual heat removal (RHR) Pump/Heat Exchanger Rooms.

- Exemption from the requirements of Appendix R, Section III.G.2.b, for Intervening Combustibles within a 20-Foot Separation Space Between Redundant Safe Shutdown System Components in the Reactor Building.

2.6 Self-Approval Process for Fire Protection Program Changes (Post-Transition)

Upon completion of the implementation of the RI/PB FPP and issuance of the license condition discussed in SE Section 2.4.2, changes to the approved FPP must be evaluated by the licensee to ensure that they are acceptable.

NFPA 805, Section 2.2.9, “Plant Change Evaluation,” states:

> In the event of a change to a previously approved fire protection program element, a risk-informed plant change evaluation shall be performed and the results used as described in 2.4.4 to ensure that the public risk associated with fire-induced nuclear fuel damage accidents is low and that adequate defense-in-depth and safety margins are maintained.

NFPA 805, Section 2.4.4, “Plant Change Evaluation,” states:

> A plant change evaluation shall be performed to ensure that a change to a previously approved fire protection program element is acceptable. The evaluation process shall consist of an integrated assessment of the acceptability of risk, defense-in-depth, and safety margins.

2.6.1 Post-Implementation Plant Change Evaluation Process

The NRC staff reviewed LAR Section 4.7.2, “Compliance with Configuration Control Requirements in Sections 2.7.2 and 2.2.9 of NFPA 805,” for compliance with the NFPA 805 PCE process requirements to address potential changes to the NFPA 805 RI/PB FPP after implementation is completed. The licensee will develop a change process that is based on the guidance provided in NEI 04-02, Section 5.3, “Plant Change Process,” as well as Appendices B, I, and J, as modified by RG 1.205 and RPs 2.2.4, 3.1, 3.2, and 4.3. In a letter dated December 20, 2013 (Reference 11), the licensee stated the change evaluation process will be based upon FAQ 12-0061 (Reference 83), when it is approved.

LAR Section 4.7.2 states that the PCE process will consist of four steps:

1. Defining the change,
2. Performing the preliminary risk screening,
3. Performing the risk evaluation, and
4. Evaluating the acceptance criteria.

In the LAR, the licensee stated that the PCE process begins by defining the change or altered condition to be examined and the baseline configuration. The licensee stated that the baseline is defined as that plant condition or configuration that is consistent with the design basis and licensing basis (NFPA 805 licensing basis post-transition) and that the changed or altered condition or configuration that is not consistent with the design basis and licensing basis is defined as the proposed alternative.

The licensee stated that once the definition of the change is established, a screening will be performed to identify and resolve minor changes to the FPP and the screening will be consistent with fire protection regulatory review processes currently in place at nuclear plants under traditional licensing bases. The licensee stated that the screening process is modeled after the NEI 02-03, “Guidance for Performing a Regulatory Review of Proposed Changes to the Approved Fire Protection Program” (Reference 86), and that this process will address most administrative changes (e.g., changes to the combustible control program, organizational changes, etc.). The licensee further stated that if the characteristics of an acceptable screening process that meet the “assessment of the acceptability of risk” requirement of Section 2.4.4 of NFPA 805 are not met, it will proceed to the risk evaluation step of the PCE process.

The licensee stated that the risk evaluation screening will be followed by engineering evaluations that may include FM and risk assessment techniques, and the results of the evaluations are compared to the acceptance criteria. The licensee stated that changes that satisfy the acceptance criteria of NFPA 805, Section 2.4.4 and the license condition can be implemented within the framework provided by NFPA 805, and that changes that do not satisfy the acceptance criteria cannot be implemented within this framework. The licensee further stated that the acceptance criteria will require that the resultant change in core damage frequency (CDF) and LERF be consistent with the license condition, and the acceptance criteria will also include consideration of DID and safety margin, which would typically be qualitative in nature.

The licensee stated that the risk evaluation involves the application of FM analyses and risk assessment techniques to obtain a measure of the changes in risk associated with the proposed change. The licensee also stated that in certain circumstances, an initial evaluation in the development of the risk assessment could be a simplified analysis using bounding assumptions, provided the use of such assumptions does not unnecessarily challenge the acceptance criteria.

The licensee stated that PCEs are assessed for acceptability using the change in CDF (delta-CDF or ΔCDF) and change in LERF (delta-LERF or ΔLERF) criteria from the license condition and that the proposed changes are assessed to ensure they are consistent with the DID philosophy and sufficient safety margins are maintained.

The licensee stated its FPP configuration is defined by the program documentation and that, to the greatest extent possible, the existing configuration control processes for modifications, calculations and analyses, and FPP license basis reviews will be utilized to maintain configuration control of the FPP documents. The licensee further stated the configuration control procedures that govern the fire protection-related documents and databases will be revised to reflect the new NFPA 805 licensing bases requirements. This action is included in Implementation Item 24, which is included in LAR Attachment S, “Modifications and Implementation Items,” Table S-3. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

The licensee stated that several NFPA 805 document types, such as nuclear safety capability assessment (NSCA) supporting information and non-power mode NSCA treatment, will generally require new control procedures and processes to be developed, since they are new documents and databases created as a result of the transition to NFPA 805. The licensee further stated the new procedures will be modeled after the existing processes for similar types of documents and databases. The licensee further stated system level design basis documents will be revised to reflect the NFPA 805 role that the systems and components now play. This action is included in Implementation Item 24, which is included in LAR Attachment S, Table S-3. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

The licensee stated that the process for capturing the impact of proposed changes to the plant on the FPP will continue to be a multiple step review and that the first step of the review will be an initial screening for process users to determine if there is a potential to impact the FPP as defined under NFPA 805 through a series of screening questions/checklists contained in one or more procedures depending upon the configuration control process being used. The licensee further stated that reviews that identify potential FPP impacts will be sent to qualified individuals (e.g., fire protection, SSD/NSCA, FPRA) to ascertain the program impacts, if any, and that if FPP impacts are determined to exist as a result of the proposed change, the issue would be resolved by one of the following:

- Deterministic Approach: Comply with NFPA 805, Chapter 3 and Section 4.2.3 requirements; or

- PB Approach: Utilize the NFPA 805 change process developed in accordance with NEI 04-02, RG 1.205, and the NFPA 805 fire protection license condition to assess the acceptability of the proposed change. This process would be used to determine if the proposed change could be implemented "as-is" or whether prior NRC approval of the proposed change is required.

The licensee stated that this process follows the requirements in NFPA 805 and the guidance outlined in RG 1.174 (Reference 45), which requires the use of qualified individuals, procedures that require calculations to be subject to independent review and verification, record retention, peer review, and a corrective action program that ensures appropriate actions are taken when errors are discovered.

Since NFPA 805 always requires the use of a PCE regardless of what element requires the change, the NRC staff concludes that, in accordance with the requirements of NFPA 805, if FPP impacts are determined to exist as a result of the proposed change, the issue would be resolved by utilizing the NFPA 805 change process developed in accordance with NEI 04-02, as modified by FAQ 12-0061, RG 1.205, and the NFPA 805 fire protection license condition to assess the acceptability of the proposed change. This process will be used to determine if prior NRC approval of the proposed change is required.

Based on the information provided by the licensee, the NRC staff concludes that the licensee's PCE process is acceptable because it meets the guidance in NEI 04-02, Revision 2 (Reference 7), as modified by FAQ 12-0061 (Reference 83), as well as RG 1.205, Revision 1 (Reference 4), and addresses attributes for using FREs in accordance with NFPA 805. NFPA 805, Section 2.4.4 requires that PCEs consist of an integrated assessment of risk, DID, and safety margin. NFPA 805, Section 2.4.3.1 requires that the PSA use CDF and LERF as measures for risk. NFPA 805, Section 2.4.3.3 requires that the risk assessment approach, methods, and data shall be acceptable to the authority having jurisdiction (AHJ), which is the NRC. NFPA 805, Section 2.4.3.3 also requires that the PSA be appropriate for the nature and scope of the change being evaluated, based on the as-built, as-operated, and maintained plant, and reflect the operating experience at the plant.

The licensee's PCE process includes the required delta risk calculations, uses risk assessment methods acceptable to the NRC, uses appropriate risk acceptance criteria in determining acceptability, involves the use of an FPRA of acceptable quality, and includes an integrated assessment of risk, DID, and safety margin as discussed above.

2.6.2 Requirements for the Self-Approval Process Regarding Plant Changes

Risk assessments performed to evaluate PCEs must utilize methods that are acceptable to the NRC staff. Acceptable methods to assess the risk of the proposed plant change may include methods that have been (1) used in developing the peer-reviewed FPRA model, (2) approved by the NRC via a plant-specific license amendment or through NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or (3) demonstrated to bound the risk impact.

Based on the information provided by the licensee in the LAR, the process established to evaluate post-transition plant changes meets the guidance in NEI 04-02, Revision 2 (Reference 7), as modified by FAQ 12-0061 (Reference 83), as well as RG 1.205, Revision 1 (Reference 4). The NRC staff concludes that the proposed PCE process at BFN, which includes defining the change, a preliminary risk screening, a risk evaluation, and an acceptability determination as described in Section 2.6.1 is acceptable, because it addresses the required delta risk calculations; uses risk assessment methods acceptable to the NRC; uses appropriate risk acceptance criteria in determining acceptability; involves the use of an FPRA of acceptable quality; and includes an integrated assessment of risk, DID, and safety margins.

However, before achieving full compliance with 10 CFR 50.48(c) by implementing the plant modifications listed in SE Section 2.7.1 (i.e., during full implementation of the transition to NFPA 805), RI changes to the licensee's FPP may not be made without prior NRC review and approval unless the changes have been demonstrated to have no more than a minimal risk impact using the screening process discussed above. The risk analysis is not consistent with the as-built, as-operated, and maintained plant because the modifications have not been completed. In addition, the licensee is required to ensure that fire protection DID and safety margins are maintained during the transition process. The "transition license conditions" in the proposed NFPA 805 license condition include the appropriate acceptance criteria and other attributes to form an acceptable method for meeting RP C.3.1 of RG 1.205, Revision 1 (Reference 4), with respect to the requirements for FPP changes during transition, and therefore, demonstrate compliance with 10 CFR 50.48(c).

The proposed NFPA 805 license condition also includes a provision for self-approval of changes to the FPP that may be made on a qualitative rather than an RI basis. Specifically, the license conditions state that prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3 fundamental FPP elements and design requirements for which an engineering evaluation demonstrates that the alternative to the NFPA 805, Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3 element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement (i.e., has not impacted its contribution toward meeting the nuclear safety and radioactive release performance criteria), using a relevant technical requirement or standard.

Use of this approach does not fall under NFPA 805, Section 1.7, "Equivalency," because the condition can be shown to meet the NFPA 805, Chapter 3 requirement. Section 1.7 of NFPA 805 is a standard format used throughout NFPA standards. It is intended to allow owner/operators to use the latest state-of-the-art fire protection features, systems, and equipment, provided the alternatives are of equal or superior quality, strength, fire resistance, durability, and safety. However, the intent is to require approval from the AHJ because not all of these state-of-the-art features are in current use or have relevant operating experience. This is a different situation than the use of functional equivalency since functional equivalency demonstrates that the condition meets the NFPA 805 code requirement.

Alternatively, the licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the changes are "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3 listed below, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement (with respect to the ability to meet the nuclear safety and radioactive release performance criteria), using a relevant technical requirement or standard. NFPA 805, Section 2.4 states that engineering analysis is an acceptable means of evaluating an FPP against performance criteria. Engineering analyses shall be permitted to be qualitative or quantitative. Use of qualitative engineering analyses by a qualified fire protection engineer to determine that a change has not affected the functionality of the component, system, procedure, or physical arrangement is allowed by NFPA 805, Section 2.4.

The four specific sections of NFPA 805, Chapter 3 for which prior NRC review and approval are not required to implement alternatives that an engineering evaluation has demonstrated are adequate for the hazard are:

1. "Fire Alarm and Detection Systems" (Section 3.8),

2. "Automatic and Manual Water-Based Fire Suppression Systems" (Section 3.9),

3. "Gaseous Fire Suppression Systems" (Section 3.10), and

4. "Passive Fire Protection Features" (Section 3.11).

The engineering evaluations described above (i.e., functionally equivalent and adequate for the hazard) are engineering analyses governed by the NFPA 805 guidelines. In particular, this means that the evaluations must meet the requirements of NFPA 805, Section 2.4, "Engineering Analyses," and NFPA 805, Section 2.7, "Program Documentation, Configuration Control, and Quality." Specifically, the effectiveness of the fire protection features under review must be evaluated and found acceptable in relation to their ability to detect, control, suppress, and extinguish a fire and provide passive protection to achieve the performance criteria and not exceed the damage threshold for the plant being analyzed. The associated evaluations must also meet the documentation content (as outlined by NFPA 805, Section 2.7.1, "Content") and quality requirements (as outlined by NFPA 805, Section 2.7.3, "Quality") of the standard in order to be considered adequate. Note that the NRC staff's review of the licensee's compliance with NFPA 805, Sections 2.7.1 and 2.7.3 is provided in SE Section 3.8.

According to the LAR, the licensee intends to use an FPRA to evaluate the risk of proposed future plant changes. SE Section 3.4.2, "Quality of the Fire Probabilistic Risk Assessment," discusses the technical adequacy of the FPRA, including the licensee's process to ensure that the FPRA remains current. The NRC staff determined that the quality of the licensee's FPRA and associated administrative controls and processes for maintaining the quality of the PRA model is sufficient to support self-approval of future RI changes to the FPP under the proposed license conditions. The NRC staff concludes that the licensee's process for self-approving future FPP changes is acceptable.

The NRC staff also concludes that the FRE methods used at BFN to model the cause and effect relationship of associated changes as a means of assessing the risk of plant changes during transition to NFPA 805 may continue to be used after implementation of the RI/PB FPP, based on the licensee's administrative controls, to ensure that the models remain current and to assure continued quality. (See SE Section 3.4.2, "Quality of the Fire Probabilistic Risk Assessment.") Accordingly, these cause and effect relationship models may be used after transition to NFPA 805 as a part of the FREs conducted to determine the change-in-risk associated with proposed plant changes.

2.7 Modifications and Implementation Items

RP C.3.1 of RG 1.205, Revision 1 (Reference 4), says that a license condition included in an NFPA 805 LAR should include (1) a list of modifications being made to bring the plant into compliance with 10 CFR 50.48(c), (2) a schedule detailing when these modifications will be completed, and (3) a statement that the licensee shall maintain appropriate compensatory measures in place until implementation of the modifications are completed.

The NRC staff noted that the list of modifications and implementation items originally submitted in the LAR have been updated by the licensee with the final version of LAR Attachment S. The updated LAR Attachment S is provided in the licensee's letters dated September 8, 2015 (Reference 29), and October 20, 2015 (Reference 30).

2.7.1 Modifications

The NRC staff reviewed LAR Attachment S, which describes the plant modifications necessary to implement the NFPA 805 licensing basis, as proposed. These modifications are identified in the LAR as necessary to bring BFN into compliance with either the deterministic or PB requirements of NFPA 805. As described below, LAR Attachment S, Table S-2 provides a description of each of the proposed plant modifications, presents the problem statement explaining why the modification is needed, and identifies the compensatory actions required to be in place pending completion and implementation of the modification.

The NRC staff's review confirmed that the modifications identified in LAR Table S-2 are the same as those identified in LAR Table B-3, "Fire Area Transition," on a fire area basis as the modifications being credited in the proposed NFPA 805 licensing basis. The NRC staff also confirmed that LAR Attachment S, Table S-2 modifications and associated completion schedule are the same as those provided in the proposed NFPA 805 license condition.

LAR Attachment S, Table S-2 provides a detailed listing of the plant modifications that must be completed in order for BFN to be in full accordance with NFPA 805, implements many of the attributes upon which this SE is based, and thereby, meets the requirements of 10 CFR 50.48(c). The modifications will be completed in accordance with the schedule provided in the proposed NFPA 805 license condition, which states that the modifications will be completed no later than the end of the second refueling outage (for each unit) following issuance of the license amendment and that appropriate compensatory measures will be maintained until the modifications are complete.

2.7.2 Implementation Items

Implementation items are items that the licensee has not fully completed or implemented as of the issuance date of the license amendments, but which will be completed during implementation of the license amendments to transition to NFPA 805 (e.g., procedure changes that are still in process or NFPA 805 programs that have not been fully implemented). The licensee identified the implementation items in LAR Attachment S, Table S-3. For each implementation item, the licensee and the NRC staff have reached a satisfactory resolution involving the level of detail and main attributes that each remaining change will incorporate upon completion. Completion of these items in accordance with the schedule discussed in SE Section 2.7.3 does not change or impact the bases for the safety conclusions made by the NRC staff in the SE.

Each implementation item will be completed prior to the deadline for implementation of the RI/PB FPP based on NFPA 805 as specified in the license condition and the letter transmitting the amended license (i.e., implementation period), which states that the implementation items listed in LAR Attachment S, Table S-3, will be completed within 240 days after issuance of the license amendment unless that date falls within a scheduled refueling outage. Implementation will then occur within 60 days after startup from that scheduled refueling outage. Implementation Items 32 and 33 are associated with modifications and will be completed after all procedure updates, modifications, and training are complete.

The NRC staff, through an onsite audit or during a future fire protection inspection, may choose to examine the closure of the implementation items with the expectation that any variations discovered during this review, or concerns with regard to adequate completion of the implementation item, would be tracked and dispositioned appropriately under the licensee's corrective action program and could be subject to appropriate NRC enforcement action as they are required by the proposed license conditions.

2.7.3 Schedule

LAR Section 5.5 provides the overall schedule for completing the NFPA 805 transition at BFN. The licensee stated that it will complete the implementation of new NFPA 805 FPP to include procedure changes, process updates, and training to affected plant personnel within 240 days after issuance of the license amendment, unless that date falls within a scheduled refueling outage. Implementation will then occur within 60 days after startup from that scheduled refueling outage. Implementation Items 32 and 33 are associated with modifications and will be completed after all procedure updates, modifications, and training are complete.
LAR Section 5.5 also states that modifications will be completed no later than the end of the second refueling outage (for each unit) following issuance of the license amendment and that appropriate compensatory measures will be maintained until modifications are complete.

Based on the information provided by the licensee, the NRC staff concludes that the completion schedules proposed by the licensee for the modifications and implementation items are acceptable.

3.0 TECHNICAL EVALUATION

The following sections evaluate the technical aspects of the LAR (Reference 8) to transition the fire protection program (FPP) at Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, to one based on NFPA 805 (Reference 3), in accordance with 10 CFR 50.48(c). While performing the technical evaluation of the licensee's submittal, the NRC staff utilized the guidance provided in NUREG-0800, Section 9.5.1.2, "Risk-Informed, Performance-Based Fire Protection" (Reference 49), to determine whether the licensee had provided sufficient information in both scope and level of detail to adequately demonstrate compliance with the requirements of NFPA 805, as well as the other associated regulations and guidance documents discussed in SE Section 2.0. Specifically:

- Section 3.1 provides the results of the NRC staff review of the licensee's transition of the FPP from the existing deterministic guidance to that of NFPA 805, Chapter 3, "Fundamental FPP and Design Elements."

- Section 3.2 provides the results of the NRC staff review of the methods used by the licensee to demonstrate the ability to meet the nuclear safety performance criteria (NSPC).

- Section 3.3 provides the results of the NRC staff review of the FM methods used by the licensee to demonstrate the ability to meet the NSPC using a fire modeling (FM) performance-based (PB) approach.

- Section 3.4 provides the results of the NRC staff review of the fire risk assessments used to demonstrate the ability to meet the NSPC using a fire risk evaluation (FRE) PB-based approach.

- Section 3.5 provides the results of the NRC staff review of the licensee's NSCA results by fire area.

- Section 3.6 provides the results of the NRC staff review of the methods used by the licensee to demonstrate an ability to meet the radioactive release performance criteria.

- Section 3.7 provides the results of the NRC staff review of the NFPA 805 monitoring program developed as a part of the transition to a risk-informed/performance-based (RI/PB) FPP based on NFPA 805.

- Section 3.8 provides the results of the NRC staff review of the licensee's program documentation, configuration control, and quality assurance (QA) program.

SE Attachments A and B provide additional detailed information that was evaluated by the NRC staff to support the licensee's request to transition to an RI/PB FPP in accordance with NFPA 805 (i.e., 10 CFR 50.48(c)). These attachments are discussed, as appropriate, in the associated SE sections.

3.1 NFPA 805 Fundamental FPP Elements and Minimum Design Requirements

NFPA 805, Chapter 3 contains the fundamental elements of the FPP and specifies the minimum design requirements for fire protection systems and features that are necessary to meet the standard. The fundamental FPP elements and minimum design requirements include necessary attributes pertaining to the fire protection plan and procedure; the fire prevention program and design controls; industrial fire brigades; and fire protection structures, systems, and components (SSCs). However, 10 CFR 50.48(c) provides exceptions, modifications, and supplementations to certain aspects of NFPA 805, Chapter 3 as follows:

- 10 CFR 50.48(c)(2)(v) – *Existing cables*. In lieu of installing cables meeting flame propagation tests as required by Section 3.3.5.3 of NFPA 805, a flame-retardant coating may be applied to the electric cables, or an automatic fixed fire suppression system may be installed to provide an equivalent level of protection. In addition, the italicized exception to Section 3.3.5.3 of NFPA 805 is not endorsed.

- 10 CFR 50.48(c)(2)(vi) – *Water supply and distribution*. The italicized exception to Section 3.6.4 of NFPA 805 is not endorsed. Licensees who wish to use the exception to Section 3.6.4 of NFPA 805 must submit a request for a license amendment in accordance with 10 CFR 50.48(c)(2)(vii).

- 10 CFR 50.48(c)(2)(vii) – *Performance-based methods*. While Section 3.1 of NFPA 805 prohibits the use of PB methods to demonstrate compliance with the

> NFPA 805, Chapter 3 requirements, 10 CFR 50.48(c)(2)(vii) states that the FPP elements and minimum design requirements of NFPA 805, Chapter 3 may be subject to the PB methods permitted elsewhere in the standard, provided a license amendment is granted and the approach satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release, maintains safety margins; and maintains fire protection defense-in-depth.

Furthermore, Section 3.1 of NFPA 805 specifically allows the use of alternatives to the NFPA 805, Chapter 3 fundamental FPP requirements that have been previously approved by the NRC (which is the authority having jurisdiction (AHJ), as denoted in NFPA 805 and Regulatory Guide (RG) 1.205), and are contained in the currently approved FPP for the facility.

3.1.1 Compliance with NFPA 805, Chapter 3 Requirements

The licensee used the systematic approach described in Nuclear Energy Institute (NEI) 04-02, Revision 2 (Reference 7), as endorsed by the NRC in RG 1.205, Revision 1 (Reference 4), to assess the proposed BFN FPP against the NFPA 805, Chapter 3 requirements.

As part of this assessment, the licensee reviewed each section and subsection of NFPA 805, Chapter 3 against the existing BFN FPP and provided specific compliance statements for each NFPA 805, Chapter 3 attribute that contained applicable requirements. As discussed below, some subsections of NFPA 805, Chapter 3 do not contain requirements or are otherwise not applicable to BFN, and others are provided with multiple compliance statements to fully document compliance with the element.

The methods used by BFN for achieving compliance with the fundamental FPP elements and minimum design requirements are as follows:

1. The existing FPP element directly complies with the requirement: Noted in license amendment request (LAR) Attachment A, "NEI 04-02 Table B-1, Transition of Fundamental Fire Protection Program and Design Elements," as "Complies." (See discussion in SE Section 3.1.1.1.)

2. The existing FPP element complies through the use of an explanation or clarification: Noted in LAR Attachment A, Table B-1 as "Complies with clarification." (See discussion in SE Section 3.1.1.2.)

3. The existing FPP element complies through the use of existing engineering equivalency evaluations (EEEEs) whose bases remain valid and are of sufficient quality: Noted in LAR Attachment A, Table B-1 as "Complies with Use of EEEEs." (See discussion in SE Section 3.1.1.3.)

4. The existing FPP element complies with the requirement based on prior NRC approval of an alternative to the fundamental FPP attribute and the bases for the NRC approval remain valid: Noted in LAR Attachment A, Table B-1 as "Complies with previous NRC approval." (See discussion in SE Section 3.1.1.4.)

5. The existing FPP element does not comply with the requirement, but the licensee is requesting specific approval for a PB method in accordance with 10 CFR 50.48(c)(2)(vii): Noted in LAR Attachment A, Table B-1 as “Submit for NRC approval.” (See discussion in SE Section 3.1.1.5.)

The licensee stated in LAR Section 4.1.1, “Overview of Evaluation Process,” that some of the Compliance Basis descriptions contain items for implementation. For these specific NFPA 805 requirements, the compliance statement (i.e., complies, complies with use of existing engineering equivalency evaluations, and complies with previous approval) is meant to convey the BFN compliance position after the items for implementation are complete (i.e., not at time of submittal of the LAR).

The NRC staff determined that, taken together, these methods compose an acceptable approach for documenting compliance with the NFPA 805, Chapter 3 requirements, because the licensee followed the compliance strategies identified in the endorsed NEI 04-02 guidance document. The process defined in the endorsed guidance provides an organized structure to document each attribute in NFPA 805, Chapter 3, allowing the licensee to provide significant detail in how the program meets the requirements. In addition to the basic strategy of “Complies,” which itself makes the attribute both auditable and inspectable, additional strategies have been provided, allowing for amplification of information, when necessary, regarding how or why the attribute is acceptable.

The licensee stated in LAR Section 4.2.2, “Existing Engineering Equivalency Evaluation Transition,” that it evaluated the EEEEs used to demonstrate compliance with the NFPA 805, Chapter 3 requirements in order to ensure continued appropriateness, quality, and applicability to the current BFN plant configuration. The licensee determined that no EEEE used to support compliance with NFPA 805 required NRC approval.

EEEEs refer to “existing engineering equivalency evaluations” (previously known as GL 86-10 evaluations) performed for fire protection design variances such as fire protection system designs and fire barrier component deviations from the specific fire protection deterministic requirements. Once a licensee transitions to NFPA 805, future equivalency evaluations are to be conducted using a PB approach. The evaluation should demonstrate that the specific plant configuration meets the performance criteria in the standard.

Additionally, the licensee stated in LAR Section 4.2.3, “Licensing Action Transition,” that the existing licensing actions used to demonstrate compliance have been evaluated to ensure that their bases remain valid. The results of these licensing action evaluations are provided in LAR Attachment K.

LAR Attachment A, Table B-1 provides further details regarding the licensee’s compliance strategy for specific NFPA 805, Chapter 3 requirements, including references to where compliance is documented.

3.1.1.1 Compliance Strategy -- Complies

For the majority of the NFPA 805, Chapter 3 requirements, as modified by 10 CFR 50.48(c)(2), the licensee determined that the RI/PB FPP complies directly with the fundamental FPP element using the existing FPP element. In these instances, the NRC staff concludes that the licensee's statements of compliance are acceptable based on the information provided by the licensee in the LAR and the information gained from the NFPA 805 site audit (the documents reviewed, discussions held with the licensee's technical staff, and the plant tours performed).

The following NFPA 805 Sections identified in LAR Attachment A, Table B-1, as complying with this method and an applicable LAR Attachment S, Table S-3, implementation item, required additional review by the NRC staff:

- 3.2.2.4
- 3.2.3(3)
- 3.3.1.2(1)
- 3.3.1.2(2)
- 3.3.1.2(4)
- 3.3.1.3.4
- 3.3.5.1
- 3.3.7
- 3.3.9
- 3.3.10
- 3.4.2
- 3.4.2.3
- 3.4.3 (a)(2)
- 3.4.3(b)
- 3.4.5.1
- 3.4.5.3
- 3.10.5

NFPA 805, Section 3.2.2.4 requires that the policy document identify the appropriate AHJ. The licensee stated that the Fire Protection Report will be updated to include the statement that the NRC is the AHJ for fire protection changes requiring approval. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 2. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.2.3(3) requires that procedures are used to review related performance and trends. The licensee stated that the monitoring program required by NFPA 805 Section 2.6 will be implemented as part of the FPP transition to NFPA 805, in accordance with NFPA 805 frequently asked question (FAQ) 10-0059, and will include a process that reviews fire protection performance and trends in performance. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 3. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.1.2(1) requires that wood used in the power block shall be listed pressure-impregnated or coated with a listed fire-retardant application. The licensee stated that it will revise the procedure for control of combustibles to only allow untreated lumber with a cross section dimension of 6 in. x 6 in. or larger to be used. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 4. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.1.2(2) requires that plastic sheeting used in the power block be fire-retardant types. The licensee stated that the control procedure for plastic sheeting allows plastic sheeting materials that meet the requirements of NFPA 701 (Reference 87) or UL Standard 214 and that UL Standard 214 has been withdrawn, and therefore, will be removed from the procedure. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 5. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.1.2(4) requires that limits be established on the types and quantities of stored materials. The licensee stated that it will revise the procedure for control of combustibles to establish limits on the types and quantities of materials in designated storage areas. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 35. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.1.3.4 requires that plant administrative procedures control the use of portable electric heaters. The licensee stated that it will revise the ignition source procedure to include controls on the use of electric heaters, and to prohibit the use of portable fuel-fired heaters in plant areas containing equipment important to nuclear safety or where there is a potential for radiological releases resulting from a fire. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 6. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.5.1 requires that electrical wiring above suspended ceilings be listed for plenum use, routed in armored cable, routed in metallic conduit, or routed in cable trays with solid metal top and bottom covers. The licensee documented that there are several fire zones in the Control Building that contain electrical wiring above suspended ceilings that are not listed for plenum use, routed in armored cable, routed in metallic conduit or routed in cable trays with solid metal top and bottom covers and asked for NRC staff approval for the use of PB methods to justify this configuration. The NRC staff's evaluation of this request is discussed in section 3.1.4.3 of this SE. The licensee stated that plant specifications do not include requirements for wiring installed above suspended ceilings; therefore, specifications will be revised to specify that future wiring above suspended ceilings shall be listed for plenum use, routed in armored cable, routed in metallic conduit, or routed in cable trays with solid metal top and bottom covers. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 8. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.7 requires that bulk compressed or cryogenic flammable gas storage not be permitted inside structures. The licensee stated that specific guidance and restrictions on bulk flammable gas storage on site will be developed. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 38. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.9 requires that transformer oil collection basins and drain paths be periodically inspected. The licensee stated that it will revise current plant transformer fire protection testing procedures to ensure that the gravel drainage areas around the transformers are free of debris and capable of performing their design function. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 10. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.10 requires that combustible liquids, including high flashpoint lubricating oils, be kept from coming in contact with hot pipes and surfaces, including insulated pipes and surfaces and that administrative controls shall require the prompt cleanup of oil on insulation. The licensee stated that the housekeeping procedure will be revised to include a requirement for the prompt cleanup of combustible liquids discovered on insulation, including high flashpoint lubricating oils and that the control of transient combustible procedure will be updated to keep such fluids from coming in contact with hot pipes and surfaces, including insulated pipes and surfaces. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 11. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Sections 3.4.2 and 3.4.2.3 require that current and detailed pre-fire plans be available to the control room (CR) and fire brigade. The licensee stated that procedures will be updated to require pre-fire plans be made available in the CR and to the plant industrial fire brigade. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 13. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.4.3(a)(2) requires that industrial fire brigade members be given quarterly training and practice in firefighting, including radioactivity and health physics considerations. The licensee stated that it will revise fire brigade training procedures to require fire brigade members to receive training in firefighting considerations of radioactivity and health physics on a quarterly basis. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 14. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.4.3(b) requires that plant personnel who respond with the industrial fire brigade be trained. The licensee stated that it will revise fire brigade training procedures to include training for the secondary response group as to their responsibilities, potential hazards to be encountered, and interfacing with the fire brigade. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 15. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.4.5.1 requires that offsite fire authorities be offered a plan for their interface during fires and related emergencies. The licensee stated that it will revise fire emergency response procedures to require that offsite fire authorities be offered a plan for their interface during fire emergencies on site. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 39. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.4.5.3 requires that plant security and radiation protection plans address offsite fire authority response. The licensee stated that it will revise the fire emergency response procedure to detail specific plans for plant security and radiation protection responsibilities regarding offsite fire authority response. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 16. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.10.5 requires that provisions for locally disarming automatic gaseous suppression systems shall be secured and under strict administrative control. The licensee stated that it will revise flow drawings for the carbon dioxide (CO_2) systems to note that the CO_2 shutoff valves are locked in the open position. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 41. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

The following NFPA 805 Sections identified in LAR Attachment A, Table B-1 as complying with this method required additional review by the NRC staff:

- 3.3.6
- 3.4.1(c)
- 3.11.2

NFPA 805, Section 3.3.6 requires that roof coverings be Class A as determined by tests described in NFPA 256, "Standard Methods of Fire Tests of Roof Coverings" (Reference 88). The licensee stated in LAR Attachment A, Section 3.3.6 that roof construction meets the Factory Mutual approval guide requirements for Class I construction. Specifically, the licensee stated that the testing for a Class I Factory Mutual rating is equivalent to testing for a Class A NFPA 256 rating. In fire protection engineering (FPE) request for additional information (RAI) 01 (Reference 31), the NRC staff requested that the licensee provide justification for this equivalency statement. In its response to FPE RAI 01 (Reference 11), the licensee indicated that NFPA 256 was withdrawn at the 2008 annual NFPA meeting because the material is listed in American Society for Testing and Materials (ASTM) E 108, "Standard Test Methods for Fire Tests of Roof Coverings" (Reference 89) and Underwriters Laboratories (UL) 790, "Tests for Fire Resistance of Roof Covering Materials" (Reference 90). The licensee further stated that ASTM E-108 specifies performance requirements for roof coverings under a simulated fire originating outside the building and that for the combustibility test above the roof assembly, the Factory Mutual Approval Standard references the ASTM E 108 fire test as the test method, and places further restrictions on the flame spread test over the ASTM E 108 fire test. The licensee further stated that the Factory Mutual Approval Standard 4470 fully encompasses ASTM E 108 and places further testing requirements on the full roof assembly, and therefore, Factory Mutual Approval Standard 4470 is equivalent to Class A of ASTM E 108 (i.e., formerly NFPA 256). The NRC staff concludes the licensee's response to the RAI and statement of compliance are acceptable because the licensee demonstrated that the testing for a Class I Factory Mutual rating is equivalent to testing for a Class A rating per NFPA 256, and therefore, meets the requirements of NFPA 805, Chapter 3.

NFPA 805, Section 3.4.1(c) requires the brigade leader and at least two brigade members to have sufficient training and knowledge of nuclear safety systems to understand the effects of fire and fire suppressants on NSPC. In FPE RAI 02 (Reference 31), the NRC staff requested that the licensee provide the details of the minimum "training and knowledge" that the incident commander receives. In addition, the NRC staff requested that the licensee describe how the incident commander is expected to function with the fire brigade. In its response to FPE RAI 02 (Reference 11), the licensee indicated that the FPP requires the incident commander to either have an operator's license (i.e., senior operator or operator) or possess equivalent knowledge of plant nuclear safety systems and that the incident commander is a member of the operations department that responds to all emergencies in the plant operating areas to evaluate and advise the fire brigade leader on firefighting activities affecting safe shutdown (SSD) equipment and other nuclear safety systems. The licensee further stated that the incident commander is competent to assess the potential safety consequences of a fire and advise the CR personnel.

The licensee provided the following list of functions expected of the incident commander. The incident commander:

- Shall respond to all emergencies in plant operating areas.
- Will be involved in the establishment of a command post.
- Will be involved in the direction of the activities of the fire brigade members.
- Will coordinate support groups.
- Will evaluate and advise the fire brigade leader on firefighting activities affecting SSD equipment and other plant operating equipment.
- Will keep in communications with the shift manager or designee to ensure they are aware of the emergency situation.
- Will direct the actions necessary per plant fire response and fire interaction procedures, including coordinating changes to ventilation system alignment through the CR.
- Will attend all fire drills occurring during an assigned shift.
- Will request the shift manager to call in offsite support as needed.
- Will establish and utilize the components of the National Incident Management System when an event escalates beyond the abilities of the onsite emergency response team.

Based on the information provided by the licensee, the NRC staff concludes the licensee's response to the RAI and statement of compliance are acceptable because the licensee demonstrated that the incident commander has sufficient training and knowledge of nuclear safety systems to understand the effects of fire and fire suppressants on the NSPC.

NFPA 805, Section 3.11.2 states that fire barriers required by Chapter 4 shall include a specific fire-resistance rating. In FPE RAI 06 (Reference 31), the NRC staff requested clarification regarding the 1-hour rated fire wrap used for exclusion of intervening combustibles within 20 foot separation zones. Specifically, the NRC staff requested that the licensee describe how it intended to transition this fire protection feature to the new RI/PB FPP. In its response to FPE RAI 06 (Reference 11), the licensee stated that the instances of 1-hour fire wrap described in the BFN Fire Protection Report will remain in place post-transition to 10 CFR, Part 50.48(c) NFPA 805; will be credited for separation as stated in LAR Attachment C, “NEI 04-02 Table B-3 Fire Area Transition,” Table C-1; and will be counted as intervening combustibles in the 20 foot separation zones. The licensee further stated that these intervening combustibles are identified in an exemption request approved by the NRC in a SE dated March 29, 2007 (Reference 91) and that this exemption will be transitioned into the NFPA 805 program as stated in the LAR Section 4.2.3 and LAR Attachment K. The NRC staff concludes the licensee's response to the RAI and statement of compliance are acceptable because the licensee identified the fire barriers as intervening combustibles in the 20 foot separation zones that were evaluated in an exemption request previously approved by the NRC, which is being transitioned to the RI/PB FPP in accordance with NFPA 805, Section 2.2.7.

3.1.1.2 Compliance Strategy -- Complies with Clarification

The licensee did not use this compliance strategy for any NFPA 805, Chapter 3 requirements.

3.1.1.3 Compliance Strategy -- Complies with Use of EEEEs

For certain NFPA 805, Chapter 3 requirements, the licensee demonstrated compliance with the fundamental FPP element through the use of EEEEs. The NRC staff reviewed the licensee's statement of continued validity for the EEEEs, identified implementation items and the statement on the quality and appropriateness of the evaluations, and concludes that the licensee's statements of compliance in these instances are acceptable.

The following NFPA 805 Sections identified in LAR Attachment A, Table B-1 as complying with this method and an applicable LAR Attachment S, Table S-2 modification or LAR Attachment S, Table S-3, implementation item, required additional review by the NRC staff:

- 3.3.1.2(6)
- 3.3.1.3.1
- 3.3.7.1
- 3.4.1
- 3.4.3
- 3.5.3
- 3.5.8
- 3.5.15
- 3.7
- 3.8.1
- 3.8.2
- 3.9.1(1)
- 3.9.1(2)
- 3.10.1
- 3.11.3

NFPA 805, Section 3.3.1.2(6) requires that controls on the use and storage of flammable gases be in accordance with applicable NFPA standards. The licensee initially stated that it requires the installation of explosion-proof electrical fixtures in the hydrogen trailer port facility. In a letter dated June 19, 2015 (Reference 27), the licensee indicated that the hydrogen trailer port facility will be demolished and the hydrogen system piping will be removed, which will remove the explosion hazard associated from the area and preclude the need for explosion-proof lighting as a result of LAR Attachment S, Table S-2, Modification 35a. The NRC staff concludes that this action is acceptable because the modification will remove the hazard and eliminate the compliance issue and because the action would be required by the proposed license condition.

NFPA 805, Section 3.3.1.3.1 requires that a hot work safety procedure be developed, implemented, and periodically updated. The licensee stated that it must revise the procedure for control of ignition sources to incorporate corrective actions identified in the code compliance review. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 43. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.7.1 requires that storage of flammable gas be located outdoors or in separate detached buildings. The licensee initially stated that two items were required to be done to meet this requirement: (1) develop specific guidance and restrictions on bulk flammable gas storage on site identified, which is addressed in LAR Attachment S, Table S-3, Implementation Item 38; and (2) Install explosion-proof electrical fixtures in the hydrogen trailer port facility, which was initially addressed in LAR Attachment S, Table S-3, Implementation Item 36. The NRC staff concludes that for item (1) described above, the licensee's statement of compliance is acceptable because the required actions as described by the licensee will incorporate the provisions of NFPA 805, Chapter 3, and the actions are included as implementation items in LAR Attachment S, which are required by the proposed license condition. In a letter dated June 19, 2015 (Reference 27), the licensee indicated that the hydrogen trailer port facility (as described in item (2)) will be demolished and the hydrogen system piping will be removed, which will remove the explosion hazard associated from the area and preclude the need for explosion-proof lighting as a result of LAR Attachment S, Table S-2, Modification 35a. The NRC staff concludes that this action is acceptable because the modification will remove the hazard and eliminate the compliance issue and because the action would be required by the proposed license condition.

NFPA 805, Sections 3.4.1(a)(1) and 3.4.3(a)(1) require that the onsite firefighting capability and training meet the requirements of NFPA 600, “Standard on Industrial Fire Brigades.” The licensee stated that corrective actions were identified in the code compliance evaluation and that these items are addressed as corrective actions in LAR Attachment S, Table S-3, Implementation Item 12. The NRC staff concludes that the licensee’s statement of compliance is acceptable because the required action as described by the licensee will incorporate the provisions of NFPA 805, Chapter 3 and the action is included as an implementation item in LAR Attachment S, which would be required by the proposed license condition.

NFPA 805, Section 3.5.3 requires that fire pumps provide 100 percent of the required flow rate and pressure, assuming failure of the largest pump or pump power source. The licensee stated that corrective actions were identified in the code compliance evaluation that includes verifying pump performance requirements. These items are addressed as corrective actions in LAR Attachment S, Table S-3, Implementation Item 17. The NRC staff concludes that the licensee’s statement of compliance is acceptable because the required actions as described by the licensee will incorporate the provisions of NFPA 805, Chapter 3, and the actions are included as an implementation item in LAR Attachment S, which is required by the proposed license condition.

NFPA 805, Section 3.5.8 requires that automatic pressure maintenance of the fire protection water system be provided independent of the fire pumps. The licensee stated that corrective actions are required to ensure that pressure is maintained without the use of fire pumps in the fire protection system during normal operation and that this item is addressed in LAR Attachment S, Table S-3, Implementation Item 44. In FPE RAI 04 (Reference 31), the NRC staff requested a more detailed description of this issue and the intended/proposed resolution. In its response to FPE RAI 04 (Reference 24), the licensee stated that during the code compliance review, it identified that a fire pump is often utilized to supplement the raw service water (RSW) system when the RSW system cannot meet the total demand. The licensee further stated that LAR Attachment S, Table S-3, Implementation Item 44 will be deleted and LAR Attachment S, Table S-2, Modification 106 added to, “Install additional equipment to provide water to the cooling tower lift pump bearing lubrication water system in order to provide this system a water supply independent from the RSW and HPFP systems to ensure that pressure is maintained in the fire protection system during normal operation without using a fire pump.” The NRC staff concludes the licensee’s response to the RAI is acceptable because the licensee provided the requested information and added a plant modification to ensure the NFPA 805, Chapter 3 requirements are met. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.5.15 requires that hydrants be equipped with auxiliary equipment specified in NFPA 24, “Standard for the Installation of Private Fire Service Mains and Their Appurtenances” (Reference 92). The licensee stated the need to equip the fire apparatus with spanner wrenches and hose connection gaskets for each size hose and to update the quarterly inspection procedures to include this information. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 18. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.7 requires that fire extinguishers be provided in accordance with NFPA 10, “Standard for Portable Fire Extinguishers” (Reference 93). The licensee stated that a contract needed to be established for maintenance and hydrostatic testing for fire extinguishers in accordance with NFPA 10. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 40. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.8.1 requires that alarm initiating devices be installed in accordance with NFPA 72, “National Fire Alarm and Signaling Code®” (Reference 94). The licensee stated that corrective actions were identified in the code compliance evaluations. These items are addressed as corrective actions identified in LAR Attachment S, Table S-3, Implementation Item 19. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.8.2 requires that if automatic fire detection is required to meet the performance or deterministic requirements of Chapter 4, then these devices shall be installed in accordance with NFPA 72, “National Fire Alarm and Signaling Code®” (Reference 94). The licensee stated that documentation will be updated for the fire detection system. These items are addressed in LAR Attachment S, Table S-3, Implementation Item 19. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.9.1(1) requires that if an automatic or manual water-based fire suppression system is required to meet the performance or deterministic requirements of NFPA 805, Chapter 4, then the system shall be installed in accordance with NFPA 13, “Standard for the Installation of Sprinkler Systems” (Reference 67). The licensee stated that corrective actions were identified in the code compliance evaluations. These items are addressed in LAR Attachment S, Table S-2, Modifications 98, 99, and 100 and in LAR Attachment S, Table S-3, Implementation Item 20. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.9.1(2) requires that if an automatic or manual water-based fire suppression system is required to meet the performance or deterministic requirements of Chapter 4, then the system shall be installed in accordance with NFPA 15, “Standard for Water Spray Fixed Systems for Fire Protection” (Reference 95). These items are addressed in LAR Attachment S, Table S-2, Modification 102, and in LAR Attachment S, Table S-3, Implementation Item 21. The NRC staff concludes that the licensee’s statement of compliance is acceptable because the required action as described by the licensee will incorporate the provisions of NFPA 805, Chapter 3, and the action is included as a modification and an implementation item in LAR Attachment S, which are required by the proposed license condition.

NFPA 805, Section 3.10.1 requires that if an automatic total flooding and local application gaseous suppression system is required to meet the performance or deterministic requirements of Chapter 4, then the system shall be designed and installed in accordance with NFPA 12, “Standard on Carbon Dioxide Extinguishing Systems” (Reference 96). The licensee identified the need to install pneumatic pre-discharge alarms and pneumatic time delays in CO_2 systems to meet NFPA 12, 2008. The licensee stated that corrective actions were identified in the code compliance evaluation. These items are addressed in LAR Attachment S, Table S-2, Modification 85 and in LAR Attachment S, Table S-3, Implementation Item 22. The NRC staff concludes that the licensee’s statement of compliance is acceptable because the required action as described by the licensee will incorporate the provisions of NFPA 805, Chapter 3, and the action is included as a modification and an implementation item in LAR Attachment S, which are required by the proposed license condition.

NFPA 805, Section 3.11.3(1) requires that penetrations in fire barriers be provided with listed fire-rated door assemblies. The licensee stated that it will revise the appropriate procedures to inspect and ensure guides and bearings of active NFPA 805 required sliding fire doors are maintained well lubricated. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 7. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

The following NFPA 805 Sections identified in LAR Attachment A, Table B-1 as complying with this method required additional review by the NRC staff:

- 3.11.5

In NFPA 805, Section 3.11.5, “Electrical Raceway Fire Barrier Systems (ERFBS),” the licensee stated compliance with the use of engineering evaluations. In FPE RAI 07 (Reference 31), the NRC staff noted that the plant documents describe all 1-hour rated ERFBS as Thermo-Lag. Specifically, the NRC staff requested that the licensee identify all the different types of ERFBS materials (e.g., 3M, Hemyc, etc.) being credited in the post-transition configurations. In its response to FPE RAI 07 (Reference 24), the licensee indicated that the credited ERFBS for the post-transition plant configuration are Thermo-Lag. The licensee further stated its analysis lists the currently installed ERFBS, which utilize Thermo-Lag 330-1. Additionally, the licensee indicated that the current plan for the ERFBS modifications is to utilize Thermo-Lag as the 1-hour barrier for wrapping cables, conduits, and junction boxes. These modifications are included in LAR Attachment S, Table S-2. The NRC staff concludes the licensee's response to the RAI is acceptable because the licensee described that its use of Thermo-Lag 330-1 is in accordance with NFPA 805, Section 3.11.5 in the application as identified in LAR Attachment S, Table S-2. The NRC staff concludes that the licensee’s statement of compliance is acceptable because the required actions as described by the licensee will incorporate the provisions of NFPA 805, Chapter 3, and the actions are included as modifications in LAR Attachment S, which are required by the proposed license condition.

3.1.1.4 Compliance Strategy -- Complies with Previous NRC Approval

Certain NFPA 805, Chapter 3 requirements were supplanted by an alternative that was previously approved by the NRC. The approvals were documented in the (1) supplemental safety evaluation report (SER), dated November 3, 1989 (Reference 43); (2) SE dated March 31, 1993 (Reference 39); and (3) license amendment dated April 25, 2007 (Reference 42).

In each instance, the licensee evaluated the basis for the original NRC approval and determined that in all cases the bases were still valid. The NRC staff reviewed the information provided by the licensee and concludes that previous NRC approval had been demonstrated using suitable documentation that meets the approved guidance contained in RG 1.205, Revision 1. The NRC staff concludes that the licensee's statements of compliance in these instances are acceptable because the licensee provided justification for the continued validity of the previously approved alternatives to the NFPA 805, Chapter 3 requirements.

The following NFPA 805 Sections identified in LAR Attachment A, Table B-1, as complying with this method and an applicable LAR Attachment S, Table S-3, implementation item, required additional review by the NRC staff:

- 3.3.3
- 3.3.5.2
- 3.3.7.2

NFPA 805, Section 3.3.3 requires that interior wall or ceiling finish classification be in accordance with NFPA 101, "Life Safety Code®" (Reference 97) requirements for Class A materials. The licensee stated that it will revise the design output procedure to ensure interior wall and ceiling finishes meet the NFPA 101 Class A material requirements. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 42. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.5.2 requires that flexible metallic conduits only be used in short lengths. The licensee stated that it will revise the installation specification to state that flexible conduit shall only be used in lengths up to 3 feet. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 9. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

NFPA 805, Section 3.3.7.2 requires that outdoor high-pressure flammable gas storage containers be located so that the long axis is not pointed at buildings. The licensee stated that it will develop specific guidance and restrictions on bulk flammable gas storage on site to meet this requirement. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 38. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

The following NFPA 805 Section identified in LAR Attachment A, Table B-1 as complying with this method required additional review by the NRC staff:

- 3.5.5

In the LAR Attachment A, Table B-1, Section 3.5.5, the fire pump separation compliance strategy indicates “Complies with Previous Approval.” In FPE RAI 03 (Reference 31), the NRC staff requested that the licensee provide more details regarding the description of the fire pump separation from each other, as well as separation from the rest of the plant. In its response to FPE RAI 03 (Reference 24), the licensee stated that BFN has three electric motor-driven fire pumps located in the Intake Pumping Station (FA 25-1) and one diesel-driven fire pump located at the Number (No.) 2 Gate Structure (FA Yard). The licensee further stated that all four pumps provide high pressure fire water to the main fire header and that the three electric fire pumps are not spatially separated from each other but are separated from the diesel-driven fire pump. The licensee further stated that the Intake Pumping Station and the No. 2 Gate Structure are separated from each other by over 400 feet and both are separated from the Reactor Building by over 200 feet. The licensee further stated that one fire pump is sufficient to adequately supply suppression capability to each required fire protection system. The licensee further stated that for FA Yard fires, all three electric fire pumps are available. The licensee further stated that for a FA 25-1 fire, the diesel-driven fire pump is available and that at least one fire pump is available for all other fire areas. The licensee stated that the “complies with previous approval” statement in LAR Attachment A, Section 3.5.5 relies on the existing four pump configuration; NRC approval of Tennessee Valley Authority’s (TVA's) FPPs conformance with Branch Technical Position (BTP) Chemical Engineering Branch (CMEB) 9.5-1; and the equivalency of BTP CMEB 9.5-1 (Reference 66), Sections C.6.b(6)(a) and (b) to NFPA 805 Section 3.5.5. The NRC staff concludes the licensee's response to the RAI is acceptable because the licensee provided sufficient justification for the fire pump separation and for the continued validity of the previously approved alternatives to the NFPA 805, Chapter 3 requirements.

3.1.1.5 Compliance Strategy -- Submit for NRC Approval

The licensee also requested approval for the use of PB methods to demonstrate compliance with fundamental FPP elements. In accordance with 10 CFR 50.48(c)(2)(vii), the licensee requested specific approvals be included in the license amendments approving the transition to NFPA 805 at BFN. The NFPA 805 Sections identified in LAR Attachment A, Table B-1 as complying with this method are as follows:

- NFPA 805, Section 3.2.3(1) concerns the establishing of procedures for inspection, testing, and maintenance for fire protection systems and features. The licensee requested the use of Electric Power Research Institute (EPRI) Report (EPRI) TR-1006756, “Fire Protection Equipment Surveillance Optimization and Maintenance Guide,” to modify fire protection system surveillance frequencies. (See SE Section 3.1.4.1.)

- NFPA 805, Section 3.3.3 concerns the classification of interior floor finish in accordance with NFPA 101 (Reference 97), Class I criteria. The licensee requested approval to use PB methods to demonstrate an equivalent level of fire protection for its use of epoxy floor coatings. (See SE Section 3.1.4.2.)

- NFPA 805, Section 3.3.5.1 concerns limitations of wiring above suspended ceiling and where installed, electrical wiring shall be listed for plenum use, routed in armored cable, routed in metallic conduit, or routed in cable trays with solid metal top and bottom covers. The licensee requested approval to use PB methods to demonstrate an equivalent level of fire protection for existing electrical wiring above the suspended ceilings in the Control Building. (See SE Section 3.1.4.3.)

- NFPA 805, Section 3.9.4 concerns the requirement to provide automatic sprinkler protection for diesel driven fire pumps. The licensee requested approval to use PB methods to demonstrate an equivalent level of fire protection for the lack of automatic sprinkler protection for the diesel engine-driven fire pump. (See SE Section 3.1.4.4.)

The following NFPA 805 Section identified in LAR Attachment A, Table B-1, as complying with this method, and the applicable NFPA 805, Chapter 3 implementation item in LAR Attachment S, Table S-3, required additional review by the NRC staff:

- 3.3.3

NFPA 805, Section 3.3.3 requires that interior floor finishes shall be in accordance with NFPA 101®, “Life Safety Code®” (Reference 97) requirements for Class I interior floor finishes. The licensee stated that it will revise its design output to ensure interior epoxy floor finishes meet the Class I requirements and interior carpet floor finishes meet the Class I requirements. This item is addressed in LAR Attachment S, Table S-3, Implementation Item 37. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

As discussed in SE Section 3.1.4, the NRC staff concludes that the use of PB methods to demonstrate compliance with these fundamental FPP elements is acceptable because the methods meet the requirements of 10 CFR 50.48(c)(2)(vii).

3.1.1.6 Compliance Strategy -- Multiple Strategies

In certain compliance statements of the NFPA 805, Chapter 3 requirements, the licensee used more than one of the above strategies to demonstrate compliance with aspects of the fundamental elements.

In each of these cases, the NRC staff concludes that the individual compliance statements are acceptable, the combination of compliance strategies is acceptable, and the licensee demonstrated compliance with the NFPA 805, Chapter 3 fundamental FPP elements and minimum design requirements.

3.1.1.7 Chapter 3 Sections Not Reviewed

Some NFPA 805, Chapter 3 sections either do not apply to the transition to an RI/PB FPP or have no technical requirements. Accordingly, the NRC staff did not review these sections for acceptability. The sections that were not reviewed fall into one of the following categories:

- Sections that do not contain any technical requirements (e.g., NFPA 805, Sections 3.4.5 and 3.11).

- Sections that are not applicable because of the following:

    — The licensee stated that it does not have systems of this type installed (e.g., Section 3.10.1(3), Clean Agent Fire Extinguishing Systems).

    — The type of system, while installed, is not required under the RI/PB FPP (e.g., Section 3.10.1(2), Halon 1301 Fire Extinguishing Systems).

    — The requirements are structured with an applicability statement (e.g., Section 3.3.12, which applies to RCPs in non-inerted containments, or Sections 3.4.1(a)(2) and 3.4.1(a)(3), which apply to the fire brigade standards used since they depend on the type of brigade specified in the FPP at the site).

3.1.1.8 Compliance with Chapter 3 Requirements Conclusion

As discussed above, the NRC staff evaluated the results of the licensee's assessment of the proposed RI/PB FPP against the NFPA 805, Chapter 3 fundamental FPP elements and minimum design requirements as modified by the exceptions, modifications, and supplementations in 10 CFR 50.48(c)(2). Based on this review of the licensee's submittal, as supplemented, the NRC staff concludes that the RI/PB FPP is acceptable with respect to the fundamental FPP elements and minimum design requirements of NFPA 805, Chapter 3 as modified by 10 CFR 50.48(c)(2), because the licensee:

- Used an overall process consistent with NRC staff approved guidance to determine the state of compliance with each of the applicable NFPA 805, Chapter 3 requirements.

- Provided appropriate documentation of the state of compliance with the NFPA 805, Chapter 3 requirements, which adequately demonstrated compliance in that the licensee was able to substantiate that it complied:

    — With the requirement directly or with the requirement directly after the completion of an implementation item or modification.

    — Via previous NRC staff approval of an alternative to the requirement.

    — Through the use of an engineering equivalency evaluation.

— Through the use of a combination of the above methods.

— Through the use of a PB method that the NRC staff has specifically approved in accordance with 10 CFR 50.48(c)(2)(vii).

3.1.2 Identification of Power Block

The NRC staff reviewed the structures identified in LAR Attachment I, "Definition of Power Block," Table I-1, "Power Block Definition," as comprising the "power block." The plant structures listed are established as part of the power block for the purpose of denoting the structures and equipment included in the RI/PB FPP that have additional requirements in accordance with 10 CFR 50.48(c) and NFPA 805. As stated in LAR Section 4.1.3, NFPA 805, Section 1.6.46 defines the "power block" as structures that have equipment required for nuclear plant operations and that this definition is clarified by NFPA 805, FAQ 06-0019. The licensee further stated that in accordance with these references, the BFN power block is defined as all structures within the plant protected area that contain equipment associated with power production and emergency operations, as well as the 161 (kilovolt) kV and 500 kV Switchyards, the Yard, and the Cooling Towers. The NRC staff concludes that the licensee has appropriately evaluated the structures and equipment as listed in LAR Attachment I, Table I-1 and adequately documented a list of those structures that fall under the definition of "power block" in NFPA 805.

3.1.3 Closure of GL 2006-03, "Potentially Nonconforming Hemyc and MT Fire Barrier Configurations," Issues

Generic Letter (GL) 2006-03 (Reference 65) requested that licensees evaluate their facilities to confirm compliance with existing applicable regulatory requirements in light of the results of NRC testing that determined that both Hemyc and MT fire barriers failed to provide the protective function intended for compliance with existing regulations for the configurations tested using the NRC's thermal acceptance criteria. In a letter dated June 7, 2006 (Reference 98), the licensee stated that it does not rely on Hemyc or MT materials to protect electrical and instrumentation cables or equipment that provide SSD capability during a postulated fire. Since Hemyc and MT ERFBS are not used, the NRC staff concludes that the generic issue (GL 2006-03) related to the use of these ERFBS is not applicable.

3.1.4 Performance-Based Methods for NFPA 805, Chapter 3 Elements

In accordance with 10 CFR 50.48(c)(2)(vii), a licensee may request NRC approval for use of the PB methods permitted elsewhere in the standard as a means of demonstrating compliance with the prescriptive FPP fundamental elements and minimum design requirements of NFPA 805, Chapter 3. The director or designee may approve PB methods if the director or designee determines that the PB approach:

(A) Satisfies the performance goals, objectives, and criteria specified in NFPA 805 related to nuclear safety and radiological release;

(B) Maintains safety margins; and

(C) Maintains fire protection defense-in-depth (DID) (fire prevention, fire detection, fire suppression, mitigation, and post-fire SSD capability).

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

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

NFPA 805, Section 1.3.2, "Radioactive Release Goal," states:

> The radioactive release goal is to provide reasonable assurance that a fire will not result in a radiological release that adversely affects the public, plant personnel, or the environment.

NFPA 805, Section 1.4.1, "Nuclear Safety Objectives," states:

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

NFPA 805, Section 1.4.2, "Radioactive Release Objective," states:

> Either of the following objectives shall be met during all operational modes and Plant configurations.
>
> (1) Containment integrity is capable of being maintained.
>
> (2) The source term is capable of being limited.

NFPA 805, Section 1.5.1, "Nuclear Safety Performance Criteria," states:

> Fire protection features shall be capable of providing reasonable assurance that, in the event of a fire, the plant is not placed in an unrecoverable condition. To demonstrate this, the following performance criteria shall be met.
>
> (a) *Reactivity Control.* Reactivity control shall be capable of inserting negative reactivity to achieve and maintain subcritical conditions.

Negative reactivity inserting shall occur rapidly enough such that fuel design limits are not exceeded.

(b) *Inventory and Pressure Control.* With fuel in the reactor vessel, head on and tensioned, inventory and pressure control shall be capable of controlling coolant level such that subcooling is maintained for a PWR [pressurized-water reactor] and shall be capable of maintaining or rapidly restoring reactor water level above top of active fuel for a BWR [boiling-water reactor] such that fuel clad damage as a result of a fire is prevented.

(c) *Decay Heat Removal.* Decay heat removal shall be capable of removing sufficient heat from the reactor core or spent fuel such that fuel is maintained in a safe and stable condition.

(d) *Vital Auxiliaries.* Vital auxiliaries shall be capable of providing the necessary auxiliary support equipment and systems to assure that the systems required under (a), (b), (c), and (e) are capable of performing their required nuclear safety function.

(e) *Process Monitoring.* Process monitoring shall be capable of providing the necessary indication to assure the criteria addressed in (a) through (d) have been achieved and are being maintained.

NFPA 805, Section 1.5.2, "Radioactive Release Performance Criteria," states:

> Radiation release to any unrestricted area due to the direct effects of fire suppression activities (but not involving fuel damage) shall be as low as reasonably achievable and shall not exceed applicable 10 CFR, Part 20, "Limits."

In LAR Attachment L, "NFPA 805, Chapter 3 Requirements for Approval (10 CFR 50.48(c)(2)(vii))," the licensee requested NRC staff review and approval of PB methods to demonstrate an equivalent level of fire protection for the requirement of the elements identified in SE Section 3.1.1.5. The NRC staff's evaluation of these proposed methods is provided below.

3.1.4.1 NFPA 805, Section 3.2.3(1), "Inspection, Testing, and Maintenance Procedures"

In LAR Attachment L, Approval Request 1, the licensee requested approval of a PB method to demonstrate an equivalent level of fire protection for the NFPA 805, Section 3.2.3(1) requirement regarding inspection, testing, and maintenance of credited fire protection systems and features. Specifically, the licensee requested approval to use PB methods to establish the inspection, testing, and maintenance frequencies for fire protection systems and features required by NFPA 805.

The licensee stated that the PB inspection, testing, and maintenance frequencies will be established as described in EPRI Technical Report (TR)-1006756, "Fire Protection Surveillance Optimization and Maintenance Guide for Fire Protection Systems and Features," Final Report, July 2003 (Reference 99).

The licensee stated that its request is specific to the use of EPRI TR-1006756 to establish the appropriate inspection, testing, and maintenance frequencies for fire protection systems and features credited by the FPP. The licensee further stated that EPRI TR-1006756, Section 10.1 states that, “The goal of a PB surveillance program is to adjust test and inspection frequencies commensurate with equipment performance and desired reliability,” and that this goal is consistent with the stated requirements of NFPA 805, Section 2.6. The licensee further stated that the EPRI TR-1006756 provides an accepted method to establish appropriate inspection, testing, and maintenance frequencies, which ensure that the required NFPA 805 availability, reliability, and performance goals are maintained.

The licensee stated that the target tests, inspections, and maintenance will be those activities for the NFPA 805 required fire protection systems and features and that the reliability and frequency goals will be established to ensure the assumptions in the NFPA 805 engineering analysis remain valid. The licensee further stated that the failure criterion will be established based on the required fire protection systems and features credited functions and will ensure those functions are maintained and that the failure probability will be determined based on EPRI TR-1006756 guidance and a 95 percent confidence level will be utilized. The licensee further stated that data collection and analysis will also follow EPRI TR-1006756 document guidance and that the performance monitoring will be performed in conjunction with the monitoring program required by NFPA 805, Section 2.6 and will ensure site-specific operating experience is considered in the monitoring process.

The licensee stated that the use of PB test frequencies established in accordance with EPRI TR-1006756 methods, combined with NFPA 805, Section 2.6, “Monitoring Program,” will ensure that the availability and reliability of the fire protection systems and features are maintained to the levels assumed in the NFPA 805 engineering analysis, and therefore, there is no adverse impact to NSPC.

The licensee stated that the radiological release performance criteria are satisfied based on the determination of limiting radioactive release (LAR Attachment E, “NEI 04-02 Radioactive Release Transition”) and that fire protection systems and features are credited as part of that evaluation. The licensee further stated that the use of PB test frequencies established per EPRI TR-1006756 methods, combined with NFPA 805, Section 2.6, “Monitoring Program,” will ensure that the availability and reliability of the systems and features are maintained to the levels assumed in the NFPA 805 engineering analysis, which includes those assumptions credited to meet the radioactive release performance criteria, and therefore, there is no adverse impact on meeting these criteria.

The licensee stated that the use of PB test frequencies established per EPRI TR-1006756 methods, combined with NFPA 805, Section 2.6, “Monitoring Program,” will ensure that the availability and reliability of the fire protection systems and features are maintained to the levels assumed in the NFPA 805 engineering analysis, which includes those assumptions credited in the Risk Evaluation safety margin discussions. The licensee further stated that the use of these methods in no way invalidates the inherent safety margins contained in the codes used for design and maintenance of fire protection systems and features, and therefore, the safety margin inherent and credited in the analysis has been preserved.

The licensee stated that the three elements of DID are 1) to prevent fires from starting; 2) rapidly detect, control, and extinguish fires that do occur, thereby limiting damage; and 3) provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed.

The licensee stated that element 1 is not affected by the use of EPRI TR-1006756 methods and that use of PB test frequencies established per EPRI TR-1006756 methods, combined with NFPA 805 Section 2.6, "Monitoring Program," will ensure that the availability and reliability of the fire protection systems and features credited for DID are maintained to the levels assumed in the NFPA 805 engineering analysis, and therefore, there is no adverse impact to elements 2 and 3 for DID.

Based on its review of the information submitted by the licensee, and in accordance with 10 CFR 50.48(c)(2)(vii), the NRC staff concludes that the proposed PB method is an acceptable alternative to the corresponding NFPA 805, Section 3.2.3(1) requirement because EPRI TR-1006756 provides an accepted method to establish appropriate inspection, testing, and maintenance frequencies, which ensures that the required NFPA 805 availability, reliability, and performance goals are maintained. Therefore, based on the above and the information provided by the licensee, the NRC staff concludes that the proposed PB method satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release, maintains sufficient safety margin, and maintains adequate fire protection DID.

3.1.4.2 NFPA 805, Section 3.3.3, "Interior Finish"

In LAR Attachment L, Approval Request 2, the licensee requested review and approval of a PB method to demonstrate an equivalent level of fire protection for the NFPA 805, Section 3.3.3 requirement regarding interior finishes. Specifically, the licensee requested the use of PB methods to justify its use of epoxy floor coatings.

The licensee stated that testing performed at certain thicknesses indicates that the epoxy floor coating meets the requirements for Class I floor finish when applied to a dry film thickness of between 40 mils and 45 mils [1 mil = 1/1000 inch]. The licensee further stated that its specifications allow for the epoxy floor coating to be applied to a dry film thickness of between 30 mils and 90 mils.

The licensee stated that the existing criteria for determining material combustibility are contained in NRC GL 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986 (Reference 100), which provides guidance for satisfying NRC regulatory requirements for fire protection. The licensee further stated that Enclosure 2 to NRC GL 86-10 provides the NRC staff's responses to a list of industry questions and that the NRC staff's response to Question 3.6.2, "In- Situ Exposed Combustibles," states that a non-combustible material is defined as:

> a. A material which in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat; and, b. Material having a structural base of noncombustible material, as defined in a., above, with a surfacing not over

> 1/8-inch [125 mils] thick that has a flame spread rating not higher than 50 when measured using the test protocol of American Society for Testing and Materials (ASTM) E 84, “Standard Test Method for Surface Burning Characteristics of Building Materials” (Reference 101).

The licensee further stated that while Information Notice (IN) 2007-26 (Reference 102) reiterated the above definition, NFPA 805 had previously re-defined the GL 86-10 definition of “non-combustible material” to become the definition of “limited combustible” as follows:

> Limited Combustible. Material that, in the form in which it is used, has a potential heat value not exceeding 3500 British thermal unit/pound (BTU/lb) (8141 kJ/kg) and either has a structural base of noncombustible material with a surfacing not exceeding a thickness of 1/8 in. (3.2 mm) that has a flame spread rating not greater than 50, or has another material having neither a flame spread rating greater than 25 nor evidence of continued progressive combustion, even on surfaces exposed by cutting through the material on any plane.

In NFPA 805, “non-combustible material” is defined as follows: Noncombustible. Material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.
The licensee provided the following basis for the approval request:

- Throughout the plant, epoxy floor finish is applied to a thickness of between 30 mils and 90 mils;

- Areas that have an epoxy application dry film thickness less than 45 mils are Class I rating, and are acceptable as is;

- At a thickness of 70 mils, the epoxy coating does not meet the Class I floor finish requirement. Therefore, the actual thickness at which the material transitions from a Class I to a Class II rating is between 45 mils and 70 mils. It is anticipated that large areas of floor are Class I, and that some areas are Class II due to floor variations;

- The areas with epoxy floor coatings that have a dry film thickness between 70 mils and 90 mils are rated Class II. Class II floor finishes will self-extinguish;

- The thickness of the material affects the critical radiant flux (the material makeup is the same) and at the thicknesses applied (up to 90 mils) the finishes self-extinguish. Therefore, the added overall fire severity of epoxy floor finish in thicknesses greater than 45 mils up to 90 mils is minimal;

- A thin floor finish applied to a non-combustible substrate presents little fire hazard because the substrate will not ignite and will absorb heat during the early stages of fire development; and

- It is not practical to replace these flooring systems.

The licensee stated that the use of epoxy floor coating does not affect nuclear safety as it meets the definition of a limited combustible material. The licensee further stated that the application of epoxy floor coatings is controlled via its specifications to ensure that the amount of material does not add appreciable amounts of combustible material to the plant and that the epoxy coating would not result in propagation across barriers or between redundant success paths, and therefore, there is no impact on the NSPC.

The licensee further stated that the use of epoxy floor coatings has no impact on the radiological release performance criteria and that it performed the radiological release review based on the manual fire suppression activities in areas containing, or potentially containing, radioactive materials and that the review is not dependent on the floor coating materials. The licensee further stated that the floor coatings do not change the radiological release evaluation, which concluded that potentially contaminated water is contained and smoke monitored and that floor coatings do not add additional radiological materials to the area or challenge system boundaries.

The licensee stated that the use of epoxy floor coatings does not affect safety margin, as they, in general, meet the definition of a limited combustible material with isolated thickness excesses and that the epoxy floor coating materials have a negligible effect on combustibility. The licensee further stated that the application of the epoxy floor coating is controlled via its specifications and that these precautions and limitations on the use of these materials have been defined by the limitations of the analysis of the fire event, and therefore, the inherent safety margin and conservatisms in the NFPA 805 nuclear safety analysis methods remain unchanged.

The licensee stated that the three elements of DID are: 1) to prevent fires from starting, 2) rapidly detect, control and extinguish fires that do occur thereby limiting damage, and 3) provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed.

The licensee stated that the use of epoxy floor coatings does not impact fire protection DID and that the use of epoxy floor coatings does not result in compromising automatic fire suppression functions, manual fire suppression functions, or post-fire SSD capability. The licensee stated that for element 1, site procedures are established to limit the epoxy floor finishing material since the epoxy floors minimally increase the amount of combustibles in any area; however, the epoxy used meets the definition of a limited combustible material. The licensee stated that for element 2, the criteria being established for the epoxy floor interior finish has no impact on the ability of the automatic suppression systems to perform their functions and that portable fire extinguishers and hose reel stations are available for manual firefighting activities by the site fire brigade such that if a fire occurred, the damage from the fire would be limited. The licensee stated that for element 3, the epoxy floor coating criteria being established meets the definition of a limited combustible material, and therefore, will not allow fire propagation through the barrier, and does not result in compromising automatic fire suppression functions, manual fire suppression functions, or post-fire SSD capability and will not prevent essential safety functions from being performed. The licensee further stated that fire area boundaries are separated by barriers that would limit fire propagation from one fire area to another; however, fire propagation is unlikely because the epoxy acts as a limited combustible material.

Based on its review of the information submitted by the licensee, and in accordance with 10 CFR 50.48(c)(2)(vii), the NRC staff concludes that the proposed PB method is an acceptable alternative to the corresponding NFPA 805, Section 3.3.3 requirement because areas that have an epoxy application dry film thickness less than 45 mils are Class I rated, because (1) the epoxy floor coatings that have a dry film thickness between 70 mils and 90 mils will self-extinguish; (2) the added overall fire severity of epoxy floor finish in thicknesses greater than 45 mils up to 90 mils is minimal; (3) a thin floor finish applied to a non-combustible substrate presents little fire hazard because the substrate will not ignite and will absorb heat during the early stages of fire development; and (4) it is not practical for the licensee to replace these flooring systems. Therefore, based on the above, and the information provided by the licensee, the NRC staff concludes that the proposed PB method satisfies the performance goals, objectives, and criteria specified in NFPA 805 related to nuclear safety and radiological release; maintains sufficient safety margin; and maintains adequate fire protection DID.

3.1.4.3 NFPA 805, Section 3.3.5.1, “Electrical Wiring above Suspended Ceiling”

In LAR Attachment L, Approval Request 3, the licensee requested approval of a PB method to demonstrate an equivalent level of fire protection for the NFPA 805, Section 3.3.5.1 requirement regarding electrical wiring above suspended ceilings being required to be listed for plenum use, routed in armored cable, routed in metallic conduit, or routed in cable trays with solid metal top and bottom covers.

The licensee stated that areas currently with suspended ceilings inside the NFPA 805 defined power block areas include:

- Control Building El 617' Corridor Rm 617-C1, Toilet Rm 617-C3, Shower Rm C4, Shower Rm C5, Locker Room Rm 617-C6, Operations Work Control Center Rm 617-C7, 617' El. – Shift Oper. Supr. Office 617' El. - Office (Fire Zone 16-B).
- Control Building El 617' Relay Room 617-C16, TSC (Technical Support Center) Operations Rm 617-C18, Corridor 617-C13, Corridor 617-C13A (Fire Zone 16-C).
- Control Building El 617' Women's Toilet Rm 617-C22, Operations Lunchroom 617-C23 (Fire Zone 16-D).
- Control Building El 593' Corridor Room 593.0-C1, Instrument Foreman's Office Rm 593.0-C3 [Process Computer Room], (Fire Zone 16-E).
- Control Building El. 593' U1/2 Computer Room (Fire Zone 16-L).
- Control Building El. 593' Communications/U3 Computer Room (Fire Zone 16-N).
- Control Building El. 593' Records Storage Room (Fire Zone 16-P).
- Control Rooms/associated offices (Fire Zone 16-A).

The licensee stated that drawings and field walkdowns in the CRs and the remainder of the 617 Elevation Control Building indicate that cables are routed in conduit or covered cable trays, except for video/communication/data cables, which have been field routed above suspended ceilings and are not plenum rated. The licensee further stated that the areas above the suspended ceiling in the CRs are provided with automatic fire detection but not automatic fire suppression.

The licensee stated that drawing reviews and comprehensive walkdowns of the 593 Elevation Control Building areas with suspended ceilings identified that there are some cables routed in cable trays without covers, in addition to video/communication/data cables, which have been field routed above suspended ceilings and are not plenum rated (some areas could not be walked down because the ceilings are plaster). The licensee further stated that current cable construction for power and control cables is compliant with the Institute of Electrical and Electronics Engineers (IEEE)-383 (or equivalent) (Reference 103), or routed in metal conduit and that original power and control cables were not required to be IEEE-383 qualified or equivalent. The licensee further stated that where non-IEEE-383 qualified cables are used in cable trays it applied fire retardant coatings and that those cables sprayed with a fire retardant coating do not pose a risk, as the combustible element of the cable jacketing has been nullified by the coating. The licensee further stated that there is no smoke detection provided above the ceiling in these areas outside of the CRs and that the areas above the suspended ceilings are not plenums, nor are they part of smoke purging systems.

The licensee stated that the cables in question that are not IEEE-383 qualified or sprayed with flame retardant are video/communication/data cables, which have been field routed above suspended ceilings and are not plenum rated and that these cables are low voltage. The licensee further stated that these low voltage cables are not susceptible to shorts, which would result in a fire.

The licensee stated that the basis for the approval request is as follows:

- The cable trays without covers above suspended ceilings do not pose a hazard.
    - Power and control cables are IEEE 383 qualified or sprayed with a flame retardant coating, and
    - There are no other ignition sources located above the suspended ceiling.
- The current video/communication/data cables above suspended ceilings do not pose a hazard.
    - Low voltage cables are not generally susceptible to shorts causing a fire and are not an ignition source,
    - There are no other ignition sources located above the suspended ceiling, and
    - The existing detection above the CR ceilings will promptly identify a fire, thereby enhancing fire brigade response time.

The licensee stated that the current cable trays without covers and current video/communication/data cables located above the suspended ceilings in the Control Building do not affect the nuclear safety capability. The licensee further stated that while there are cables in the areas with suspended ceilings in the Control Building that are credited in the NFPA 805 nuclear safety analysis, the power and control cables comply, or comply with the intent of this section. The licensee further stated that other wiring, while it may not be in armored cable, in metallic conduit, coated in a flame retardant material, or plenum rated, is low voltage video/communication/data cabling not generally susceptible to shorts that would result in a fire, and therefore, there is no impact on the NSPC.

The licensee also stated that the current cable trays without covers and current video/communication/ data cables located above the suspended ceilings in the Control Building have no impact on the radiological release performance criteria. The licensee further stated that it performed the radiological review based on the potential location of radiological concerns and that the review is not dependent on the type of cables or locations of suspended ceilings. The licensee further stated that the trays and cables do not change the results of the radiological release evaluation performed that concluded that potentially contaminated water is contained and smoke is monitored and that the trays and cables do not add additional radiological materials to the area or challenge systems boundaries.

The licensee stated that power and control cables meet the requirements, or the intent, of this requirement and that other wiring, while it may not be in armored cable, in metallic conduit, coated in a flame retardant material, or plenum rated, is low voltage cable not susceptible to shorts that would result in a fire. The licensee further stated that those areas with cable trays without covers and video/communication/data cables have been analyzed in their current configuration and that the inherent safety margin and conservatisms in the NFPA 805 nuclear safety analysis remain unchanged.

The licensee stated that the three elements of DID are 1) to prevent fires from starting; 2) rapidly detect, control, and extinguish fires that do occur thereby limiting damage; and 3) provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed.

The licensee stated that the existing cable trays without covers and video/communication/data cables routed above suspended ceilings do not impact fire protection DID. The licensee stated that the wiring located above the ceilings in the power block does not compromise administrative fire prevention controls and does not directly result in challenging automatic fire detection and suppression functions, manual fire suppression functions, or post-fire SSD capability. The licensee stated that for element 1, the current cables installed above the suspended ceilings that are not rated for plenum use are IEEE 383 qualified, sprayed with a flame retardant coating, or low voltage cables and are less susceptible to self-ignition and electrical shorts that could result in a fire in the enclosed space. The licensee further stated that there are no additional ignition sources in the listed areas above the suspended ceilings. The licensee stated that for element 2, the current cables installed above the suspended ceilings have no impact on the ability of the automatic suppression systems to perform their functions and that portable fire extinguishers and hose reel stations are available for manual firefighting activities by the site fire brigade such that if a fire occurred, the damage from the fire would be limited. The licensee stated that for element 3, the introduction of the non-rated plenum cables routed above the suspended ceilings does not prevent essential safety functions from being performed and that the quantity of combustibles associated with the non-rated cabling is considered insignificant with regard to combustible loading in the affected areas. The licensee further stated that the non-rated plenum cabling does not compromise automatic or manual fire suppression functions or the NSCA.

Based on its review of the information submitted by the licensee, and in accordance with 10 CFR 50.48(c)(2)(vii), the NRC staff concludes that the proposed PB method is an acceptable alternative to the corresponding NFPA 805, Section 3.3.5.1 requirement, because (1) the cable trays without covers above suspended ceilings do not pose a hazard since power and control cables are IEEE 383 qualified or sprayed with a flame retardant coating, and there are no other ignition sources located above the suspended ceiling; and (2) the current video/communication/data cables above suspended ceilings do not pose a hazard since low voltage cables are not generally susceptible to shorts causing a fire and are not an ignition source, since there are no other ignition sources located above the suspended ceiling, and since the existing detection above the CR ceilings will promptly identify a fire, thereby enhancing fire brigade response time. Therefore, based on the above, and the information provided by the licensee, the NRC staff concludes that the proposed PB method satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release; maintains sufficient safety margin; and maintains adequate fire protection DID.

3.1.4.4 NFPA 805, Section 3.9.4, "Automatic Sprinkler Protection for Diesel Fire Pumps"

In LAR Attachment L, Approval Request 4, the licensee requested approval of a PB method to demonstrate an equivalent level of fire protection for the NFPA 805, Section 3.9.4 requirement for automatic sprinkler protection for the diesel engine-driven fire pump. The licensee stated that the diesel engine-driven fire pump is located in the Diesel Fire Pump Building adjacent to gate structure 2 on the Condenser Circulating Water (CCW) cold water channel, and that the building is dedicated to the diesel engine-driven fire pump and is not provided with automatic sprinkler protection.

The licensee stated that the basis for the approval request is:

- A fire in the Diesel Fire Pump Building will not affect safety-related equipment; and

- Due to the separation distance between the diesel engine-driven fire pump and the electric fire pumps, there are no credible fire scenarios that would impact both the diesel engine driven fire pump and the electric fire pumps.

The licensee stated that the lack of automatic sprinklers to protect the diesel engine-driven fire pump does not affect nuclear safety and that each fire pump, individually, has the ability to supply the required fire water, and the diesel engine-driven fire pump is not relied upon for other water requirements. The licensee concluded that there is no impact on the NSPC.

The licensee stated that the lack of automatic sprinklers to protect the diesel engine-driven fire pump has no impact on the radiological release performance criteria and that it performed the radiological release review based on the manual fire suppression activities in areas containing, or potentially containing, radioactive materials, and that the review is not dependent on the location of the fire pumps. The licensee further stated that the location of the fire pumps does not change the radiological release evaluation performed that concluded that potentially contaminated water is contained and smoke is monitored. The licensee further stated that the configuration of the fire pumps does not add additional radiological materials to the area or challenge systems boundaries.

The licensee stated that the lack of automatic sprinklers to protect the diesel engine-driven fire pump does not negate the ability to supply the required fire water in a fire event. The licensee further stated that only one fire pump is required for fires in safety-related areas. The licensee further stated that the use of the diesel engine-driven fire pump has been defined by the limitations of the analysis of the fire event, and therefore, the inherent safety margin and conservatisms in the NFPA 805 nuclear safety analysis methods remain unchanged.

The licensee stated that the three elements of DID are 1) to prevent fires from starting; 2) rapidly detect, control, and extinguish fires that do occur thereby limiting damage; and 3) provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed.

The licensee stated that the lack of automatic sprinklers to protect the diesel engine-driven fire pump does not impact fire protection DID due to the capabilities of each of the three other electric motor-driven fire pumps and that the lack of automatic suppression over the diesel engine-driven fire pump does not result in compromising automatic fire suppression functions, manual fire suppression functions, or post-fire SSD capability and will not prevent essential safety functions from being performed. The licensee stated that for element 1, the lack of automatic sprinklers to protect the diesel engine-driven fire pump does not affect administrative controls for preventing fires from starting. The licensee stated that for element 2, the lack of automatic sprinklers to protect the diesel engine-driven fire pump does not impact the ability of the automatic suppression systems to perform their functions, because a fire affecting the diesel-driven fire pump would not impact the ability to provide 100 percent of the required fire water demand for safety-related areas. The licensee stated that for element 3, the lack of automatic sprinklers to protect the diesel engine-driven fire pump does not allow fire propagation through the barrier, and does not result in compromising automatic fire suppression functions, manual fire suppression functions, or post-fire SSD capability, and will not prevent essential safety functions from being performed.

Based on its review of the information submitted by the licensee, and in accordance with 10 CFR 50.48(c)(2)(vii), the NRC staff concludes that the proposed PB method is an acceptable alternative to the corresponding NFPA 805, Section 3.9.4 requirement because a fire in the Diesel Fire Pump Building will not affect safety-related equipment, because of the separation distance between the diesel engine-driven fire pump and the electric fire pumps, and because there are no credible fire scenarios that would impact both the diesel engine driven fire pump and the electric fire pumps. Therefore, based on the above and the information provided by the licensee, the NRC staff concludes that the PB method satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release, maintains sufficient safety margin, and maintains adequate fire protection DID.

3.2 Nuclear Safety Capability Assessment Methods

NFPA 805 (Reference 3), is a risk-informed/performance-based (RI/PB) standard that allows engineering analyses to be used to show that FPP features and systems provide sufficient capability to meet the requirements of 10 CFR 50.48(c).

NFPA 805, Section 2.4, "Engineering Analyses":

> Engineering analysis is an acceptable means of evaluating a fire protection program against performance criteria. Engineering analyses shall be permitted to be qualitative or quantitative… The effectiveness of the fire protection features shall be evaluated in relation to their ability to detect, control, suppress, and extinguish a fire and provide passive protection to achieve the performance criteria and not exceed the damage threshold defined in Section [2.4] for the plant area being analyzed.

Chapter 1 of the standard defines the goals, objectives, and performance criteria that the FPP must meet in order to be in accordance with NFPA 805.

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

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

NFPA 805, Section 1.4.1, "Nuclear Safety Objectives":

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

NFPA 805, Section 1.5.1, "Nuclear Safety Performance Criteria":

> Fire protection features shall be capable of providing reasonable assurance that, in the event of a fire, the plant is not placed in an unrecoverable condition. To demonstrate this, the following performance criteria shall be met.
>
> (a) *Reactivity Control*. Reactivity control shall be capable of inserting negative reactivity to achieve and maintain subcritical conditions.

Negative reactivity inserting shall occur rapidly enough such that fuel design limits are not exceeded.

(b) *Inventory and Pressure Control*. With fuel in the reactor vessel, head on and tensioned, inventory and pressure control shall be capable of controlling coolant level such that subcooling is maintained for a PWR [pressurized-water reactor] and shall be capable of maintaining or rapidly restoring reactor water level above top of active fuel for a BWR [boiling water reactor] such that fuel clad damage as a result of a fire is prevented.

(c) *Decay Heat Removal*. Decay heat removal shall be capable of removing sufficient heat from the reactor core or spent fuel such that fuel is maintained in a safe and stable condition.

(d) *Vital Auxiliaries*. Vital auxiliaries shall be capable of providing the necessary auxiliary support equipment and systems to assure that the systems required under (a), (b), (c), and (e) are capable of performing their required nuclear safety function.

(e) *Process Monitoring*. Process monitoring shall be capable of providing the necessary indication to assure the criteria addressed in (a) through (d) have been achieved and are being maintained.

3.2.1 Compliance with NFPA 805, “Nuclear Safety Capability Assessment Methods”

NFPA 805, Section 2.4.2, “Nuclear Safety Capability Assessment,” states:

The purpose of this section is to define the methodology for performing a nuclear safety capability assessment. The following steps shall be performed:

(1) Selection of systems and equipment and their interrelationships necessary to achieve the nuclear safety performance criteria in Chapter 1

(2) Selection of cables necessary to achieve the nuclear safety performance criteria in Chapter 1

(3) Identification of the location of nuclear safety equipment and cables

(4) Assessment of the ability to achieve the nuclear safety performance criteria given a fire in each fire area

This safety evaluation (SE) section evaluates the first three topics listed above. Section 3.5 addresses the assessment of the fourth topic.

Regulatory Guide (RG) 1.205, Revision 1 (Reference 4) endorses Nuclear Energy Institute (NEI) 04-02, Revision 2 (Reference 7) and Chapter 3 of NEI 00-01, Revision 2 (Reference 44), and promulgates the method outlined in NEI 04-02 for conducting a nuclear safety capability assessment (NSCA). This NRC-endorsed guidance (i.e., NEI 04-02 Table B-2, “NFPA 805 Chapter 2 – Nuclear Safety Transition – Methodology Review,” and NEI 00-01, Chapter 3) has been determined to address the related requirements of NFPA 805, Section 2.4.2. The NRC staff reviewed LAR Section 4.2.1, “Nuclear Safety Capability Assessment Methodology,” and license amendment request (LAR) Attachment B, “NEI 04-02 Table B-2 – Nuclear Safety Capability Assessment – Methodology Review,” against these guidelines.

The endorsed guidance provided in NEI 00-01, Revision 2 provides a framework to evaluate the impact of fires on the ability to maintain post-fire safe shutdown (SSD). It provides detailed guidance for:

- Selecting systems and components required to meet the nuclear safety performance criteria (NSPC),
- Selecting the cables necessary to achieve the NSPC,
- Identifying the location of nuclear safety equipment and cables, and
- Appropriately conservative assumptions to be used in the performance of the NSCA.

The licensee developed the LAR based on the three guidance documents cited above. Although RG 1.205, Revision 1 endorses NEI 00-01, Revision 2, the licensee performed its review based on the guidance in NEI 00-01, Revision 1 (Reference 74), as discussed below. Additionally, the licensee performed a review (gap analysis) of NEI 00-01, Revision 2, Chapter 3, to identify the substantive changes from NEI 00-01, Revision 1 that are applicable to the FPP. The NRC staff concludes that based on the information provided in the licensee’s submittal, as supplemented, the licensee used a systematic process to evaluate the post-fire SSA against the requirements of NFPA 805, Section 2.4.2, subsections (1), (2), and (3), which meet the methodology outlined in the latest NRC-endorsed industry guidance.

Frequently asked question (FAQ) 07-0039 (Reference 75) provides one acceptable method for documenting the comparison of the safe shutdown analysis (SSA) against the NFPA 805 requirements. This method first maps the existing SSA to the NEI 00-01, Chapter 3 methodology, which in turn, is mapped to the NFPA 805, Section 2.4.2 requirements.

The licensee performed this evaluation by comparing its SSA against the NFPA 805, NSCA requirements using the NRC-endorsed process in Chapter 3 of NEI 00-01, Revision 1 and documenting the results of the review in the LAR Attachment B in accordance with NEI 04-02, Revision 2.

The categories used to describe alignment with the NEI 00-01, Chapter 3 attributes are as follows:

1. The SSA directly aligns with the attribute: Noted in LAR Attachment B, Table B-2 as “Aligns.” (See discussion in SE Section 3.2.1.1.)

2. The SSA aligns with the intent of the attribute: Noted in LAR Attachment B, Table B-2 as "Aligns with Intent." (See discussion in SE Section 3.2.1.2.)

3. The attribute was not required for the SSA: Noted in the LAR Attachment B, Table B-2 as "Not required."

4. The attribute was not applicable to the SSA (for example, the attribute may be applicable only to PWRs): Noted in LAR Attachment B, Table B-2 as "Not applicable." (See discussion in SE Section 3.2.1.6.)

The licensee identified alignment approach number 4, "Not applicable," as a modification from the NEI 04-02 based approach in that it is a new category not included in NEI 04-02. The intent of this choice is to identify FPP elements that will not need to align because the element does not apply to the plant.

As stated above, the licensee performed the review of the NSCA to the guidance of NEI 00-01, Revision 1 instead of Revision 2. In addition, the licensee conducted a review (gap analysis) of NEI 00-01, Revision 2, Chapter 3, to identify the substantive changes from NEI 00-01, Revision 1 that are applicable to an NFPA 805 FPP. The licensee performed this review and documented the results separately. The results of this review are summarized as follows:

- 3.1.2.1 Post-fire reactivity control of [BWR] control rod drive system

  The additional considerations of Revision 2 will be addressed by linking the Emergency Operating Instructions to fire SSD procedures consistent with the recommendations of the BWR Owners Group document, with the exception of the main control room (MCR) abandonment fire SSD procedures. The MCR abandonment fire SSD procedures will include procedure steps for fires impacting the ability to scram from the MCR. This action is identified in LAR Attachment S, Table S-3, Implementation Item 25. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

- 3.2.1.2 Post-fire manual operation of rising stem valves in the fire area of concern

  NFPA 805, "Operator Action Feasibility Analysis," documents the acceptability of using manually operated valves that are located in the fire area. This includes effects on coefficient of friction.

- 3.5.1.1 and 3.5.2.3 Analysis of the impact of NRC IN 92-18 on circuit analysis failure due to hot shorts

  An evaluation of a representative population of motor-operated valves (MOVs) was conducted to address potential pressure boundary concerns. All of the valves evaluated were found to be acceptable and the licensee concluded that there is a high degree of confidence that the successful pressure boundary evaluations would apply to all NFPA 805 MOVs in the population of concern, which are of similar and bounded characteristics. The licensee also determined that a breach of the pressure boundary due to actuator stall forces did not warrant further consideration based on the results of its quantitative analysis.

In SSA request for additional information (RAI) 01 (Reference 31), the NRC staff requested that the licensee provide clarification as to the number of MOVs that may be required to be operated as an RA. In its response to SSA RAI 01 (Reference 11), the licensee stated that for MOVs, it considered the possibility of an IN 92-18 (Reference 104) failure (i.e., cable damage that bypasses the motor operator torque/limit switches) as part of the feasibility evaluation and that it considered any RA involving the positioning of an MOV subject to IN 92-18 cable damage in a given fire scenario to not be feasible for that scenario. The licensee stated that it did not take any analysis credit for repositioning a MOV in any fire scenario where the MOV may be subject to the IN 92-18 failure mode. The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee did not take any credit for repositioning a MOV subject to IN 92-18 failure in any fire scenario.

- 3.5.2.1 Analysis of open circuits on a high voltage (e.g., 4.16 kV) ammeter current transformers (CTs)

The evaluation of open circuits on CTs showed that when an open circuit on a CT occurs in the NSCA model, a fire risk evaluation (FRE) was performed.

In SSA RAI 02 (Reference 31), the NRC staff requested that the licensee provide more detail with regard to resolution of verification from deterministic requirements (VFDRs) concerning secondary fires resulting from open circuit failures on CTs. In its response to SSA RAI 02 (Reference 13), the licensee stated that the methodology of resolution is the same irrespective of the fire scenario being MCR abandonment, loss of control with alternate shutdown, or if operators remain in the MCR. The licensee further stated that in the absence of additional industry guidance on the likelihood of fire-induced open circuits and postulated secondary fire characteristics, it used a conservative approach for postulated secondary fires from the open circuit of higher ratio CTs in the NFPA 805 analysis. The licensee further stated that the targets in the zone of influence (ZOI) of the secondary fires were included in the target set for the primary fire scenario/ignition source and that recovery actions (RAs) were also included in the logic model. The licensee further stated that it determined credit for operator actions considering the effects associated with the secondary fires and that there were no RAs taken at the panels susceptible to secondary fires and no components that would be involved in the secondary fire at the CT locations of interest were required to support a RA. The licensee further stated that secondary fire locations are balance of plant non-safety-related switchgear or generators located in the Turbine Building and that the justification for no further action required is based on the delta risk meeting the performance criteria. The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee demonstrated that its method conservatively estimated the impacts of secondary fires, and the targets in the ZOI of the secondary fires were included in the target set for the primary fire scenario/ignition source.

- 3.5.2.4 Analysis of control power for switchgear with respect to breaker coordination

  For switchgear that requires control power for breaker operation, the NSCA model reflects the need to have control power to protect the switchgear from fault concerns.

  The licensee indicated that the method used to perform the NSCA with respect to selection of systems and equipment, selection of cables, and identification of the location of equipment and cables either directly meets the NRC-endorsed guidance from NEI 00-01, Revision 1, Chapter 3, as supplemented by the gap analysis, or meets the intent of the endorsed guidance with adequate justification as documented in LAR Attachment B, Table B-2.

The NRC staff concludes that taken together, these methods compose an acceptable approach for documenting compliance with the NFPA 805, Section 2.4.2, "Nuclear Safety Capability Assessment," requirements because the licensee has followed the alignment strategies identified in the endorsed NEI 04-02 guidance document. The process defined in the endorsed guidance provides an organized structure to document each attribute in NEI 00-01, Chapter 3, allowing the licensee to provide significant detail in how the program meets the requirements. In addition to the basic strategy of "Aligns," which itself makes the attribute both auditable and inspectable, additional strategies have been provided, allowing for amplification of information, when necessary, regarding how or why the attribute is acceptable.

3.2.1.1 Attribute Alignment -- Aligns

For the majority of the NEI 00-01, Chapter 3 attributes, the licensee determined that the SSA aligns directly with the attribute. In these instances, based on the information provided by the licensee in the LAR, the documents reviewed and discussions held with the licensee's technical staff during the onsite NFPA 805 audit, the NRC staff concludes that the licensee's statements of alignment are acceptable because the analyses are consistent with regulatory guidance for selecting the systems and equipment and their interrelationships necessary to achieve the NSPC, selection of the cables necessary to achieve the NSPC, and the identification of the location of nuclear safety equipment and cables.

The following attributes identified in LAR Attachment B, Table B-2 as aligning with this method required additional review by the NRC staff:

- 3.2.1.2
- 3.3.3.1
- 3.5.2.5

LAR Attachment B, Table B-2, Section 3.2.1.2 provides guidance regarding the need to include heat sensitive piping materials, including tubing with brazed or soldered joints, when considering fire damage to mechanical equipment. In SSA RAI 11 (Reference 31), the NRC staff requested that the licensee describe how it considered the failure of brazed or soldered joints in the NSCA. In its response to SSA RAI 11 (Reference 11), the licensee stated that the nuclear safety capability analysis aligns with the NEI 00-01 guidance regarding the susceptibility of brazed or soldered joints to fire-induced failures. The licensee further stated that the systems containing tubing/piping with brazed or soldered joints are associated with pneumatic supplies (e.g., plant control air) and that plant control air system success logic within the analysis includes logic elements representing plant control air system piping locations. The licensee further stated that these logic elements ensure that assumed fires in plant locations where plant control air piping of sufficient size is routed would result in plant control air system failure in the NSCA. The licensee stated that for fire areas where brazed/soldered joints in pneumatic supply tubing associated with a specific component might fail due to fire-effects, it assumed the component that directly utilizes this tubing to fail by the NSCA analysis logic due to its location within the fire area. The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's method specifically addresses the fire effects on tubing with brazed or soldered joints, and therefore, aligns with the NRC-endorsed guidance.

LAR Attachment B, Table B-2, Section 3.3.3.1 provides guidance that for electrical power distribution equipment, such as power supplies, the nuclear safety capabilities assessment should identify any circuits whose failure may cause a coordination concern for the bus under evaluation. In SSA RAI 09 (Reference 31), the NRC staff requested that the licensee describe whether it credited cable length as additional impedance in the study necessary to meet the maximum available fault current to demonstrate coordination with upstream power supply breakers. In its response to SSA RAI 09 (Reference 13), the licensee stated that, in general, cable length is not credited to demonstrate adequate protective device coordination; however, in two specific cases to reduce maximum available fault current by a small amount, cable impedance is considered as described below:

- 250 Volts direct current (DC) (VDC) Battery Boards 4, 5, and 6

  For these three boards, the load-side breakers and fuses must coordinate with the battery main breaker and fuse. There is minor miscoordination between load-side breakers that did not coordinate with the battery fuse near the maximum theoretical available fault current. The coordination calculation did not explicitly credit cable length to reduce fault current but it did include it in the qualitative argument for acceptability when considering locations more likely to experience a bolted fault at the maximum fault current.

- 120 Volts alternating current (AC) (VAC) Reactor Protection Systems (RPSs) “A” and “B” (Units 1, 2, and 3)

  For these boards, load-side breakers for RPS “Bus A” and ”Bus B” must coordinate with their respective Motor Generator (MG) Set output breaker to support the NSCA and Fire Probabilistic Risk Assessment (FPRA) circuit selection. The limiting coordination case is the load-side breakers on each RPS bus and the respective unit motor generator (MG) Set output breaker. The applicable coordination calculation identified that slight miscoordination exists between the load-side breakers and the MG Set output breakers near the

> maximum theoretical available fault current from the MG sets. The lower tolerance limit of the MG Set output breaker instantaneous trip is only 8 amps below the maximum fault current from the MG Sets, thus resulting in potential miscoordination. For simplification purposes, the existing coordination calculation conservatively assumes the available short circuit current at the RPS buses is equivalent to the maximum available fault current at the MG set terminals and thus no system impedance is taken into consideration in determining the maximum available fault current at the RPS buses. Crediting the impedance of the 4/0 AWG cable between the MG Set output breaker and the respective RPS bus does not constitute "crediting cable length" within the context of this RAI response. Crediting cable length to reduce available fault current is of potential concern when the cable being credited is on the load-side of the downstream breaker. In this case, no credit is taken for cable on the load-side of the 100 A load-side breakers. Cable length has not been credited in the NSCA or FPRA coordination calculations to reduce available fault current to levels that demonstrate full coordination between upstream and downstream overcurrent protective devices. On this basis, the established fire scenario zones of influence used in the FPRA are independent of electrical coordination considerations, including cable length for load-side overcurrent protective devices.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee did not generally credit cable length for load-side overcurrent protective devices, except in two cases and in the two cases, the licensee provided sufficient justification that the cable length assumptions met the goal of the NSCA, FPRA analysis, and NEI 00-01, Sections 3.3.1.7 and 3.3.2 regarding recognizing and analyzing associated circuits by common power supply.

LAR Attachment B, Table B-2, Section 3.5.2.5 provides guidance for circuit failures that could cause fire damage due to a circuit either whose isolation device fails to isolate the cable fault or protect the faulted cable from reaching its ignition temperature, or the fire somehow propagates along the cable into adjoining fire areas. In SSA RAI 03 (Reference 31), the NRC staff requested additional information regarding the resolutions of VFDRs where the VFDRs identify the potential of ignition of secondary fires at locations outside the fire area being analyzed. In its response to SSA RAI 03 (Reference 24) the licensee stated that electrically-induced secondary fires can potentially result from the failure of a circuit breaker to isolate an electrical fault caused by the initial fire. Larger circuit breakers require control power to operate, and fire events can cause breaker control power to be lost. Within a fire event time sequence, such a loss-of-control power may be early (e.g., the initial fire damages the cable providing control power to an electrical board) or late (e.g., the fire fails a battery charger or its power supply such that the available control power voltage degrades over time as the associated battery depletes). The licensee provided the strategy to resolve each of these cases as follows:

- The majority of VFDRs related to early control power loss concurrent with the potential for an associated power cable fire induced fault are being deterministically resolved by a plant modification such that the secondary fire initiation vulnerability is removed. However, there are some applications of 1-hour rated electrical raceway fire barrier system (ERFBS) in fire areas without automatic suppression where the VFDR resolution does not meet deterministic separation requirements. These VFDRs are resolved by the performance-based approach.

The plant response to secondary fires is not modeled in the PRA, and application of ERFBS that do not meet deterministic separation requirements to VFDRs involving secondary fires due to failure of fault protection is limited. In these cases, equipment and cables affecting circuit breaker control power and power cables requiring fault protection will be sufficiently separated such that they are not damaged in a single fire scenario. Thus secondary fire events are prevented.

- Regarding the late loss-of-control power situations, the VFDR risk was evaluated by the FPRA. The FPRA determined the risk was insignificant from potential secondary fires resulting from breaker control power loss due to battery depletion.

The licensee stated that considering the factors for late control power loss situations, the initiation of a secondary fire would require the following events and human failure actions:

- Loss of the control power battery charger soon after the onset of the fire. A delay in the charger loss would add to the length of time the board retained control power. Delayed charger loss would allow greater time for breaker control power to function while the fire is being suppressed.
- Inability of Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, fire operations personnel to suppress the fire to prevent further damage within the battery depletion time once the charger was lost.
- Failure by BFN staff to transfer the board to an alternate control power supply or restore the associated charger to service prior to battery depletion.
- Development of fire damage such that an associated power cable faults only after battery depletion.
- Energizing the associated power cable (i.e., its breaker closed) when it is damaged.

The licensee concluded that the occurrence of the set of events necessary to create the secondary fire due to late loss-of-control power was judged to be so improbable as to be incredible, plant risk was insignificant, and such potential secondary fires did not warrant further modeling in the FPRA. The licensee concluded that no secondary fire locations exist, no components are involved in a secondary fire, and no RAs are impeded or affected by a secondary fire. The licensee indicated that the loss-of-control power condition, which results in a breaker's inability to open under a fault condition, was addressed in the NFPA 805 transition by either (1) ensuring by plant modification that no early loss of DC control power will occur for breakers protecting power cables that could be faulted in the same fire area, or 2) by evaluation in the FPRA judging the risk to be insignificant from fire-induced faults, which could occur only after battery depletion. The NRC staff concludes that the licensee's response to the RAI is acceptable because the methods as described by the licensee are within the methodology of NFPA 805 resolutions of separation issues using either deterministic or PB compliance evaluation, because the licensee recognized secondary fires and included them in the resolution of VFDRs; and therefore, aligns with the NRC-endorsed guidance.

3.2.1.2 Attribute Alignment -- Aligns with Intent

For certain of the NEI 00-01, Chapter 3 attributes, the licensee determined that the SSA aligns with the intent of the attribute and provided additional clarification when describing its means of alignment. The attributes identified in LAR Attachment B, Table B-2 as having this condition are as follows:

- 3.1 Safe Shutdown Systems and Path Development
- 3.1.1.9 72-Hour Coping
- 3.1.2.4 Decay Heat Removal
- 3.4.1.5 Repairs

The licensee indicated that for the above-listed attributes, the NSCA does not ensure CSD and does not specifically align with the guidance. The licensee further stated that NFPA 805 does not require a plant to transition to CSD following a fire and that the NSCA and NFPA 805 only require maintaining the fuel in a safe and stable condition (i.e., there is no requirement to achieve and maintain CSD) and contains no 72-hour coping time. The NRC staff concludes that the methods as described by the licensee are acceptable because they meet the requirement of NFPA 805, which is to maintain the fuel in a safe and stable condition.

- 3.1.1.7 Offsite Power

The licensee indicated that the NSCA does not specifically align with the guidance regarding redundant and alternate shutdown capability. The distinction of redundant shutdown versus alternate shutdown is not defined in NFPA 805, and therefore, the licensee's analysis does not incorporate the associated provision. However, as part of the NFPA 805 transition, the licensee performed the analysis to credit the use of offsite power when it was available. The licensee did not take any credit for a fire causing a loss of offsite power. The NRC staff concludes that the method as described by the licensee is acceptable because it is similar to the specific method in NEI 00-01 and the licensee has credited use of offsite power when appropriate, and therefore, aligns with the intent of NRC-endorsed guidance.

- 3.1.3.3 Define Combination of Systems for Each Safe Shutdown Path
- 3.1.3.4 Assign Shutdown Paths to Each Combination of Systems
- 3.2.2.3 Develop a List of Safe Shutdown Equipment and Assign the Corresponding System and Safe Shutdown Path(s) Designation to Each

For these attributes, the licensee indicated that systems needed to satisfy the NFPA 805 performance criteria were selected. The performance criteria were established as performance goals in the separation analysis. Sets of systems are not directly designated as SSD paths in the NSCA and do not specifically align with this guidance. Shutdown paths were established using logical relationships in the separation analysis software. Additional support systems identified were also included in the appropriate logical relationships. Each performance criteria is established as a separation analysis software performance goal and has one or more success paths contained within the logic. The combination of systems and equipment relied upon to achieve the NSPC are selected from the systems and equipment available in the fire area analysis to satisfy the performance goals. The NRC staff concludes that the methods as described by the licensee are acceptable because they are similar to the specific methods in NEI 00-01, and therefore, align with the intent of NRC-endorsed guidance.

- 3.2.1.1 Primary Secondary Components

The licensee indicated that equipment is not specifically identified as primary or secondary in the NSCA. Components which correspond to the primary equipment are identified in the Safe Shutdown Equipment List (SSEL). Components which correspond to the secondary equipment are either on the SSEL or within the BFN separation analysis software by logical ties to the SSEL components. The NRC staff concludes that the methods as described by the licensee are acceptable because they are similar to the specific methods in NEI 00-01 and the required primary and secondary components were identified and addressed in the analysis, and therefore, align with the intent of NRC-endorsed guidance.

- 3.2.2.1 Identify the System Flow Path for Each Shutdown Path

The licensee indicated that piping and instrumentation diagram (P&ID) markups or annotated P&ID drawings were not documented or maintained, which does not specifically align with this guidance. The required systems and components were identified, and then the P&IDs and the existing safe shutdown equipment list were reviewed to identify all components in these systems that were necessary to support fire SSD. The licensee performed this by reviewing the flow paths for the systems and identifying system boundaries. The NRC staff concludes that the methods as described by the licensee are acceptable because they are similar to the specific methods in NEI 00-01 and the required systems and components were identified, and therefore, align with the intent of NRC-endorsed guidance.

- 3.2.2.4 Identify Equipment Information Required for the Safe Shutdown Analysis

The licensee indicated that all equipment-related information necessary for performing the post-fire shutdown analysis for the equipment is not tabulated on the SSD equipment list, which does not specifically align with this guidance. The NSCA SSD equipment list has been developed and the required information to support an SSA using the separation analysis software is documented. Each component on the list has information documented on the SSD equipment list. However, other equipment-related information necessary to perform the post-fire SSA is contained in the separation analysis database and is documented in the calculation. The NRC staff concludes that the methods as described by the licensee are acceptable because they are similar to the specific methods in NEI 00-01 and the required systems and components were appropriately identified and documented and align with the intent of NRC-endorsed guidance.

- 3.3.3.3 Assign Cables to the Safe Shutdown Equipment

The licensee indicated that all cables that could adversely affect the ability to achieve and maintain safe and stable conditions are identified. The cable to SSD component logic relationships is contained in a relational database. Drawing information on cable selection is contained in the separation analysis database for reference. The licensee completed a coordination review for the NSCA power supplies, and in cases with insufficient coordination that is not being modified, the licensee logically tied the uncoordinated power cable to the power source to ensure that the power source is identified as affected equipment in the fire areas where the cable may be damaged.

The licensee indicated that treatment of interlocks does not specifically align with this guidance and that investigated interlocks are not specifically tabulated in a separate data field. However, interlocks are evaluated and their impact is accounted for in the software logic ties. The NRC staff concludes that the methods as described by the licensee are acceptable because they are similar to the specific methods in NEI 00-01 and cables and interlocks were appropriately assigned and evaluated and align with the intent of NRC-endorsed guidance.

- 3.3.3.5 Identify Location of Raceway and Cables by Fire Area

The licensee indicated that the identification of raceway (any channel that is designed and used expressly for supporting wires, cable, or busbars, raceways consist primarily of, but are not restricted to, cable trays and conduits) fire area locations does not specifically align with this guidance. The fire area locations of the raceways are not identified in the software. However, this information is not required to be in the software since the fire area/fire zone location of cables is directly assigned to the cables in the software. The cable location information is documented in the calculation. The NRC staff concludes that the methods as described by the licensee are acceptable because they are similar to the specific methods in NEI 00-01; and therefore, align with the intent of NRC-endorsed guidance.

In SSA RAI 14 (Reference 31), the NRC staff requested that the licensee provide a detailed description of the processes related to cable routing information and justification of how they were used to validate accuracy of the cable data. The NRC staff requested that the licensee include in that description the efforts and scope to provide more accurate location information and to discuss how it used walkdown information to assist in this validation. In its response to SSA RAI 14 (Reference 11), the licensee stated that its Appendix R analysis associated fire area location information directly to the Appendix R cables and that it used the BFN Integrated Cable and Raceway Data System to determine the raceways in the cable routes. The Appendix R cable fire area location information was developed by identifying the cable's raceway routing on plant physical drawings and identifying the fire areas that the cable routes via those raceways and the cable termination locations. For the NFPA 805 NSCA deterministic analysis, the cable fire area route information from the Appendix R data was used for cables associated with SSD systems. Cables for newly credited systems were assigned to fire areas using the same Appendix R method. Utilizing the fire area assignment to cables and equipment, failures for a given fire area were evaluated for their effect on the ability to meet the NFPA 805 performance criteria. Additional supporting information provided in the response included:

- The BFN FPRA only used the Appendix R cable fire area location data for full compartment burn scenarios. Otherwise, the BFN FPRA analysis derived the cable targets independent of the Appendix R cable fire area route information.

- The BFN FPRA fire scenarios, except full compartment burn scenarios, were developed by performing plant walkdowns. A ZOI was determined for the fire source and then raceway and equipment targets were identified from plant walkdowns with the aid of plant physical drawings.

- The FPRA scenario failures were compared to the NSCA failures for a given fire area. The expected result was that the FPRA scenario failures typically would be a subset of the NSCA fire area (full compartment burn) failures. In instances where this was not the case, the cable causing the failure was investigated to determine the cause for the discrepancy (e.g., either the fire area assignments for the cable were incorrect or the cable was added to the fire scenario in error). This cross-comparison method of review provided a level of independent validation for both the cable fire area routing and the fire scenario modeling.

- The Unit 3 tray raceways were nodalized prior to the BFN NFPA 805 project. The nodalized segmented trays in Unit 3 provided a more precise cable location footprint for the Unit 3 fire scenarios.

- Many tray raceways for Unit 1 and Unit 2 were not nodalized. Early in the NFPA 805 transition project, BFN decided to "nodalize" selected trays that were identified as fixed source targets in the Unit 1 or Unit 2 Reactor Building. Plant walkdowns were used as needed to complete this tray nodalization work.

- The tray node network drawings were used by fire modelers to establish the appropriate tray segments that would be a target for the fire scenarios. The tray segment target raceways added to the fire scenario then caused the failure of the appropriate cables contained in those tray node segments. Performing this tray nodalization work required a detailed cable route review, which also provided an opportunity to validate the fire area location assignment accuracy of the NFPA 805 cables, including Appendix R cables that were routed in the nodalized trays.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee demonstrated methods that reinforce the accuracy of cable routing information, which is the basis for NFPA 805 impact resolution and align with the intent of NRC-endorsed guidance.

- 3.5.2.3 Circuit Failures Due to a Hot Short Ungrounded Circuits

The licensee indicated that hot shorts on ungrounded circuits were considered to occur either from internal cable wire-to-wire shorts or external cable-to-cable shorts. For cable failures on ungrounded circuits, the methodology assumes the hot short would have sufficient potential to cause a spurious operation of the component. In specific cases, the effect of a fire-induced hot short may not be assumed if a detailed evaluation demonstrates that no aggressor hot short source conductors are routed in the same raceways as the target conductor. These evaluations are documented in the analysis.

The licensee indicated that treatment of hot shorts on ungrounded circuits does not specifically align with this guidance. Two types of cable hot short conditions are considered to be of low likelihood based on current guidance, that they are not assumed credible, except for analysis involving high/low pressure interface components in accordance with NEI 00-01. These hot short exceptions are 3 phase AC power circuit cable-to-cable proper phase sequence faults and 2-wire ungrounded DC motor power circuit cable-to-cable proper polarity faults.

LAR Attachment B, Table B-2, Section 3.5.2.3 provides guidance for treatment of circuit failures due to hot shorts. In SSA RAI 04 (Reference 31) the NRC staff requested that the licensee provide a more detailed justification for the two types of cable hot short conditions considered to be of sufficiently low likelihood that they are not assumed credible, except for Hi/Lo pressure interface components. In its response to SSA RAI 04 (Reference 11) the licensee indicated that Section 3.5.2.3 does not discuss the circuit failures excluded from deterministic analysis allowed in NEI 00-01, Revision 1, Appendix B. The "aligns with intent" statement in LAR Attachment B, Table B-2, Section 3.5.2.3, was made to clarify that hot short circuit failure exclusions are not discussed in Section 3.5.2.3 but, are included in NEI 00-01, Revision 2, Appendix B, Table B.1-0. The likelihood of all of these faults occurring, without grounding, is very low. Additionally, there are far fewer DC power cables in a plant, and even fewer, if any, continually running DC loads in the plant to serve as aggressors, making the possibility of consequential hot shorts in DC power cables for compound motors as implausible as three-phase consequential hot shorts. Therefore, considering hot shorts for 3-phase AC power circuit cable-to-cable proper phase sequence faults and 2-wire ungrounded DC motor power cable-to-cable proper polarity faults only for high/low pressure interfaces is justified.

In its revised response to SSA RAI 04 (Reference 24), the licensee stated that subsequent to the project instruction for the Browns Ferry Post-Fire Safe Shutdown Cable Identification, NUREG/CR-7150, Vol. 1, "Joint Assessment of Cable Damage and Quantification of Effect from Fire (JACQUE-FIRE)" (Reference 105) was issued in October 2012. In this report, irrespective of high/low pressure interface consideration, the Phenomena Identification and Ranking Table (PIRT) panel concluded the spurious operation of a three-phase AC motor due to proper polarity hot shorts on three-phase power cabling is incredible and the spurious operation of DC compound-wound motors due to proper polarity hot shorts in the motive/power cabling is incredible. As defined in the report, "the term 'incredible' used in conjunction with the phenomenon of a fire-induced circuit failure, signifies the PIRT panel's conclusion that the event cannot occur. In these cases, the PIRT panel could find no evidence of the phenomenon ever occurring, and there were no credible engineering principles or technical argument to support its happening during a fire. Any likelihood value assigned to these types of phenomena would have little meaning." Therefore, the licensee does not consider these hot short type circuit failures as credible based on the PIRT panel conclusions.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee demonstrated that the likelihood of all of these faults occurring, without grounding, is very low and consistent with existing guidance on hot short phenomenon. In addition, the licensee provided adequate justification for using the specific methods described in NEI 00-01, and therefore, the NRC staff concludes that those methods align with the intent of NRC-endorsed guidance.

In discussions with the licensee during the NFPA 805 site audit, the NRC staff discovered that the licensee utilized shorting switches as a resolution to potential hot short induced spurious actuations. In SSA RAI 10 (Reference 31), the NRC staff requested, for those components required to meet the nuclear safety performance goals of NFPA 805, that the licensee provide a list of components that will rely on this protection scheme. The licensee was requested to include the equipment type, type of control circuit (grounded or ungrounded, CPT or non-CPT), and fire locations where credit was taken. In its response to SSA RAI 10 (Reference 13), the licensee identified eight components (three air operated valves (AOVs) and 5 MOVs) in the NSCA where these shorting switching circuits were used. The licensee stated that protection from spurious operation was provided only if the shorting switch, the shorting conductors, and the end device (i.e., the actuating coil) were free of fire damage. The NRC staff recognizes that use of these shorting switches does not preclude consideration of failures based on the other circuit failure modes. These shorting switches do not serve as the basis for deterministically eliminating potential spurious operations that could result from postulated open circuit of conductors subject to the fire, which might defeat the shorting switch function. The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee provided adequate justification for using the shorting switches in conditional, limited failure modes, and therefore, align with the intent of NRC-endorsed guidance.

3.2.1.3 Attribute Alignment – Not in Alignment, but Prior NRC Approval

The licensee did not identify any attributes in this category.

3.2.1.4 Attribute Alignment – Not in Alignment, but No Adverse Consequences

The licensee did not identify any attributes in this category.

3.2.1.5 Attribute Alignment – Not in Alignment

The licensee did not identify any attributes in this category.

3.2.1.6 Attribute Alignment – Not Applicable

The licensee identified an alignment attribute that was not applicable to the SSA (for example, the attribute may be applicable only to PWRs): Noted in LAR Table B-2 as "Not applicable." For some of the NEI 00-01, Chapter 3 attributes, the licensee determined that the attribute was not applicable to the SSA. In these instances, the NRC staff concludes that the licensee's statements of alignment are acceptable based on the licensee's conclusions that the attribute is not applicable.

3.2.1.7 NFPA 805, Nuclear Safety Capability Assessment Methods Conclusion

The NRC staff reviewed the documentation provided by the licensee describing the process used to perform the NSCA required by NFPA 805, Section 2.4.2. The licensee performed this evaluation by comparing the SSA against the NFPA 805, NSCA requirements using NEI 00-01, Revision 1 (Reference 74) with a gap analysis to the NRC-endorsed process in Chapter 3 of NEI 00-01, Revision 2. The results of the review are documented in LAR Attachment B, Table B-2 in accordance with NEI 04-02, Revision 2 and the gap analysis of NEI 00-01, Revision 2 (Reference 44). The licensee identified the differences and indicated appropriate resolutions to the alignment with NEI 00-01, Revision 1 and NEI 00-01, Revision 2.

Based on the information provided in the licensee's submittal, as supplemented, the NRC staff accepts the method the licensee used to perform the NSCA with respect to the selection of systems and equipment, selection of cables, and identification of the location of nuclear safety equipment and cables, as required by NFPA 805, Section 2.4.2. The NRC staff concludes the licensee's method is acceptable because the applicable attribute:

- Met the NRC-endorsed guidance directly; or
- Met the intent of the endorsed guidance and adequate justification was provided; or
- Was not applicable.

3.2.2 Maintaining Fuel in a Safe and Stable Condition

The nuclear safety goals, objectives, and performance criteria of NFPA 805 allow more flexibility than the previous deterministic FPPs based on Appendix R to 10 CFR 50 and NUREG-0800, Section 9.5.1.1 (Reference 106), since NFPA 805 only requires the licensee to maintain the fuel in a safe and stable condition rather than achieve and maintain cold shutdown (CSD) in 72 hours. In LAR Section 4.2.1.2, "Safe and Stable Conditions for the Plant," the licensee stated that the NFPA 805 licensing basis is to achieve and maintain (hot shutdown) HSD conditions following any fire occurring at-power with reactor water level restored and maintained above the top of active fuel and a decay heat removal path established.

In SSA RAI 05 (Reference 31), the NRC staff requested additional information regarding the at-power analysis to achieve safe and stable HSD conditions. In its response to SSA RAI 05 (Reference 12), the licensee stated that the credited success paths for achieving the NSPC of NFPA 805, Section 1.5.1 remain the same throughout the event (i.e., the credited success paths do not change after 24 hours). A description of the credited systems and capabilities that are required beyond 24 hours was provided in the response for each NSPC (Reactivity Control, Inventory and Pressure Control, Decay Heat Removal, Vital Auxiliaries, and Process Monitoring). The licensee also indicated that diesel generator fuel oil, lubricating oil, drywell pneumatic supplies for safety relief valve operation, battery power with charger restoration by RAs, and reactor pressure vessel make-up water are credited in the NSCA and have limitations. Each of these elements was addressed in detail in the analysis. There are no repair actions credited in the NSCA to sustain safe and stable conditions. RAs are listed in LAR Attachment G, "Recovery Actions Transition." With regard to actions beyond 24 hours, the licensee indicated that they are qualitatively determined to be very low risk based on the nature of the activities and the amount of available resources. The NRC staff concludes that the licensee's response to the RAI and the corresponding statement of compliance are acceptable because the licensee demonstrated an appropriate method for meeting the NSPC in the safe and stable condition beyond 24 hours.

On the basis of the licensee's analysis described in the LAR, as supplemented, the NRC staff concludes that the licensee has provided reasonable assurance that the fuel can be maintained in a safe and stable condition, post-fire, for an extended period of time.

3.2.3 Applicability of Feed and Bleed

The limitations of 10 CFR 50.48(c)(2)(iii), "Use of feed-and-bleed," are not applicable to boiling water reactors.

3.2.4 Assessment of Multiple Spurious Operations

NFPA 805, Section 2.4.2.2.1, "Circuits Required in Nuclear Safety Functions," states:

> Circuits required for the nuclear safety functions shall be identified. This includes circuits that are required for operation, that could prevent the operation, or that result in the maloperation of the equipment identified in 2.4.2.1 ["Nuclear Safety Capability Systems and Equipment Selection"]. This evaluation shall consider fire-induced failure modes such as hot shorts (external and internal), open circuits, and shorts to ground, to identify circuits that are required to support the proper operation of components required to achieve the nuclear safety performance criteria, including spurious operation and signals.

In addition, NFPA 805, Section 2.4.3.2 states that the probabilistic safety analysis (PSA) evaluation shall address the risk contribution associated with all potentially risk-significant fire scenarios. Because the RI/PB approach taken used FREs in accordance with NFPA 805, Section 4.2.4.2, "Use of Fire Risk Evaluation," adequately identifying and including potential multiple spurious operation (MSO) combinations is required to ensure that all potentially risk-significant fire scenarios have been evaluated.

The NRC staff reviewed LAR Section 4.2.1.4, "Evaluation of Multiple Spurious Operations," and LAR Attachment F, "Fire-Induced Multiple Spurious Operations Resolution," to determine whether the licensee has adequately addressed MSO concerns. The licensee indicated that as part of the NFPA 805 transition project, a review and evaluation of its susceptibility to fire-induced MSOs was performed. The process was conducted in accordance with NEI 04-02 (Reference 7) and RG 1.205 (Reference 4), as supplemented by FAQ 07-0038 (Reference 73).

The licensee indicated in LAR Attachment F that the first expert panel originally met in January 2010 and reviewed the list of generic MSOs referenced in NEI 00-01, Revision 2. Training was conducted in the form of an introductory overview and slide presentation, including the following topics:

- Post-fire Safe Shutdown
- PRA Overview and Results
- MSO Overview (including background on fire-induced MSOs and MSO classification)
- Types of Circuit Failures
- Fire Testing Results
- MSO Expert Panel Process

The licensee identified in LAR Attachment F that the MSO expert panel was selected to provide plant-specific input in the areas of fire protection, fire SSA, PRA, operations, systems engineering, and electrical circuits. Using the Boiling Water Reactor Owners Group generic MSO list as guidance, a step-by-step discussion was held, typically by reviewing flow diagrams; control diagrams; and simplified training diagrams, and postulating scenarios; discussing the potential consequences; discussing operator response; and recommending additional course of action. New plant-specific MSOs were developed using plant documentation, including drawings and the licensee's analysis, ideas from the previous MSOs, and plant-specific expert knowledge. These new MSOs were numbered with specific designators.

The licensee stated that the following guidelines were used in the MSO determination process:

- All BFN specific potential MSO scenarios identified by expert panel were added to the list for documented disposition.
- A flow diversion path for a system protected by one or more passive/mechanical devices not affected by a fire may be eliminated from further analysis and that equipment not added to the component list.
- Automatic actuation systems were not credited when determining MSOs unless they created an undesired effect.
- Locations of components or cables involved in potential MSOs were not considered. (The endorsed guidance in FAQ 07-0038 does not require consideration of component and/or cable location at this stage in the process. The NRC staff confirmed through review of information provided in LAR Attachment B that during circuit analysis and fire area analysis, location of both components and cables was identified, considered, and factored into the NSCA.)
- MSOs involving the bypassing of torque and limit switches, allowing a valve to fail due to over-thrust, were considered.
- No presupposed limits on the number of fire-induced spurious operations are assumed.
- Any number of hot shorts (inter-cable or intra-cable) were considered when assuming spurious operation of equipment.

The licensee also stated that after all safety functions were reviewed, the expert panel looked for combinations of MSOs that could have more serious implications than the individual MSOs. PRA insights were considered as part of the MSO expert panel review, as well as MSOs of concern to FPRA systems not credited in the NSCA.

The first meeting was followed-up by an April 2010 meeting to discuss new MSOs. The expert panel met again in December 2012 to align the MSOs in NEI 00-01, Revision 3 (Reference 107) with the BFN MSOs. They also approved the final disposition for several MSOs. This meeting was followed-up with a meeting on January 28, 2013, to approve final dispositions for several more MSOs. The BWR generic MSO list in Revision 2 of NEI 00-01 (Reference 44) was initially utilized in the first expert panel meeting in January 2010. The alignment of the BWR generic MSO list in Revision 3 of NEI 00-01 (Reference 107) with the MSO list was incorporated in December 2012.

The licensee stated in LAR Attachment F that the FPRA model and NSCA were updated to include equipment, appropriate cables, and cable routing. The MSO combination components of concern were also evaluated as part of the NSCA. For cases where the pre-transition MSO combination components did not meet the deterministic compliance, the MSO combination components were added to the scope of the FREs. The process and results for FREs are summarized in LAR Section 4.5, “Fire PRA and Performance-Based Approaches.” RAs are used to demonstrate the availability of a success path in the event of certain MSOs. They have been determined to be feasible and reliable and listed in LAR Attachment G. The additional risk presented by the use of RAs is provided in LAR Attachment W, “Fire PRA Insights.”

The NRC staff reviewed the licensee’s expert panel process for identifying circuits susceptible to MSOs as described above and concludes that the licensee adopted a systematic and comprehensive process for identifying MSOs to be analyzed using available industry guidance. Furthermore, the NRC staff concludes that the process used provides reasonable assurance that the FRE appropriately identifies and includes risk-significant, multiple spurious operation combinations and that the licensee’s approach for assessing the potential for MSO combinations is acceptable.

3.2.5 Establishing Recovery Actions

NFPA 805, Section 1.6.52, “Recovery Action,” defines a recovery action (RA) as follows:

> Activities to achieve the nuclear safety performance criteria that take place outside the main control room or outside the primary control station(s) for the equipment being operated, including the replacement or modification of components.

NFPA 805, Section 4.2.3.1, states:

> One success path of required cables and equipment to achieve and maintain the nuclear safety performance criteria without the use of recovery actions shall be protected by the requirements specified in either 4.2.3.2, 4.2.3.3, or 4.2.3.4, as applicable. Use of recovery actions to demonstrate availability of a success path for the nuclear safety performance criteria automatically shall imply use of the performance-based approach as outlined in 4.2.4.

NFPA 805, Section 4.2.4, “Performance-Based Approach,” states:

> When the use of recovery actions has resulted in the use of this approach, the additional risk presented by their use shall be evaluated.

The NRC staff reviewed LAR Section 4.2.1.3, “Establishing Recovery Actions,” and LAR Attachment G to evaluate whether the licensee meets the associated requirements for the use of RAs per NFPA 805.

The licensee indicated that the process to define, evaluate, and document RAs was in accordance with FAQ 07-0030 (Reference 72) and consisted of the following steps:

Step 1: Clearly define the primary control station(s) (PCSs) and determine which pre-transition operator manual actions are taken at primary control station(s). Activities that take place at PCSs or in the MCR are not RAs, by definition;

Step 2: Determine the population of RAs that are required to resolve variances from deterministic requirements (to meet the risk acceptance criteria or maintain a sufficient level of defense-in-depth (DID));

Step 3: Evaluate the additional risk presented by the use of RAs required to demonstrate the availability of a success path;

Step 4: Evaluate the feasibility of the RAs; and

Step 5: Evaluate the reliability of the RAs.

In LAR Attachment G, the licensee indicated that for most fire areas, the PB evaluations resulted in the need for RAs to meet the risk acceptance criteria or maintain a sufficient level of DID. While most RAs are listed against a specific VFDR in LAR Attachment G, Table G-1, some RAs provide a risk reduction for the fire area. These RAs are designated as "Fire PRA Risk Action" in LAR Attachment G, Table G-1. The set of RAs that is necessary to demonstrate the availability of a success path for the NSPC (i.e., Risk-RAs listed against a VFDR) was evaluated for additional risk using the process described in NEI 04-02 (Reference 7), FAQ 07-0030 (Reference 72), and RG 1.205 (Reference 4) and compared against the guidelines of RG 1.174 (Reference 45) and RG 1.205. Each of the feasibility criteria in FAQ 07-0030 were assessed for the RAs listed in LAR Attachment G, Table G-1. The licensee stated that each action identified in LAR Attachment G, Table G-1 has been determined to be feasible. The following implementation items resulted from the feasibility evaluation:

- Develop/revise post-fire response procedures to reflect NSCA;
- Identify required tools during the post-fire response procedure validation and verification;
- Document staffing requirements for revised post-fire response procedures. Train operators on revised post-fire response procedures; and
- Revise training requirements for post-fire response procedures to include periodic drills.

Each of these items is identified in LAR Attachment S, Table S-3, Implementation Items 27, 28, 29, 30, and 31, and the NRC staff concludes that these actions are acceptable because they will incorporate the provisions of NFPA 805, and the actions are included as implementation items in LAR Attachment S, which are required by the proposed license condition.

Operator manual actions meeting the definition of an RA are required to comply with the NFPA 805 requirements outlined above. Some of these operator manual actions may not be required to demonstrate the availability of a success path for the NSPC, but may still be required to be retained in the RI/PB FPP because of DID considerations described in NFPA 805, Section 1.2. Accordingly, the licensee identified Risk-RAs, as well as actions that are not needed to meet the NSPC but have been retained to provide DID. In each instance, the licensee determined whether transitioning operator manual actions was a Risk-RA, a DID-RA, or not necessary for the post-transition RI/PB FPP.

The licensee stated that all credited RAs as listed in LAR Attachment G were subjected to a feasibility review. In accordance with the NRC-endorsed guidance in NEI 04-02, the feasibility criteria used in the licensee's assessment process were based on the criteria in FAQ 07-0030 (Reference 72). Each of the 11 individual feasibility attributes was addressed. LAR Attachment G, Table G-1, "Recovery Actions, and Activities Occurring at the Primary Control Stations," describes RAs associated with the disposition of a VFDR from the fire area assessments as documented in LAR Attachment C. The licensee included Implementation Items 27, 28, 29, 30, 31, and 33 in LAR Attachment S, Table S-3 to revise post-fire SSD procedures, identify required tools, document staffing and training requirements, and update the HRA as necessary to incorporate updated NSCA strategies. The NRC staff concludes that these actions are acceptable because they will incorporate the provisions of NFPA 805, and the actions are included as implementation items in LAR Attachment S, which are required by the proposed license condition.

The NRC staff concludes that the licensee has followed the endorsed guidance of NEI 04-02 and RG 1.205 to identify and evaluate RAs in accordance with NFPA 805, and therefore, there is reasonable assurance of meeting the regulatory requirements of 10 CFR 50.48(c). The NRC staff concludes that the feasibility criteria applied to RAs are acceptable because the criteria conforms with the endorsed guidance contained in NEI 04-02 and because they will be in compliance with the regulation upon completion of implementation items that are required by the proposed license condition.

3.2.6 Plant-Specific Treatments or Technologies

3.2.6.1 Very Early Warning Fire Detection System

The licensee proposed the installation of several very early warning fire detection systems (VEWFDS) to monitor conditions inside key electrical cabinets, as well as provide indications and alarms during the incipient stage of a fire. The following discussion is based on the information provided by the licensee in LAR Section V.2.4, "Credit for VEWFDs and Automatic Suppression for Fire Scenarios in Cable Spreading Room and Unit 1 Auxiliary Instrument Room," as supplemented.

In FPE RAI 10 (Reference 31), the NRC staff requested that the licensee provide clarification of the number and extent of VEWFDS being installed as described in the LAR. Specifically, the NRC requested that the licensee provide more details regarding NFPA code(s) of record (including year), proposed installation configuration (common piping or individual cabinet or areawide), acceptance testing, sensitivity and setpoint control(s), alarm response procedures and training, and routine inspection, testing, and maintenance that will be implemented. The NRC staff further requested that the licensee provide the specified design features for the proposed system along with the installation testing criteria to be met prior to operation. The NRC staff also requested that the licensee describe whether this design and installation will be in compliance with each of the elements, limitations, and criteria of NUREG/CR-6850, Supplement 1, "Fire Probabilistic Risk Assessment Methods Enhancements," Chapter 13, and FAQ 08-0046, including the closeout memo (Reference 77), and to provide justification for any deviations. In its response to FPE RAI 10 (Reference 25), the licensee identified three modifications associated with VEWFDS in LAR Attachment S, Table S-2: Items 3, 77, and 78. BFN has decided not to install areawide VEWFDS in the plant. In its response, the licensee revised LAR Attachment S, Table S-2 to delete modifications 77 and 78 and stated that the risk increase of removing the credit for prompt detection is less than 1 percent total plant core damage frequency (CDF) and large early release frequency (LERF) and has a negligible effect on the FPRA.

The licensee stated that LAR Attachment S, Table S-2, Item 3 addresses VEWFDS that have been installed in the electrical panels in the Units 1, 2, and 3 Auxiliary Instrument Rooms (AIRs). These detection systems have been designed and the modifications have been implemented. NFPA 72-2010, “National Fire Alarm and Signaling Code” (Reference 94), applies to these detection systems along with meeting the requirements of NFPA 76-2012, “Standard for the Fire Protection of Telecommunications Facilities” (Reference 108), for response transport times and sensitivity settings. The licensee stated that these systems have been designed with and meet the requirements of these codes. For the AIRs, the design of the detection systems will include one detector installed in each AIR, with each detector monitoring four zones. Each of the four zones will monitor the electrical panels in one of the four rows of panels. The detection system will send an alarm to the MCR fire alarm annunciator and fire operation’s annunciator. This would alert personnel to respond to a potential fire so it can be extinguished manually during the incipient stage. The system will indicate which of the four zones is in alarm to permit personnel to investigate the row of panels from which the alarm is originating.

In its response to FPE RAI 10, the licensee indicated that testing and commissioning of each incipient detector have been completed in accordance with the vendor’s acceptance test and associated sensitivity testing. The vendor commissioning of the detector demonstrates compliance with criteria established by applicable standards, which includes testing the sensitivity and transport time. In accordance with NFPA 76, this type of system is required to have a transport time of no greater than 60 seconds from any one sampling point. The sensitivity and setpoints will be controlled by surveillance procedure(s). Routine inspection, testing, and maintenance will be conducted in accordance with vendor recommendations, including sensitivity and transport time tests. Procedures and training will be developed as part of NFPA 805 implementation covering responses to an alarm as described in LAR Attachment S, Table S-3 Implementation Item 48. Personnel will respond to alarm conditions to locate the source and extinguish any fire that may occur. The licensee further stated that the design and installation are in compliance with each of the elements, limitations, and criteria of NUREG/CR-6850, Supplement 1, “Fire Probabilistic Risk Assessment Methods Enhancements,” Chapter 13, and FAQ 08-0046, including the closeout memo. The NRC staff concludes that the licensee’s responses to the RAI and the corresponding statement of compliance are acceptable because the licensee demonstrated that the design, testing, and operation of the system will meet the elements, limitations, and criteria of NUREG/CR-6850, Supplement 1, “Fire Probabilistic Risk Assessment Methods Enhancements,” Chapter 13, and FAQ 08-0046.

In FPE RAI 10, the NRC staff requested that the licensee provide additional information regarding the cable spreading rooms’ (CSR) proposed areawide VEWFDS and total flooding gaseous suppression system. In its response to FPE RAI 10 (Reference 25), the licensee stated that the areawide VEWFDS and total flooding gaseous suppression system would not be installed. In its response, the licensee revised LAR Attachment S, Table S-2 to delete modifications 77 and 78 because the risk increase of removing the credit for prompt detection is less than 1 percent total plant CDF and LERF and has a negligible effect on the FPRA.

The NRC staff concludes that the fire protection aspects related to the proposed installation of the VEWFDS are acceptable because:

- The installation has been performed in accordance with the appropriate NFPA codes, the equipment manufacturers' requirements, and NUREG 6850, Supplement 1, Chapter 13.

- The VEWFDS will be properly tested during commissioning such that the alert and alarm triggers will be set to provide an appropriate level of sensitivity without unnecessary nuisance or spurious alarms.

- The configuration and design control process will control and maintain the setpoints for both alert and alarm functions from the VEWFDS.

- The VEWFDS equipment will be periodically tested and maintained in accordance with the NFPA 76, NFPA 72, and manufacturer's practices requirements.

- The licensee's procedures and training will be developed as part of NFPA 805 implementation covering responses to an alert and/or alarm. Personnel will respond to alert/alarm conditions to locate the source and extinguish any fire that may occur. These actions are documented in LAR Attachment S, Table S-3, Implementation Item 48.

In addition, the FPRA modeled the installation of the VEWFDS and took credit for its use in assessing the risk of various fire areas during certain scenarios. SE Section 3.4 addresses the technical review of the treatment of the VEWFDS in the FPRA, as well as the acceptability of the risk credit taken for the associated fire areas.

3.2.6.2 Self Induced Station Blackout

In LAR Section 4.8.3.2, the licensee stated that the 10 CFR 50, Appendix R SSD strategy involves operator actions which intentionally de-energize power distribution equipment to establish the lineup of credited equipment. These actions are primarily to transfer from non-credited offsite power to onsite power sources and address spurious supply breaker operation. This strategy will no longer be used after the NFPA 805 transition.

In SSA RAI 15 (Reference 31) the NRC staff requested that the licensee provide a description of the steps being undertaken to ensure a complete and smooth transition with RAs (including feasibility), modifications, training, and operating procedures from self-induced station blackout (SISBO) to fire protection procedures using the PB analysis of NFPA 805. In its response to SSA RAI 15 (Reference 13), the licensee indicated that the plan for transition of fire SSD instructions includes migration away from strategies that instruct the operators to take detrimental actions such as intentionally disconnecting offsite power, commonly referred to as SISBO. With the exception of the MCR abandonment procedure, the new procedures will be executed concurrently with the symptom based emergency operating instructions (EOIs) and other operating procedures. This is in contrast to the current strategy in the safe shutdown instructions (SSIs) that calls for exiting the EOIs and other operating procedures when the SSIs are entered. The symptom based strategy will allow the operators to use the systems and equipment that are available, as opposed to being limited by procedure to a single, predetermined success path. For MCR abandonment, the Fire Safe Shutdown (FSS) procedure will not be used concurrently with the EOIs, which is similar to the current MCR abandonment procedure for non-fire events. The MCR abandonment FSS procedures will include the instructions for transfer of control to the Primary Control Station, the use of credited equipment to meet the nuclear safety performance criteria (NSPC), and the risk and DID recovery actions (RAs). The fire safe shutdown (FSS) procedure for MCR abandonment will allow the use of offsite power, if available, and does not require SISBO. The following three actions are planned to ensure a smooth transition to new procedures:

(1) The procedures required to implement the new NFPA 805 fire SSD will be prepared and implemented before NFPA 805 transition. The structure of the procedures will use the current EOIs supplemented by fire area specific instructions that will include risk and DID-RAs with the exception of MCR abandonment. For MCR abandonment, the FSS procedure will not be used concurrent with the EOIs, which is similar to the current MCR abandonment procedure for non-fire events. These instructions will be similar to the current SSIs that contain actions specific to fires in that area and identify the credited SSD path. Modifications will be in progress while the new SSIs are being implemented, and therefore, revisions to incorporate the modifications will be a continuous process.

(2) The new and revised procedures will be validated prior to implementation to ensure they are feasible as written, given the plant configuration. The feasibility validation will follow the FAQ 07-0030 (Reference 72) guidance.

(3) Operator training will be developed using the systematic approach to training. Initial training will be conducted prior to transition, addressing the new procedure structure and SSD strategies. Operators will be trained on the effect of modifications on operating procedures, similar to the current training process.

These implementation items are identified in LAR Attachment S, Table S-3, Implementation Items 27, 28, 29, 30, 31, and 33. The NRC staff concludes that these actions are acceptable because they will incorporate the provisions of NFPA 805, Chapter 3 and the actions are included as implementation items in LAR Attachment S, which are required by the proposed license condition.

Additionally the licensee stated that the new procedure strategy is already familiar to the operators because it will utilize the current EOIs for monitoring and controlling critical parameters and utilization of plant systems. The operation of the systems that is unique to a fire condition, such as the use of RAs, will be similar to the way the equipment is currently operated in the SSIs. The NRC staff concludes that the licensee’s response to the RAI is acceptable because it describes a systematic process suitable to ensure a complete and smooth transition with RAs (including feasibility), modifications, training, and operating procedures, and because implementation items have been developed for any required actions and are required by the proposed license condition.

3.2.7 Conclusion for Section 3.2

The NRC staff reviewed the licensee's LAR, as supplemented, for conformity with the requirements contained in NFPA 805, Section 2.4.2 regarding the process used to perform the NSCA. The NRC staff concludes that the declared safe and stable condition proposed is acceptable and that the licensee's process is adequate to appropriately identify and locate the systems, equipment, and cables required to provide reasonable assurance of achieving and maintaining the fuel in a safe and stable condition, as well as to meet the NFPA 805 NSPC.

The NRC staff reviewed the licensee's process to identify and analyze MSOs. Based on the LAR, as supplemented, the process used to identify and analyze MSOs is considered comprehensive and thorough. Through the use of an expert panel process, in accordance with the guidance of RG 1.205, NEI 04-02, and FAQ 07-0038, potential MSO combinations were identified and included as necessary in the NSCA, as well as the applicable FREs. The NRC staff also considers the approach the licensee used for assessing the potential for MSO combinations acceptable because it was performed in accordance with NRC-endorsed guidance.

The NRC staff concludes that the process used by the licensee to review, categorize, and address RAs during the transition is consistent with RG 1.205 and the NRC-endorsed guidance contained in NEI 04-02, and therefore, the information provided by the licensee provides reasonable assurance that the regulatory requirements of 10 CFR 50.48(c) and NFPA 805 for NSCA methods are met.

The NRC staff reviewed the proposed installation of a VEWFDS to monitor conditions in certain key electrical cabinets in the Units 1, 2, and 3 Auxiliary Instrument Rooms. Based on the information provided in the LAR, as supplemented, the NRC staff concludes that the fire protection aspects of the proposed VEWFDS installation are acceptable because the installation will be done in accordance with appropriate NFPA codes; the original equipment manufacturer requirements; NUREG/CR-6850, Supplement 1, Chapter 13; and NRC FAQ 08-0046.

3.3 Fire Modeling

NFPA 805 (Reference 3) allows both fire modeling (FM) and fire risk evaluations (FREs) as performance-based (PB) alternatives to the deterministic approach outlined in the standard. These two PB approaches are described in NFPA 805, Sections 4.2.4.1 and 4.2.4.2, respectively. Although FM and FREs are presented as two different approaches for PB compliance, the FREs approach generally involves some degree of FM to support engineering analyses and fire scenario development. NFPA 805, Section 1.6.18 defines a fire model as a "mathematical prediction of fire growth, environmental conditions, and potential effects on SSCs, based on the conservation equations or empirical data."

The NRC staff reviewed license amendment request (LAR) (Reference 8) Section 4.5.2, "Performance-Based Approaches." This describes how the licensee used FM as part of the transition to NFPA 805. The staff also reviewed LAR Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805." This describes how the licensee performed FM calculations in compliance with the NFPA 805 PB evaluation quality requirements for fire protection systems and features to determine whether the FM used to support transition to NFPA 805 is acceptable.

In LAR Section 4.5.2.1, the licensee stated that the FM approach (NFPA 805, Section 4.2.4.1) was not used for the NFPA 805 transition. The licensee used the FRE PB method (i.e., Fire Probabilistic Risk Assessment (FPRA)), with input from FM analyses. Therefore, the NRC staff reviewed the technical adequacy of the FREs, including the supporting FM analyses as documented in safety evaluation (SE) Section 3.4.2, to evaluate compliance with the nuclear safety performance criteria (NSPC).

The licensee did not propose any FM methods to support PB evaluations in accordance with NFPA 805, Section 4.2.4.1 as the sole means for demonstrating compliance with the NSPC. There are no plant-specific FM methods acceptable for use to support compliance with NFPA 805, Section 4.2.4.1 as part of this licensing action supporting the transition to NFPA 805 at Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3.

3.4 Fire Risk Assessments

This section addresses the licensee's FRE PB method, which is based on NFPA 805 (Reference 3), Section 4.2.4.2, "Use of Fire Risk Evaluations." The licensee chose to use only the FRE PB method in accordance with NFPA 805, Section 4.2.4.2. The FM PB method of NFPA 805, Section 4.2.4.1, "Use of Fire Modeling," was not used for this application.

NFPA 805, Section 4.2.4.2 states the following:

> Use of fire risk evaluation for the performance-based approach shall consist of an integrated assessment of the acceptability of risk, defense in depth [DID], and safety margins.
>
> The evaluation process shall compare the risk associated with implementation of the deterministic requirements with the proposed alternative. The difference in risk between the two approaches shall meet the risk acceptance criteria described in NFPA 805, Section 2.4.4.1 ["Risk Acceptance Criteria"]. The fire risk shall be calculated using the approach described in NFPA 805, Section 2.4.3 ["Fire Risk Evaluations"].

3.4.1 Maintaining Defense-in-Depth and Safety Margins

NFPA 805, Section 4.2.4.2 requires that the "use of fire risk evaluation for the performance-based approach shall consist of an integrated assessment of the acceptability of risk, defense-in-depth, and safety margins."

3.4.1.1 Defense-in-Depth

NFPA 805, Section 1.2, "Defense-in-Depth," states the following:

> Protecting the safety of the public, the environment, and plant personnel from a plant fire and its potential effect on safe reactor operations is paramount to this standard. The fire protection standard shall be based on the concept of defense-in-depth. Defense-in-depth shall be achieved when an adequate balance of each of the following elements is provided:
>
> - Preventing fires from starting.
> - Rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage.
> - Providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

The NRC staff reviewed LAR (Reference 8), Section 4.5.2.2, "Fire Risk Approach," LAR Section 4.8.1, "Results of the Fire Area Review," and LAR Attachment C, "NEI 04-02 Table B-3 – Fire Area Transition," as well as the associated supplemental information, in order to determine whether the principles of DID were maintained in regard to the planned transition to NFPA 805.

When implementing the PB approach, the licensee followed the guidance contained in Section 5.3, "Plant Change Process," of NEI 04-02 (Reference 7), which includes a detailed consideration of DID and safety margins as part of the change process. The licensee documented the methodology used to meet the DID requirements of NFPA 805 in LAR Section 4.5.2.2. LAR Attachment C, Table C-1 and LAR Attachment C, Table C-2 document the results of the licensee's review of the required fire suppression and fire detection systems.

The licensee's methodology for evaluating DID refers to each of the three DID elements identified in NFPA 805, Section 1.2 (i.e., (1) Preventing fires from starting, (2) Rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage, and (3) Providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed). In its response to SSA RAI 13 (Reference 13), the licensee provided a table where, for each of the three elements, several examples of fire protection features that addressed that element are identified, along with a discussion of the considerations used in assessing those features. The assessment determined whether changes would be needed to assure that each element has been satisfactorily achieved or whether reliance on features in other elements were needed and should be developed. Many of the identified fire protection features are required to be in place in order to demonstrate compliance with the fundamental fire protection program (FPP) and design elements of NFPA 805, Chapter 3 (e.g., combustible control program, hot work control program, etc.). However, the capabilities for some of the fire protection features for DID were evaluated and improved as needed based on the results of the PB analyses.

As described in its response to SSA RAI 13, this method for addressing DID was implemented by the licensee in the FREs performed on each PB fire area. Per LAR Attachment C, the FRE: 1) documents the fire protection systems/features required to either meet the deterministic criteria of NFPA 805, Section 4.2.3, "Deterministic Approach," or to meet the risk criteria for the PB approach of NFPA 805, Section 4.2.4; 2) notes whether changes or improvements are necessary for each fire protection system/feature to maintain a balance among the DID elements; and 3) provides a justification or basis for why the required fire protection systems/features are adequate for DID. As such, the FRE is the licensee's internal record of the systems required to meet the nuclear safety performance criteria (NSPC) and DID requirements of NFPA 805.

Based on its review of the LAR, the licensee's response to SSA RAI 13, and the NRC staff's review of a sample of the FREs, the NRC staff concludes that the licensee systematically and comprehensively evaluated fire hazards, area configuration, detection and suppression features, and administrative controls in each fire area and concludes that the methodology as proposed in its LAR adequately evaluates DID against fires as required by NFPA 805, and therefore, the proposed RI/PB FPP adequately maintains DID.

3.4.1.2 Safety Margins

NFPA 805, Section 2.4.4.3, "Safety Margins," states the following:

> The plant change evaluation shall ensure that sufficient safety margins are maintained.

NEI 04-02, Section 5.3.5.3, "Safety Margins," lists two specific criteria that should be addressed when considering the impact of plant changes on safety margins:

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

LAR Section 4.5.2.2 discusses how safety margins are addressed as part of the FRE process and that this process is based on the requirements of NFPA 805, industry guidance in NEI 04-02, and RG 1.205 (Reference 4). An FRE was performed for each fire area containing a variance from deterministic requirement (VFDR). The FREs contain the details of the licensee's review of safety margins for each PB fire area.

As discussed in LAR Section 4.5.1.2, "Fire PRA," and the licensee's response to SSA RAI 13 (Reference 13), the fire probabilistic risk assessment (FPRA), including FM performed to support the FPRA, applies methodologies consistent with the guidance in NUREG/CR-6850 (Reference 52), (Reference 53), and (Reference 54), and NRC-approved frequently asked questions (FAQs) according to LAR Attachment H, “NFPA 805 Frequently Asked Question Summary Table.” LAR Attachment J, “Fire Modeling Verification and Validation (V&V),” and the licensee’s response to safe shutdown analysis (SSA) RAI 13 explain that FM, including V&V, performed in support of the FPRA utilized accepted codes and standards including NUREG/CR-6850, NUREG-1805 (Reference 58) and NUREG-1824 (Reference 59). In its response to SSA RAI 13, the licensee further described the methodology used to evaluate safety margins in the FREs to include the following evaluations and determinations:

- Plant System Performance: Plant system performance was evaluated using methods, input parameters and acceptance criteria consistent with that used for the plant design basis events; and

- PRA Logic Model: The PRA logic model was reviewed in accordance with the ASME/ANS RA-Sa-2009 PRA standard (Reference 47) and RG 1.200, Revision 2 (Reference 46).

The results of the licensee’s safety margin assessment by fire area are provided in LAR Attachment C, Table C-1, as supplemented.

The NRC staff concludes that the safety margin criteria described in Nuclear Energy Institute (NEI) 04-02, Section 5.3.5.3 and the LAR, as supplemented, are consistent with the criteria as described in RG 1.174 (Reference 45), and therefore, acceptable. The NRC staff found that the licensee used appropriate codes and standards (or NRC guidance), and met the safety analyses acceptance criteria in the licensing basis and concludes that the licensee's approach adequately addressed the issue of safety margins in the implementation of the FRE process.

3.4.2 Quality of the Fire Probabilistic Risk Assessment

The objective of the PRA quality review is to determine whether the plant-specific PRA used in evaluating the proposed LAR is of sufficient scope, level of detail, and technical adequacy for the application. The NRC staff evaluated the PRA quality information provided by the licensee in its NFPA 805 submittal, as supplemented, including industry peer review results and self-assessments performed by the licensee. The NRC staff reviewed LAR Section 4.5.1, “Fire PRA Development and Assessment”; LAR Section 4.7, “Program Documentation, Configuration Control, and Quality Assurance”; LAR Attachment C, “NEI 04-02 Table B-3 – Fire Area Transition”; LAR Attachment U, “Internal Events PRA Quality”; LAR Attachment V, “Fire PRA Quality”; and LAR Attachment W, “Fire PRA Insights”; as well as associated supplemental information.

The licensee developed its internal events probabilistic risk assessment (IEPRA) during the individual plant examination process and continued to maintain and improve the PRA as RG 1.200, and supporting industry standards have evolved. The licensee developed its FPRA model for both Level 1 (core damage) and partial Level 2 (large early release) PRA during at-power conditions. For the development of the FPRA, the licensee modified its IEPRA model to capture the effects of fire.

The licensee identified administrative controls and processes used to maintain the FPRA model current with plant changes and to evaluate any outstanding changes not yet incorporated into the PRA model for potential risk impact as a part of the routine change evaluation process. In LAR Section 4.8.2, "Plant Modifications and Items to be Completed During the Implementation Phase," the licensee stated that no significant plant changes (beyond those identified and scheduled to be implemented as part of the transition to a FPP based on NFPA 805) are outstanding with respect to their inclusion in the FPRA model. Further, as described in SE Section 3.8.3, the licensee has a program for ensuring that developers and users of these models are appropriately trained and qualified. The NRC staff concludes that the PRA should be capable of supporting post-transition FREs to support, for example, the self-approval process, after any changes required during implementation are completed.

3.4.2.1 Internal Events PRA Model

The licensee's evaluation of the technical adequacy of the portions of its IEPRA model used to support development of the FPRA model consisted of a full scope peer review that was performed in May 2009 using the NEI 05-04 process (Reference 109) and the combined American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) PRA standard as clarified by Regulatory Guide (RG) 1.200, Revision 2 (Reference 46), as discussed in LAR Attachment U. A separate, similar review was performed for the internal flooding portion of the BFN PRA in September 2009. The IEPRA model that was reviewed for the full scope peer review serves as the basis of the FPRA used in performing PRA evaluations for the LAR. In its response to PRA RAI 11 (Reference 13), the licensee stated that since the last full-scope peer review, no changes have been made to the IEPRA that are consistent with the definition of a "PRA upgrade" as defined by the ASME/ANS PRA standard.

For supporting requirements (SRs) in the PRA standard, there are three degrees of "satisfaction" referred to as capability categories (CCs) (i.e., I, II, and III), with CC-I being the minimum, CC-II considered widely acceptable, and CC-III indicating the maximum achievable scope/level of detail, plant specificity, and realism. For many supporting requirements, the CCs may be combined (e.g., the requirement for meeting CC-I may be combined with CC-II), or the requirement may be the same across all CCs so that the requirement is simply met or not met.

LAR Attachment U, Table U-1 provides the licensee's dispositions to 125 facts and observations (F&Os) findings from both the internal events and internal flooding peer reviews, all of which are characterized in LAR Attachment U as findings per the NEI 05-04 peer review guidelines. In general, an F&O is written for any SR that is judged not to be met or does not fully satisfy CC-II of the ASME standard and RG 1.200, Revision 2.

In LAR Attachment U, the licensee reconciled each F&O by either providing a description of how the F&O was resolved or providing an assessment of the impact of resolution of the F&O on the FPRA and the results for the NFPA 805 application. The NRC staff evaluated each F&O and the licensee's disposition in LAR Attachment U to determine whether the F&O had any significant impact for the application. The NRC staff requested supplemental information for the review of some of the F&Os that were resolved by the licensee in its RAI responses (Reference 12), (Reference 13), and (Reference 15). The NRC staff's review and conclusion for the licensee's resolution of each F&O and basis of acceptability of SRs that are "not met" or only meet CC-I are summarized in the NRC's Record of Review dated July 9, 2015 (Reference 110).

A summary of an issue identified during the NRC staff's review of the F&Os and methods used in the IEPRA is provided below, along with the associated resolution.

In PRA RAI 23.d (Reference 31) associated with F&O 2-41, the NRC staff advised the licensee that plant system models supporting the Level 2 analysis were not complete prior to the May 2009 peer review of the IEPRA. In its response to PRA RAIs 23.d (Reference 15), and PRA RAI 11 (Reference 13) and (Reference 24), the licensee updated Implementation Item 47 of LAR Attachment S, Table S-3 to ensure that a peer review is performed on plant system models supporting the FPRA Level 2 analysis and that any resulting finding-level F&Os will be resolved prior to self-approval of post-transition changes. The NRC staff concludes that the BFN internal review process is sufficient for the development of the transition change-in-risk estimates, because major errors are needed to invalidate the large estimated risk decrease arising from the installation of new equipment, and such major errors should have been discovered in the internal reviews. The NRC staff further concludes that this issue is resolved for the post-transition time because a peer review will be performed on plant system models supporting the FPRA Level 2 analysis and associated finding-level F&Os will be resolved prior to self-approval of post-transition changes.

As a result of the review of the LAR and responses to RAIs, the NRC staff concludes that the BFN IEPRA is technically adequate and that its quantitative results, considered together with sensitivity study results, can be used to demonstrate that the change-in-risk due to the transition to NFPA 805 meets the acceptance guidelines of RG 1.174. To reach this conclusion, the NRC staff reviewed all F&Os provided by the peer reviewers and determined that the resolution of every F&O supports the determination that the quantitative results are adequate or have no significant impact on the FPRA. Accordingly, the NRC staff concludes that the licensee has demonstrated that the IEPRA meets the guidance in RG 1.200, Revision 2, that it is reviewed against the applicable SRs in ASME/ANS-RA-Sa 2009, and that it is technically adequate to support the FREs and other risk calculations required for the LAR.

3.4.2.2 Fire PRA Model

The licensee evaluated the technical adequacy of the FPRA model by conducting peer reviews of the FPRA model using the NEI 07-12 process (Reference 111) and the FPRA part (Part 4) of the ASME/ANS-RA-Sa-2009 (Reference 47) PRA Standard, as clarified by RG 1.200, Revision 2 (Reference 46). A January 2012 full-scope peer review, as well as a June 2012 focused-scope peer review of the FPRA serve as the basis for the quantitative risk evaluations presented in the LAR.

LAR Attachment V, Table V-7 provides the licensee's dispositions of all 77 F&Os that were written against SRs of Part 4 of the ASME/ANS RA-Sa-2009 PRA standard as clarified by RG 1.200, Revision 2 and left unresolved by the follow-on focused-scope peer review. LAR Attachment V, Table V-4 provides the results of the peer review capable categories (CC) assessment for each SR and identifies those that were determined by the peer review to be not met or only met at CC-I.

As described in LAR Attachment V, as supplemented, the licensee resolved each F&O by assessing the impact of the F&O on the FPRA and on the results for the LAR. The NRC staff requested additional information to assess the adequacy of some of the dispositions for the review. The NRC staff evaluated each F&O, as well as the licensee's respective disposition in LAR Attachment V, to determine whether the issue had any significant impact for the LAR. The NRC staff's review and conclusion for the resolution of each F&O and unreviewed SR is summarized in the NRC's Record of Review dated July 9, 2015 (Reference 110). A summary of issues identified during the NRC staff's review of the F&Os and methods used in the FPRA is provided below along with the associated resolution.

In PRA RAI 01.d (Reference 31) associated with F&O 2-38, the NRC staff requested that the licensee provide clarification as to whether the human reliability analysis (HRA) performed for the FPRA is representative of the post-transition fire response procedures given that a number of open F&Os (i.e., F&Os 2-38, 2-39, 2-41, 2-50, 4-3, 4-7, 4-12, 4-17, 4-21, 9-4, and 10-1) remain only partially addressed due to the incompleteness of the fire procedures. In its response to PRA RAI 01.d (Reference 14), the licensee stated that although fire procedures are not finalized, development of procedures will focus on satisfying analysis assumptions and that changes to procedures are not expected to significantly affect the evaluation of risk, defense-in-depth (DID), or safety margin presented in the LAR. Additionally, in its response to PRA RAI 14.01 (Reference 23), the licensee clarified that the FPRA results are to be verified as part of LAR Attachment S, Table S-3, Implementation Items 32 and 33 after all procedure updates, modifications, and training are complete. The NRC staff concludes this issue is resolved because the FPRA uses currently available information to support the HRA and the change-in-risk results will subsequently be verified against the as-built, as-operated plant upon completion of all planned procedure updates, modifications, and training documented in LAR Attachment S, as supplemented, and because this action would be required by the proposed license condition.

In PRA RAI 01.f (Reference 31) associated with F&O 2-54, the NRC staff requested that the licensee provide clarification on the frequency applied to main control board (MCB) scenarios. In its response to PRA RAIs 01.f and 24 (Reference 24), the licensee indicated that it updated the FPRA to apply the full Bin 4 frequency to all MCB fire scenarios that were developed using guidance in NUREG/CR-6850, Appendix L. In its response to PRA RAI 24 (Reference 24), the licensee confirmed that it incorporated the revised treatment of MCB fire scenarios in the integrated analysis provided by the response. The NRC staff concludes this issue is resolved because the FPRA applies the full Bin 4 frequency to all MCB fire scenarios consistent with guidance in NUREG/CR-6850, Appendix L.

In PRA RAI 01.h (Reference 31) associated with F&O 2-56, the NRC staff requested that the licensee provide clarification regarding the frequency and severity factor of catastrophic turbine generator fires. In its response to PRA RAI 01.h.ii (Reference 14) and (Reference 15), and PRA RAI 24 (Reference 24), the licensee indicated that it updated the frequency and severity factor applied to catastrophic turbine generator fires in the FPRA to be consistent with Table O-2 of NUREG/CR-6850. In its response to PRA RAI 24, the licensee also indicated that the revised treatment of catastrophic turbine generator fires was incorporated in the integrated analysis provided by the response. The NRC staff concludes this issue is resolved because the FPRA treats catastrophic turbine generator fires consistent with guidance in NUREG/CR-6850.

In PRA RAI 01.o (Reference 31) associated with F&O 4-30, the NRC staff identified that LERF actions were not included in the fire HRA dependency analysis. In its response to PRA RAI 01.o (Reference 15) and PRA RAI 24 (Reference 24), the licensee indicated that it updated the FPRA HRA to address large early release frequency (LERF) actions in the HRA dependency analysis, which, according to the licensee's response to PRA RAI 06 (Reference 12), is consistent with guidance in NUREG/CR-6850 and NUREG-1921 (Reference 62). In its response to PRA RAI 24, the licensee also indicated that the revised treatment of LERF actions in the HRA dependency analysis was incorporated in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA addresses dependencies between LERF actions consistent with guidance in NUREG/CR-6850 and NUREG-1921.

In PRA RAI 01.r (Reference 31) associated with F&O 5-11, the NRC staff requested clarification regarding the treatment of junction box fires as ignition sources. In its response to PRA RAI 19.b.01.a (Reference 24), the licensee explained that the fire ignition frequency for junction box fires is summed with those for self-ignited cable fires and cable fires caused by welding and cutting (cable fires). Cable fire evaluation as described in FAQ 13-0005 (Reference 84), and junction box fire evaluation as described in FAQ 13-0006 (Reference 112), are normally two different evaluations. In its response to PRA RAI 01.r.01 (Reference 24), and PRA RAI 17.d (Reference 24), the licensee clarified that in all physical analysis units (PAUs) except 16-A and 25-1, the summed frequencies were multiplied with a single conditional core damage probability (CCDP), either the full room burnout or based on a target set determined by applying the zone of influence (ZOI) from a cable tray fire. This conservative calculation is consistent with both FAQ 13-0005 and FAQ 13-0006 and acceptable, except for the PAUs 16-A and 25-1, which are discussed separately for cable fires and junctions box fires below.

In its response to PRA RAIs 01.r.01 (Reference 24) and PRA RAI 01.r.01.01 (Reference 26), the licensee stated that sometimes cable tray length instead of the FAQ 13-0005 recommended cable tray loading was used as a frequency weighting factor in physical analysis units (PAUs) 16-A and PAU 25-1. In its response to PRA RAIs 01.r.01 and PRA RAI 17.d (Reference 24), the licensee stated that it apportioned the combined fire ignition frequency for PAU 16-A between the main control room (MCR) and cable spreading room (CSR) portions of PAU 16-A by the combustible load of cables contained within each portion, consistent with NUREG/CR-6850. However, within the MCR portion of PAU 16-A, the licensee stated that it used relative cable tray length to apportion the fire frequency between the three units' MCRs. A fire in any unit's MCR was assumed to damage all cable trays located in that unit's MCR with acceptable risk results; thus, no further divisions were performed. The NRC staff concludes that apportioning the fire frequency among the CRs based on cable tray length is acceptable because the three CRs are similar types of rooms designed with similar objectives and constraints, and therefore, tray length is expected to be an acceptable surrogate for cable loading.

In its response to PRA RAI 01.r.01.01 (Reference 26), the licensee provided the results of a sensitivity study demonstrating that the use of cable tray length as a frequency weighting factor for individual junction box fire scenarios in PAU 25-1 and the CSR portion of PAU 16-A has an insignificant impact on the FPRA risk results with respect to both the transition and the self-approval risk acceptance guidelines. The NRC staff concludes that this issue is resolved because the junction box fire scenarios in the FPRA are modeled consistent with, or conservative relative to, the guidance contained in FAQ 13-0006 or have an insignificant impact on the FPRA risk results with respect to both the transition and the self-approval risk acceptance guidelines.

In PRA RAI 01.s (Reference 31) associated with F&Os 5-18 and 8-3, the NRC staff identified that the risk contribution from the fraction of fires for an ignition source that does not propagate to targets beyond the ignition source is only selectively quantified. In its response to PRA RAI 01.s (Reference 14) and PRA RAI 24 (Reference 24), the licensee indicated that it revised the quantitative screening criteria used by the FPRA to screen fire scenarios to be consistent with guidance in NUREG/CR-6850 and quantitative screening element CC-II of the ASME/ANS RA-Sa-2009 PRA standard with clarifications contained in RG 1.200, Revision 2. In its response to PRA RAI 24, the licensee also confirmed that the revised treatment of quantitative screening was incorporated in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA screens non-propagating fire scenarios consistent with the guidance contained in NUREG/CR-6850 and RG 1.200.

In PRA RAI 01.v (Reference 31) associated with F&O 10-1, the NRC staff requested that the licensee provide justification with respect to the establishment of acceptable minimum (or "floor") values for human error probability (HEP) combinations. In its response to PRA RAI 01.v (Reference 24), and PRA RAI 24 (Reference 24), the licensee indicated that it updated the FPRA to apply a floor value of 1.0E-05 to all HEP combinations that do not include long-term decay heat removal (DHR) human failure events (HFEs) for FPRA CDF or those HFEs cued and guided by Severe Accident Mitigation Guideline (SAMG) procedures for FPRA LERF. For the remaining combinations, the licensee stated that the FPRA applied a floor value of 1.0E-06, given that a low dependency exists between long-term DHR and SAMG actions and other earlier actions. In its response to PRA RAI 24, the licensee indicated that the revised floor values were incorporated in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA includes the use of floor values consistent with guidance contained in NUREG-1921.

In PRA RAI 02 (Reference 31), the NRC staff requested that the licensee provide further clarification on transient fire placement within PAUs. In its response to PRA RAI 02 (Reference 24), the licensee stated that the FPRA considered general transient fires and transient fires caused by welding and cutting in each PAU. With the exception of the CSR portion of PAU 16-A, the licensee explained that such fires were postulated over all accessible floor areas, and thereby, all potential pinch point locations above those areas were considered. Transient fires need not be postulated in inaccessible areas. For the CSR portion of PAU 16-A, the licensee clarified that the full frequency of transient fires was apportioned to risk significant cable trays or full room burnup and that non-suppression probabilities were calculated for each scenario based on the time to damage for the applicable scenario. This methodology ensured that transient fires in the CSR portion of PAU 16-A were analyzed at risk significant locations and pinch points were included if affected by such fires. The NRC staff concludes that this issue is resolved because the licensee's method for locating transient fires appropriately addresses pinch points for all PAUs, consistent with guidance in NUREG/CR-6850.

In PRA RAIs 04 (Reference 31), PRA RAI 04.01 (Reference 34), PRA RAI 04.c.01 (Reference 34), PRA RAI 04.k.01 (Reference 34), and PRA RAI 04.l.01 (Reference 34), the NRC staff requested that the licensee provide justification for the modeling of fire scenarios in which abandonment of the MCR is credited. In its response to PRA RAI 04 (Reference 14), as revised (Reference 24), the licensee clarified that MCR abandonment is evaluated for loss of control for fires in PAUs 16-A, 16-K, 16-M, and 16-O as well as for loss of MCR habitability for fires in the MCR portion of PAU 16-A. In its response to PRA RAIs 04.01 (Reference 23) and PRA

RAI 04.c.01 (Reference 23), as revised (Reference 24), the licensee indicated that it updated the FPRA model to include a fully integrated fault tree to evaluate accident scenarios with MCR evacuation followed by a failure to control the reactor remotely.

In its response to PRA RAIs 04 (Reference 14), as revised (Reference 24), and PRA RAI 04.01 (Reference 23), the licensee stated that the updated MCR abandonment logic considers failure of both equipment and operator actions (including RAs) needed to successfully shut down per the abandonment procedure. In its response to PRA RAI 04.01 (Reference 23), the HRA performed on abandonment actions, including the decision to abandon, was conducted within the capabilities of the FPRA's HRA quantification techniques, which, according to the response to PRA RAI 06 (Reference 12), are consistent with the guidance contained in NUREG/CR-6850 and NUREG-1921. The licensee explained that it based the cognitive and execution timing assumptions on thermal-hydraulic analysis, as well as operator interviews, simulator runs, and walkthroughs of the abandonment procedure. In its response to PRA RAI 04 (Reference 14), as revised (Reference 24), and PRA RAI 04.k.01 (Reference 23), the licensee also evaluated HRA dependencies between abandonment actions.

In response to PRA RAI 18.01 (Reference 27), the licensee clarified that not all fires in these areas are modeled as MCR abandonment fires. The FPRA identifies equipment in these fire areas that is affected by the fire scenarios, and the non-fire affected equipment is nominally available to mitigate the fire. In its response to PRA RAI 24 (Reference 24), the licensee indicated that it incorporated the revised treatment of MCR abandonment scenarios in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA includes an acceptable MCR abandonment method in which 1) the fault tree structure includes basic events for the range of possible abandonment outcomes and addresses failure of both equipment and operator actions; 2) a basis for the values assigned to the HEPs has been developed using HRA methods acceptable to the NRC and utilizing timing based on thermal-hydraulic analysis, as well as operator interviews, simulator runs, and walkthroughs of the abandonment procedure; 3) abandonment criteria that will be incorporated into plant procedures as part of Implementation Item 27 has been developed; and 4) scenarios have a CCDP or conditional large early release probability (CLERP) based on an acceptable PRA evaluation of failure of equipment and/or required operator actions.

In PRA RAI 05 (Reference 31), the NRC staff requested that the licensee provide clarification on whether the FPRA made use of any deviations from accepted methods and approaches. In its response to PRA RAI 05 (Reference 24), the licensee identified all deviations from accepted methods and approaches. The NRC staff concludes that this issue is resolved because other than those deviations addressed elsewhere in this SE section, the licensee identified no other deviations from accepted methods and approaches.

In PRA RAI 10 (Reference 31), the NRC staff requested that the licensee provide clarification regarding credit given to areawide incipient detection systems proposed in PAUs 16-K, 16-M, and 16-O, as well as the CSR portion of PAU 16-A. In its response to PRA RAI 10 and PRA RAI 24 (Reference 24), the licensee stated that modifications to install areawide incipient detection systems have been removed from LAR Attachment S, Table S-2 and the FPRA model was updated to remove credit for areawide incipient detection. In its response to PRA RAI 24, the licensee indicated that it incorporated this update in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA no longer credits areawide incipient detection systems.

In PRA RAI 10.c.01 (Reference 34), the NRC staff requested that the licensee provide justification for the total unavailability and unreliability assumed by the FPRA for a total flooding, clean agent, suppression system proposed in the CSR portion of PAU 16-A. In its response to PRA RAI 10.c.01 and PRA RAI 24 (Reference 24), the licensee stated that the modification to install such a system has been removed from LAR Attachment S, Table S-2, and the FPRA model was updated to remove any associated credit. In its response to PRA RAI 24, the licensee indicated that it incorporated this update in the integrated analysis provided by the response. The NRC staff concludes that this issue is resolved because the FPRA no longer credits this modification.

In PRA RAI 11 (Reference 31), the NRC staff requested that the licensee identify any changes made to the FPRA since the last full-scope peer review that are consistent with the definition of a "PRA upgrade" as defined by the ASME/ANS RA-Sa-2009 PRA standard. In its response to PRA RAI 11 (Reference 13) and (Reference 24), the licensee identified a number of PRA upgrades. The licensee added Implementation Item 47 to LAR Attachment S, Table S-3, requiring a focused-scope peer review on identified PRA upgrades and resolution of F&Os prior to self-approval of post-transition changes. The NRC staff concludes that this issue is resolved because PRA upgrades will undergo a focused-scope peer review, and associated finding-level F&Os will be resolved prior to self-approval of post-transition changes and because completion of the implementation item would be required by the proposed license condition.

In PRA RAI 12 (Reference 31), the NRC staff requested that the licensee provide clarification on whether random equipment failures were considered while developing the timing for HFEs associated with emergency depressurization. In its response to PRA RAIs 12 (Reference 15) and PRA RAI 24 (Reference 24), the licensee updated the FPRA to consider scenario-specific timing that is dependent on both fire-induced and random equipment failures. In its response to PRA RAI 24, the licensee indicated that it incorporated the treatment of the timing for HFEs associated with emergency depressurization in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA considers the impact of both fire-induced and random equipment failures on the timing for HFEs associated with emergency depressurization.

In PRA RAI 16 (Reference 31), the NRC staff requested that the licensee provide clarification on the licensee's use of an HRR of 69 kilowatts (kW) instead of 317 kW for modeling transient fires in some PAUs. In its response to PRA RAI 16 (Reference 14), the licensee stated that as part of LAR Attachment S, Table S-3, Implementation Item 45, it will implement strict controls on combustible materials to significantly reduce the amount of combustible material that might be in these PAUs. The licensee referenced the NRC letter to NEI dated June 21, 2012 (Reference 113), which accepted the use of an HRR lower than 317 kW based on specific attributes and considerations applied to that location. The licensee also indicated that it performed a review of past transient fire experience and identified no violations of existing transient combustible controls for these PAUs over a 52-month period. The NRC staff concludes that the licensee's use of a reduced transient HRR is consistent with guidance in the NRC letter to NEI dated June 21, 2012, and therefore, acceptable.

In PRA RAI 22 (Reference 31), the NRC staff requested justification for the circuit failure probabilities (CFPs) applied to the FPRA. In its response to PRA RAI 22.01 (Reference 21) and PRA RAI 24 (Reference 24), the licensee indicated that it updated the CFPs applied to the FPRA to be consistent with guidance provided in NUREG/CR-7150 (Reference 105) and (Reference 114). However, in its response to PRA RAI 15 (Reference 15), the licensee identified eight valves for which shorting switches were credited in the FPRA and explained that the combinations of concurrent failures required to fail a protective shorting switch were either incredibly rare or qualitatively justified as being of such insignificant likelihood that a 1.0E-03 CFP was determined to be bounding. In its response to PRA RAI 24, the licensee indicated that the revised treatment of CFPs was incorporated in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA includes CFPs that are, with the exception of those applied to circuits with shorting switches, consistent with guidance contained in NUREG/CR-7150. While the 1.0E-03 CFP that the licensee applies to circuits with shorting switches is somewhat arbitrary, the NRC staff considers the likelihood of the conditions required to fail a shorting switch to be insignificant and thus immaterial to this application.

As a result of its review of the LAR, as supplemented, the NRC staff concludes that the FPRA is of technically adequate and that its quantitative results considered together with the sensitivity studies, can be used to demonstrate that the change-in-risk due to the transition to NFPA 805 meets the acceptance guidelines in RG 1.174, and is acceptable. To reach this conclusion, the NRC staff reviewed all F&Os provided by the peer reviewers and determined that the resolution of every F&O supports the determination that the quantitative results are adequate. In addition, the NRC staff reviewed FPRA-related issues, many summarized above, and determined that the licensee's resolution of the identified issues supports the determination that the quantitative results are adequate to transition to NFPA 805 and to support subsequent self-approval as described in the applicable license condition. Accordingly, the NRC staff concludes that the licensee has demonstrated that the FPRA meets the guidance in RG 1.200, Revision 2, and that it is technically adequate to support the FREs and other risk calculations required for the NFPA 805 application.

3.4.2.3 Fire Modeling in Support of the Development of the Fire Risk Evaluation

The NRC staff performed detailed reviews of the FM used to support the FREs in order to gain further assurance that the methods and approaches used for the application to transition to NFPA 805 (Reference 3) were technically adequate. NFPA 805 has the following requirements that pertain to FM used in support of the development of the FRE:

NFPA 805, Section 2.4.3.3, "Acceptability":

> The PSA [probabilistic safety assessment] approach, methods, and data shall be acceptable to the AHJ [authority having jurisdiction].

NFPA 805, Section 2.7.3.2, "Verification and Validation":

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

NFPA 805, Section 2.7.3.3, “Limitations of Use”:

> Acceptable engineering methods and numerical models shall only be used for applications to the extent these methods have been subject to verification and validation. These engineering methods shall only be applied within the scope, limitations, and assumptions prescribed for that method.

NFPA 805, Section 2.7.3.4, “Qualification of Users”:

> 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 fire protection, and power plant operations.

NFPA 805, Section 2.7.3.5, “Uncertainty Analysis”:

> An uncertainty analysis shall be performed to provide reasonable assurance that the performance criteria have been met.

The following sections discuss the results of the NRC staff’s review of the acceptability of the FM (first requirement). The results of the NRC staff’s review of compliance with the remaining requirements are discussed in SE Sections 3.8.3.2 through 3.8.3.5.

3.4.2.3.1 Overview of Fire Models Used to Support the Fire Risk Evaluations

FM was used to develop the zone of influence (ZOI) around ignition sources in order to determine the thresholds at which a target would exceed the critical temperature or radiant heat flux. This approach provides a basis for the scoping or screening evaluation as part of the BFN FRE. The following algebraic fire models and correlations were used for this purpose:

- Flame Height, Method of Heskestad (Reference 58), Chapter 3
- Plume Centerline Temperature, Method of Heskestad (Reference 58), Chapter 9
- Radiant Heat Flux, Point Source Method (Reference 58), Chapter 5
- Ceiling Jet Temperature, Method of Alpert (Reference 115)

The first three algebraic models are described in NUREG-1805, “Fire Dynamics Tools (FDTs): Quantitative Fire Hazard Analysis Methods for the US Nuclear Regulatory Commission Fire Protection Inspection Program” (Reference 58). Alpert’s ceiling jet temperature correlation is described in FIVE, “EPRI Fire Induced Vulnerability Evaluation Methodology,” Revision 1 (Reference 115), and serves as the basis for FDT[s] that are used to estimate sprinkler, smoke detector, and heat detector response times as documented in NUREG-1805, Chapters 10, 11, and 12, respectively. V&V of these algebraic models is documented in NUREG-1824, “Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications,” Volume 3 (Reference 59).

The algebraic fire models and empirical correlations were implemented in a database and workbook referred to as the Fire Modeling Workbook (FMWB).

In addition, the licensee developed screening approaches for the evaluation of ignition sources to determine the potential for the generation of a hot gas layer (HGL) in the compartment or fire area being analyzed. The FRE used these HGL screening approaches to further screen ignition sources, scenarios, and compartments that would not be expected to generate an HGL, and to identify the ignition sources that have the potential to generate an HGL for further analysis. The following correlations were used to determine the potential for the development of an HGL:

- Method of McCaffrey, Quintiere and Harkleroad
- Method of Beyler (for closed compartments)

This HGL correlation is also described in NUREG-1805, Chapter 2 and implemented in the FMWB.

In LAR (Reference 8) Attachment J, the licensee also identified the use of the following empirical correlations that are not addressed in NUREG-1824, Volumes 3 and 4 (Reference 59).

- Sprinkler Activation Correlation (Reference 58), Chapter 10
- Smoke Detection Actuation Correlation, Method of Heskestad and Delichatsios (Reference 58), Chapter 11
- Corner and Wall Heat Release Rate (Reference 116)
- Lee's Correlation for Heat Release Rates of Cables (Reference 58), Chapter 7
- Correlation for Flame Spread over Horizontal Cable Trays, FLASH-CAT, described in NUREG/CR-7010, "Cable Heat Release, Ignition, and Spread in Tray Installations During Fire (CHRISTIFIRE), Volume 1: Horizontal Trays" (Reference 60)

The licensee's ZOI approach was used as a screening tool to distinguish between fire scenarios that required further evaluation and those that did not require further evaluation. Qualified personnel performed a plant walkdown to identify ignition sources and surrounding targets or structures, systems, and components (SSCs) in compartments and applied the empirical correlation screening tool to assess whether the SSCs were within the ZOI of the ignition source. Based on the fire hazard present, these generalized ZOIs were used to screen from further consideration those plant-specific ignition sources that did not adversely affect the operation of credited SSCs, or targets, following a fire. The licensee's screening was based on the 98th percentile fire heat release rate (HRR) from NUREG/CR-6850 methodology (Reference 53).

The CFAST, Version 6 was used for:

- Hot gas layer (HGL) temperature and height calculations in specific areas
- Temperature sensitive equipment HGL study

Fire Dynamics Simulator, Version 5 was used for:

- Abandonment time calculations based on HGL temperature and smoke concentration in the main control rooms (MCRs)
- Temperature sensitive equipment ZOI study
- Plume/HGL interaction study

Verification and validation (V&V) of the consolidated fire and smoke transport (CFAST) model and fire dynamics simulator (FDS) is documented in NUREG-1824, Volumes 5 and 7, respectively. The V&V of all correlations and fire models that were used to support the FPRA are discussed in detail in SE Section 3.8.3.2.

3.4.2.3.2 Fire Modeling RAIs

In a letter dated November 19, 2013 (Reference 31), the NRC staff sought additional information (RAIs) concerning the FM conducted to support the FPRA. In letters dated December 20, 2013 (Reference 11); January 10, 2014 (Reference 12); January 14, 2014 (Reference 13); February 13, 2014 (Reference 14); March 14, 2014 (Reference 15); and December 17, 2014 (Reference 24), the licensee responded to the RAIs. In a letter dated May 21, 2014 (Reference 33), the NRC staff sent additional RAIs to the licensee. By a letter dated June 13, 2014 (Reference 17), the licensee provided a response to the additional RAIs.

- In FM RAI 01.a (Reference 31), the NRC staff requested that the licensee provide information on how non-cable intervening combustibles were identified and accounted for in the FM analyses. In its response to FM RAI 01.a (Reference 14), the licensee explained that the combustible loading calculation was used to locate non-cable combustible materials in fire compartments where detailed FM was performed, and that plant walkdown notes, photographs, and videos were reviewed to identify the presence of secondary combustible materials that could affect FPRA targets. The licensee further explained that additional walkdowns were then performed for these fire compartments to confirm the FM with regard to the presence, quantity, and location of non-cable combustible materials. The licensee stated that based on the various walkdowns, paper contained within closed metal storage boxes and foil-faced fiberglass duct insulation was confirmed to screen out from further analysis. In addition, the licensee provided qualitative arguments to screen out secondary combustibles in areas that were not ruled out through walkdowns.

The NRC staff concludes that the licensee's response to the RAI is acceptable because secondary combustibles in plant areas that were not ruled out through walkdowns can be screened based on the conservatism in the licensee's FM analyses.

- In FM RAI 01.b.i (Reference 31), the NRC staff requested that the licensee describe how the ignition of and subsequent flame spread and fire propagation in stacks of horizontal cable trays, and the corresponding HRR of cables were calculated. In its response to FM RAI 01.b.i (Reference 24), the licensee explained that the time to ignition of a horizontal stack of cable trays was determined as the time for the ignition source to reach the critical HRR (i.e., the minimum HRR needed to damage the closest cable tray in the stack). The licensee further explained that, ignition timing and flame propagation of adjacent stacks was modeled consistent with NUREG/CR-6850, Section R 4.2.2 for thermoset cables (i.e., fire propagation to the first (bottom) tray in the adjacent stack was assumed to occur concurrently with fire propagation to the third tray in the stack). For thermoplastic cables, fire propagation to the first tray in an adjacent stack was assumed to occur one minute after ignition of the first tray in the original stack. Subsequent trays in the adjacent stack were assumed to mimic continued fire growth in the first stack, at one minute intervals.

  In FM RAI 01.01 (Reference 33), the NRC staff requested that the licensee explain how "immediately adjacent" is defined in this context. In its response to FM RAI 01.01 (Reference 17), the licensee explained that two tray stacks are considered to be "immediately adjacent" if both stacks are located directly above the ignition source such that they are either fully or at least partially immersed in the fire plume.

  The NRC staff concludes that the licensee's response to FM RAI 01.b.i is acceptable because the licensee's approach to calculate the ignition of and subsequent flame spread and fire propagation in stacks of horizontal cable trays and the corresponding HRR of cables is consistent or more conservative than the models described in NUREG/CR-6850 and NUREG/CR-7010. The NRC staff further concludes that the licensee's response to FM RAI 01.01 is acceptable because the licensee's definition of an "immediately adjacent" cable tray is consistent with the guidance in FAQ 08-0049 (Reference 78).

- In FM RAI 01.b.ii (Reference 31), the NRC staff requested that the licensee explain how cables with Flamemastic 77 coating and cable trays with covers were treated in the cable tray fire propagation calculations. In its response to FM RAI 01.b.ii (Reference 24), the licensee provided the following explanation:

  (1) In the scoping FM analysis, Flamemastic 77 was credited to delay damage to and ignition of coated cables in trays by 10 minutes for self-ignited cable fires and cable fires caused by welding and cutting, except that the cables in the initial tray were considered damaged without delay.

(2) In the Cable Spreading Room portion of fire compartment 16-A, the Flamemastic 77 coating was credited to delay time for 12 minutes for ignition and 10 minutes for damage for transient fires and transient fires caused by welding and cutting.
(3) Cable trays provided with bottom covers were credited to delay damage to and ignition of thermoset cables by 20 minutes.
(4) Cable trays provided with bottom covers were credited to delay damage to and ignition of thermoplastic cables by 4 minutes.
(5) Fire growth and propagation was not postulated for any fully enclosed cable tray.
(6) Cable tray covers were not credited when located within the ZOI of a high-energy arcing fault (HEAF).

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's approach to credit Flamemastic 77 and tray covers is consistent with the guidance in NUREG/CR-6850, Appendix Q, or is justified based on test results reported in NUREG/CR-0381 (Reference 117).

- In FM RAI 01b.iii (Reference 31), the NRC staff requested that the licensee explain how the presence of holes in cable tray covers was accounted for in the cable tray fire propagation calculations. In its response to FM RAI 01b.iii (Reference 12), the licensee explained that it was determined, based on plant walkdowns, that all cable tray covers credited in the FPRA analysis are robust and without holes.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because walkdowns performed by the licensee confirmed that there were no holes in cable tray covers credited in the FPRA analysis.

  In FM RAI 01.c (Reference 31), the NRC staff requested that the licensee explain how the wall and corner effects were accounted for in the HGL and multi-compartment FM analysis. In its response to FM RAI 01.c (Reference 13), the licensee explained that HGL temperatures were calculated in the scoping FM analysis, detailed FM analysis, multi-compartment analysis (MCA), and the MCR analysis. The majority of ignition sources modeled in these analyses were found to be located in the center of the fire compartment; therefore, the wall and corner effects were not applicable to the majority of fire scenarios. The licensee performed a sensitivity analysis to consider wall/corner effects for scenarios modeled by BFN FRE, where the fire is expected to be within 2 feet of a wall or corner. The licensee identified the following fire scenarios that involved ignition sources within 2 feet of a wall or corner and performed a sensitivity analysis for HGL calculations:

  - Scoping FM analysis using Method of Byler and CFAST
  - Detailed FM analysis using the McCaffrey, Quintiere, and Harkleroad's Method (MQH)
  - MCA using Method of Byler, MQH, and CFAST
  - MCR abandonment calculation using FDS

The licensee concluded that the sensitivity analysis results of these scenarios will not be affected by the wall and corner effects.

Based on the explanation provided, the NRC staff concludes that the licensee's approach to account for wall and corner effects in the Method of Byler, MQH, CFAST, and FDS is acceptable. The results of the sensitivity analysis show that these scenarios will not be affected by the wall and corner effects. For example, the sensitivity analysis resulted in abandonment times greater than those used in the MCR analysis; therefore, the MCR analysis is conservative and bounds the effects of a fire located at the wall or corner.

- During the onsite audit walkdown the NRC staff noted an electrical cabinet in the MCR back panel area with an open door. In FM RAI 01.d.i (Reference 31), the NRC staff requested that the licensee provide justification for the assumption in the FM analyses that there are no open cabinets in the plant. In its response to FM RAI 01.d.i (Reference 12), the licensee explained that the assumption was based on plant procedures that require personnel to promptly correct conditions that could create a fire hazard. The licensee further explained that an action to verify that the electrical cabinet doors meet the FM assumptions will be included in LAR Attachment S, Table S-3, Implementation Item 46. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because a future update to the monitoring program will further strengthen an already existing requirement that personnel promptly correct potentially unsafe conditions, such as an open electrical cabinet door, and because an action to verify that the electrical cabinet doors meet the FM assumptions is included as an implementation item which would be required by the proposed license condition.

- In FM RAI 01.d.ii (Reference 31), the NRC staff requested that the licensee describe and provide technical justification for the HRR that was assigned to the electrical cabinets in the auxiliary instrument rooms that have plexiglass doors. In its response to FM RAI 01.d.ii (Reference 12), the licensee explained that the HRR for cabinets with plexiglass doors was not used in the scoping FM analysis of scenarios that involve these cabinets, since for those scenarios, damage is assumed to all targets in the compartment. In addition, the licensee calculated the HRR of a cabinet with plexiglass doors and demonstrated that it is approximately 10 percent lower than the electrical cabinet HRR that was used in the MCA.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the HRR of the cabinets with plexiglass doors was not used in the scoping FM, and the HRR that was used, was lower than the cabinet HRR used in the MCA based on the guidelines in NUREG/CR-6850.

- In FM RAI 01.e (Reference 31), the NRC staff requested that the licensee explain how the guidance in Appendix M in NUREG/CR-6850, Volume 2 was used to determine the damage due to HEAFs, or to provide technical justification if a different approach was used. In addition, the NRC staff requested that the licensee provide technical justification for the assumption that a fire following a HEAF event has an HRR of 211 kW for duration of 20 minutes, followed by a 20-minute decay. In its response to FM RAI 01.e (Reference 11), the licensee explained that FPRA targets within the initial blast ZOI as defined in NUREG/CR-6850, Section M.4.2, were considered damaged and ignited in HEAF scenarios at time zero, and that fire wraps and cable tray enclosures were not credited in the analysis. The licensee further explained that the 211 kW HRR is based on the 98th percentile HRR of a single bundle electrical cabinet fire, which is assumed to bound the remaining contents of the cabinet after the initial HEAF event. The licensee further stated that the 20-minute burn duration is a combination of the 12 minutes needed to reach the peak HRR and the 8 minutes sustained at peak HRR.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee followed the guidance in NUREG/CR-6850, Appendix M, and because the 20-minute burn duration at peak HRR used in the analysis is conservative.

- During the audit, the NRC staff noted transient combustibles in several areas that may not have been considered in the FM analyses. In FM RAI 01.f (Reference 31), the NRC staff requested that the licensee demonstrate that the FM analyses that were conducted are bounding for scenarios that involve these transient combustibles, and to explain how it is ensured that the model assumptions in terms of transient combustibles in a fire area or zone will not be violated during and post-transition. In its response to FM RAI 01.f (Reference 12), the licensee explained that the type and amount of transient combustibles expected to be found in most areas of the plant are bounded by the typical fuel package configurations identified in NUREG/CR-6850, Table G-7 and that in these areas; therefore, the 317 kW 98th percentile transient HRR identified in NUREG/CR-6850, Table G-1 was used in the FM analyses. The licensee further explained that since this is not the case in the turbine building where the NRC staff observed a large quantity of resin during the onsite audit walkdown, the FM analysis for transient combustibles assumed damage to all targets in the fire compartment. The licensee further explained that a reduced transient HRR of 69 kW was applied in selected compartments and transient zones where combustible controls, physical limitations, or lack of maintenance activities would preclude the presence of transient fuel packages of sufficient size necessary to create a 317 kW fire, and where the types of combustibles that can be expected have a peak HRR of 50 kW or less.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee either used the HRR for transient fires recommended in NUREG/CR-6850, assumed that all targets would be damaged in compartments where a large amount of transient combustibles is present, or used a lower HRR that is representative of the transients that can be expected in compartments with combustible controls, space limitations, and/or other restrictions.

- In FM RAI 01.g (Reference 31), the NRC staff requested that the licensee explain whether fire scenarios involving oil from mechanical equipment were considered in the FM analyses for the Unit 3 Cable Spreading Room. In its response to FM RAI 01.g (Reference 24), the licensee explained that the FM analysis performed in support of the LAR assumed that damage by the oil fire scenarios would be bounded by the electrical fires of the mechanical equipment. The licensee further explained that based on additional analysis, it was determined that oil fires for these ignition sources have the potential to be larger, and therefore, the fire modeling workbook (FMWB) was updated and the FPRA quantifications were revised to include the new oil fire scenarios.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee performed additional FM and revised the FPRA quantifications to include the risk contribution of oil fire scenarios in the Unit 3 Cable Spreading Room.

- In FM RAI 01.h.i (Reference 31), the NRC staff requested that the licensee explain how the elevation of ignition source fires was determined in the algebraic models, and to describe whether the assumptions are consistent with plant conditions or confirm that they lead to conservative ZOI and HGL temperature estimates. In its response to FM RAI 01.h.i (Reference 12), the licensee explained that the height of each fixed ignition source was determined through plant walkdowns and was either the highest opening or vent through which combustible material could be observed inside the electrical cabinet, or the top of the electrical cabinet if no combustible material could be observed. The licensee further explained that the latter resulted in a conservative ZOI. The licensee further stated that the height of transient fire sources was selected as 2 feet for most fire compartments and 3.3 feet in the remaining compartments. The licensee further explained that the transient fire heights were consistent with most plant conditions and selected for conservatism in the ZOI determination.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because in cases where the transient fire height used in the FM analyses was not consistent with plant conditions, the licensee assumed a height that results in a conservative ZOI.

- In FM RAI 01.h.ii (Reference 31), the NRC staff requested that the licensee provide technical justification for using a fixed Froude number (the inertial force divided by the gravitational force) value of one (1) to determine the diameter of the fire in the algebraic models (as opposed to the actual diameter of the fire) to determine the range of fire diameters that correspond to a Froude number of one for the HRRs of the fires that were considered in the FM analyses, and to show that this range is reasonably consistent with the dimensions of transient combustibles in the plant. In its response to FM RAI 01.h.ii (Reference 12), the licensee calculated the fire diameter corresponding to a Froude number of one for 211 kW and 464 kW electrical cabinet fires, and for 317 kW and 69 kW transient fires, and demonstrated that the corresponding fire area is consistent with the dimensions of these types of ignition sources in the plant. The licensee further demonstrated that the assumption of a Froude number value of one, in combination with the assumed HRR, resulted in more severe ZOI estimates for cable tray and oil fires.

The NRC staff concludes that the licensee's response to the RAI is acceptable because a Froude number of one is within the NUREG-1824 (Reference 59) validated range, corresponds to fire dimensions that are consistent with those of fixed and transient ignition sources in the plant, and leads to conservative ZOI estimates for cable tray and oil fires.

- In FM RAI 01.h.iii (Reference 31), the NRC staff requested that the licensee provide technical justification for the exclusive use of the MQH method for the HGL calculations and for the assumed vent dimensions of 3 by 7 ft. or 10 by 10 ft. In its response to FM RAI 01.h.iii (Reference 14), the licensee explained that fire compartments were determined to be naturally ventilated based on walkdowns and analysis of plant layout drawings, and therefore, the exclusive use of the MQH method was appropriate because using the method of Beyler would have produced overly conservative results, since assuming completely closed compartments is not consistent with plant conditions. The licensee further explained that in cases where a 3 ft. x 7 ft. vent was assumed, the fire compartment either has large openings to adjacent spaces not included in the FM volume, or, once the fire is detected, fire brigade personnel will be dispatched to the room and are expected to open a door and perform suppression activities, which would provide the 3 ft. x 7 ft. opening assumed in the FM analysis. The licensee provided a list of all compartments where a 10 ft. x 10 ft. vent was assumed, and demonstrated that the areas of the actual openings for these compartments exceeds 100 ft.^{2}. The licensee further stated that actual vent dimensions were used for fire compartment 20-E because they are smaller than 10 ft. x 10 ft.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the naturally-vented compartment configuration assumed in the MQH method most closely matches plant conditions, and the vent opening sizes assumed in the HGL analyses are either consistent with the actual dimensions or lead to conservative HGL temperature estimates.

- In FM RAI 01.i.i (Reference 31), the NRC staff requested that the licensee provide technical justification for not considering fires that involve the polycarbonate ceiling panels in the MCR abandonment calculations. In its response to FM RAI 01.i.i (Reference 14), the licensee explained that a sensitivity study was performed to demonstrate that the polycarbonate ceiling panels would not significantly contribute to a fire. The licensee further explained that a bin 15 electrical panel fire outside the MCR horseshoe was used in the sensitivity analysis as it is the bounding case, and that the analysis shows that regardless of whether the ceiling is assumed to melt where it is heated by the plume of the ignition source or stay in place, the MCR abandonment times calculated without accounting for involvement of the polycarbonate ceiling panels are still valid. The licensee identified a number of conservative assumptions in the MCR abandonment analysis to further substantiate the validity of the results of the MCR abandonment time calculations for use in the FPRA.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the sensitivity analysis shows that in the worst case (i.e., the ceiling is assumed to stay in place and ignite when the plume temperature at the ceiling reaches the ignition temperature of polycarbonate), the HRR in the MCR will not be affected soon enough to invalidate the calculated MCR abandonment times calculated without accounting for involvement of the polycarbonate ceiling.

- In FM RAI 01.i.ii (Reference 31), the NRC staff requested that the licensee provide technical justification for using a soot yield of 0.12 for the cables in the FDS MCR abandonment calculations, and to demonstrate that the soot yield and heat of combustion values that were used in the analysis result in conservative estimates of the soot generation rate. In its response to FM RAI 01.i.ii (Reference 11), the licensee explained that polyethylene (PE)/polyvinyl chloride (PVC) cabling was assumed for the MCR analysis, as these are the most common insulation materials for thermoplastic cables, and that the soot yield that was used in the analysis (0.12 g/g) is the highest value reported for flaming combustion of PVC in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering. The licensee further explained that the heat of combustion of cables was not specified but calculated by FDS based on the stoichiometry of the combustion reactions. The licensee further explained that the same soot yield value was assumed for transient fires, which typically involve ordinary combustibles. The licensee indicated that according to NUREG-1934 (Reference 63), FDS, on average, overestimates the smoke concentration by a factor of 2.70, and the lower oxygen limit in FDS was set to zero to prevent ventilation-limited conditions from occurring.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee demonstrated that the MCR abandonment calculations were based on conservative estimates of soot generation rate and resulting smoke concentration.

- In FM RAI 01.i.iii (Reference 31), the NRC staff requested that the licensee confirm that the 10 inch (in.) by 6 in. holes in the polycarbonate ceiling in the FDS model are consistent with the actual openings to the interstitial space, or to explain why the assumed hole dimensions are conservative in terms of MCR abandonment. In its response to FM RAI 01.i.iii (Reference 12), the licensee explained that ventilation holes are located throughout the drop ceilings of both MCRs. The licensee further explained that the total area of the modeled openings is less than 50 percent of the actual area in the Unit 1 and Unit 2 MCRs, and less than 25 percent of the actual area in the Unit 3 MCR.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the assumed 10 in. x 6 in. openings conservatively bound the actual hole dimensions, in terms of MCR abandonment.

- In FM RAI 01.i.iv (Reference 31), the NRC staff requested that the licensee provide technical justification for running FDS to calculate MCR abandonment times with D*/δx values outside the NUREG-1824 recommended range. In its response to FM RAI 01.i.iv (Reference 15), the licensee stated that the 20 centimeter (cm) mesh size was selected in order to maximize accuracy within a reasonable computation time, and that the HRR in the majority of fire scenarios was too low to allow for the D*/δx to fall within the NUREG-1824 (Reference 59) 4-16 validation range. The licensee further explained that a sensitivity analysis was performed to justify the 20 cm mesh size by conducting a series of FDS runs with a reduced mesh size of 10 cm so that the corresponding D*/δx values were within the 4-16 range. Based on the results of the sensitivity analysis the licensee concluded that reducing the mesh size from 20 cm to 10 cm leads to a slight overall reduction of the calculated probability for MCR abandonment.

  The NRC staff concludes that the license's response to the RAI is acceptable because the mesh size that was used in the MCR abandonment time calculations results in conservative estimates of the probability for CR abandonment.

- In FM RAI 01.i.v (Reference 31), the NRC staff requested that the licensee provide technical justification for the assumed transient fire elevation in the FDS MCR abandonment calculations, and for choosing a fire diameter so that the Froude number is within the NUREG-1824 validated range.

  In its response to FM RAI 01.i.v (Reference 11), the licensee explained that transient scenarios were modeled in FDS at an elevation of 0.6 meters (m) above the floor, and that most transient fires are expected to be below this height or at floor level. The licensee further explained that the Froude number is predominantly used to validate plume temperature and flame height, and that it is not important to the MCR analysis because CR abandonment is dependent on the HRR and soot yield of the combustible material.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the height (0.6 m) and area (0.6 x 0.6 m) are bounding values for the dimensions of transient combustibles that may be found in the MCR.

- In FM RAI 01.i.vi (Reference 31), the NRC staff requested that the licensee describe the technical basis for the placement of the FDS "devices" (temperature, heat flux, and optical density) in the MCR abandonment calculations.

  In its response to FM RAI 01i(vi) (Reference 11), the licensee explained that the devices were located (1) to ensure complete coverage of the CR, (2) in areas that represent the most likely fire scenario points of origin, (3) in proximity to the expected location of the operators, and (4) in locations where smoke was expected to accumulate. The licensee further explained that devices to monitor temperature were placed vertically in 3 foot increments at the selected locations, and the devices to monitor habitability conditions were placed 6 feet above the floor.

The NRC staff concludes that the licensee's response to the RAI is acceptable because devices were placed throughout the MCR to conservatively monitor the effect of the HGL on habitability conditions.

- In FM RAI 01.i.vii (Reference 31), the NRC staff requested that the licensee provide technical justification for assuming in the MCR abandonment calculations that transient fires reach peak HRR in 8 minutes.

  In its response to FM RAI 01.i.vii (Reference 12), the licensee explained that its Transient Combustible Program prohibits trash bags left outside of trash cans and does not permit the accumulation of a significant amount of flammable or combustible liquids in the MCR. The licensee further explained that walkdowns of both MCRs confirmed compliance with the program, and therefore, the HRR growth rate for transients was determined to be that of a common trash can fire scenario.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because (1) the licensee's combustible control program prohibits the accumulation of any type of trash in the MCRs except for limited quantities of paper, plastics, or other solid materials contained in a common trash can; and (2) a time from ignition to peak HRR of 8 minutes for this type of transient combustible is consistent with the guidelines in FAQ 08-0052 (Reference 79).

- In FM RAI 01.i.viii (Reference 31), the NRC staff requested that the licensee describe the technical basis for the locations of the cabinet and transient fires that were chosen in the MCR abandonment calculations.

  In its response to FM RAI 01.i.viii (Reference 11), the licensee explained that two transient and two electrical cabinet scenario locations were postulated for both Unit 1 and Unit 2 MCRs and Unit 3 MCR. The licensee further explained that each electrical cabinet fire scenario location was selected such that the fire would spread to two additional cabinets, and that the locations for the transient fires were selected both inside and outside of the horseshoe at locations in close proximity to the MCBs and operators.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the locations of the fires were selected to bound electrical cabinet fires and transient fires at any location within the room.

- In FM RAI 01.j.i (Reference 31), the NRC staff requested that the licensee describe the criteria that were used in the MCA to screen multi-compartment scenarios based on the size of the exposing and exposed compartments. In its response to FM RAI 01.j.i (Reference 11), the licensee explained that three exposing compartments and exposed compartments in six plant locations were screened based on their size and summarized the rationale for screening MCA scenarios that involve these compartments.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's criteria to qualitatively screen MCA scenarios were based on either the exposing compartment not being able to generate an HGL due to its size and configuration, or the exposed compartment being of sufficient volume to preclude the generation of an HGL.

- In FM RAI 01.j.ii (Reference 31), the NRC staff requested that the licensee provide technical justification for the vent dimensions in the exposing and exposed compartments assumed in the CFAST multi-compartment calculations. In its response to FM RAI 01.j.ii (Reference 12), the licensee explained that the ventilation openings from the exposing compartment to other areas of the plant were characterized by a 3 x 7 ft. vent; this was representative of the various natural air flow paths to adjacent spaces (prior to fire brigade arrival) or a single open door (subsequent to fire brigade arrival). The licensee further explained that exposed compartments were modeled in CFAST as closed compartments, and that this assumption was justified based on the results of a sensitivity analysis.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's assumptions concerning the vent size in the exposing compartment are consistent with plant conditions, and the sensitivity analysis indicated that for the worst-case scenarios, adding a ventilation opening in the exposed compartment does not significantly increase the HGL temperature in the exposed compartment (<10 degrees Celsius (ºC)).

- In FM RAI 02.a (Reference 31), the NRC staff requested that the licensee describe how the installed cabling in the power block was characterized. In its response to FM RAI 02.a (Reference 15), the licensee explained that the damage criteria in Table H-1 of NUREG/CR-6850 was used, and that raceways were analyzed as thermoplastic targets in all fire compartments, unless the use of thermoset damage criteria was technically justified.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's characterization is consistent with plant conditions and the guidelines in NUREG/CR-6850.

- In FM RAI 02.b (Reference 28), the NRC staff requested that the licensee provide clarification on the assumptions that were made in terms of damage thresholds of cables. In its response to FM RAI 02.b (Reference 15), the licensee explained that in all PAUs, with the exception of cable trays in Fire Compartments (FC) 5 and 9, all raceways were conservatively analyzed as thermoplastic targets. The licensee indicated that a review of the cable insulation and cable jacket material was performed for the cables routed through cable trays in FC 05 and FC 09. The results of this review determined that all cables routed in cable trays within FC 05 have a thermoset insulation and jacket material. The results of the cable jacket and insulation review in FC 09 determined that one cable tray contained cables with thermoplastic jacket material. For this compartment, a bounding analysis approach was used.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's data is based on a survey of the cables in the plant which demonstrates that the assumptions concerning cable flame spread, HRR characteristics, and cable damage thresholds are appropriate since they are based on plant conditions.

- In FM RAI 02.c (Reference 31), the NRC staff requested that the licensee describe how cable tray covers and conduits affect the damage thresholds that were used in the FM analyses, and to explain how holes in cable tray covers were treated in this respect. In its response to FM RAI 02.c (Reference 11), the licensee explained that conduit was not credited to delay damage to the cable. The licensee further explained that cable trays provided with bottom covers were credited to delay damage to thermoset cables as allowed by NUREG/CR-6850, Section Q.2.2, and credited to delay damage to thermoplastic cables based on test results from NUREG/CR-0381 (Reference 117). The licensee further stated that plant walkdowns confirmed that there were no holes in any of the cable tray covers credited to delay damage to target cables.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because (1) the licensee's approach to determine the effect of conduit and cable tray covers on damage to cable targets was consistent with the guidelines in NUREG/CR-6850 and the test results described in NUREG/CR-0381 (Reference 117), and (2) consideration of the effect of holes in cable tray covers was not applicable.

  In its response to FM RAI 02.c (Reference 11), the licensee referred to Section Q.2.2 of NUREG/CR-6850 to substantiate the damage delay time that was assumed for covered trays. However, the delay time that is recommended in NUREG/CR-6850, Section Q.2.2 should only be used for qualified cable. In FM RAI 02.01 (Reference 33), the NRC staff requested that the licensee confirm that all cables for which the delay time in Section Q.2.2 of NUREG/CR-6850 was used are qualified cables. In its response to FM RAI 02.01 (Reference 17), the licensee confirmed that all cables that use the damage delay time guidance in NUREG/CR-6850, Section Q.2.2 are qualified.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee applied the delay time recommended in NUREG/CR-6850, Section Q.2.2 exclusively to qualified cables.

- In FM RAI 02.d (Reference 31), the NRC staff requested that the licensee explain what damage thresholds and associated time delays were used in the FM analyses for cables coated with Flamemastic 77. In its response to FM RAI 02.d (Reference 11), the licensee explained that the damage thresholds for coated cables were based on those identified in NUREG/CR-6850, Table H-1 (i.e., 205 °C and 6 kW/m^2 for thermoplastic cables, and 330 °C and 11 kW/m^2 for thermoset cables). The licensee further explained that the cable coating was credited to delay damage to, and ignition of, cables in trays adjacent to the initial tray by 10 minutes for certain risk-significant, self-ignited cable fires and cable fires caused by welding and cutting.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the damage and ignition delays for cables coated with Flamemastic 77 assumed by the licensee are consistent with, or more conservative than, the delay times recommended in NUREG/CR-6850, Section Q.2.1.

- During the audit, the NRC staff noted that several electrical cabinets in the auxiliary instrument rooms have plexiglass doors with gaskets. The plexiglass doors of two cabinets were partially open. The cabinets with plexiglass doors appear to contain sensitive electronic equipment. In FM RAI 02.e (Reference 31), the NRC staff requested that the licensee describe and provide technical justification for the damage criteria that were used for this equipment. In its response to FM RAI 02.e (Reference 14), the licensee explained that there are two cabinets within each of the auxiliary instrument rooms (Fire Compartments 16-K, 16-M, and 16-O) that each have a plexiglass door. The licensee further explained that (1) fixed ignition source scenarios capable of damaging FPRA targets beyond the source itself were assumed to fail all targets in the fire compartment; (2) transient fire scenarios within the auxiliary instrument rooms were modeled as 69 kW fires and do not produce sufficient energy to generate an HGL greater than the critical damage temperature for sensitive electronic equipment of 65 °C, as recommended in NUREG/CR-6850, Section H.2; and (3) assuming that sensitive electronic equipment in a cabinet with plexiglass doors fails when exposed to a radiant heat flux of 3 kW/m^2 (instead of 6 kW/m^2 assumed in the analysis) results in an insignificant risk increase due to the low CCDP and CLERP values associated with damaging the entire contents of the cabinets with plexiglass doors that contain FPRA targets.

  The NRC staff concludes that the response to the RAI is acceptable because assuming a critical damage temperature of 65 °C (as opposed to 205 °C in the analysis) and a critical heat flux of 3 kW/m^2 (as opposed to 6 kW/m^2 in the analysis) for sensitive electronic equipment in the electrical cabinets that have a plexiglass door would not affect the conclusions of the FPRA.

3.4.2.3.3 Conclusion for Section 3.4.2.3

Based on the licensee's description in the LAR, as supplemented, of the process for performing FM in support of the FREs and clarifications provided in response to the RAIs, the NRC staff concludes that the licensee's approach for meeting the requirements of NFPA 805, Section 2.4.3.3 is acceptable.

3.4.2.4 Conclusions Regarding Fire PRA Quality

Based on NUREG-0800, Section 19.2 (Reference 51), Section III.2.2.4.1, summarizing the NRC staff's review of PRA quality required for an LAR, the NRC staff concludes that the licensee's PRA satisfies the guidance contained in RG 1.174, Section 2.3 and RG 1.205, Section 4.3 regarding the technical adequacy of the PRA used to support risk assessment to support transition to NFPA 805.

The NRC staff concludes that the PRA approach, methods, and data are acceptable, and therefore, NFPA 805, Section 2.4.3.3 is satisfied for the request to transition to NFPA 805. The NRC staff based this conclusion on the findings that (1) the PRA model meets the criteria in that it adequately represents the current, as-built, as-operated configuration as it will be configured after full implementation of NFPA 805, and is, therefore, capable of being adapted to model both the post-transition and compliant plant as needed; (2) the PRA model conforms to the applicable industry PRA standards for internal events and fires at an appropriate capability category, considering the acceptable disposition of the peer review and NRC staff review findings; and (3) the FM used to support the development of the FPRA has been confirmed as appropriate and acceptable.

The FPRA used to support RI self-approval of changes to the FPP must use an acceptable PRA approach and acceptable methods and data. The NRC staff concludes that the changes already made to the baseline FPRA model to incorporate acceptable methods, as detailed in the licensee's response to PRA RAI 24 (Reference 23) (Reference 24) and discussed above, and following completion of all implementation items described in LAR Attachment S, Table S-3, as supplemented, demonstrate that NFPA 805 criteria are satisfied and the PRA is acceptable for use to support self-approval of changes to the FPP.

Based on the licensee's administrative controls to maintain the PRA models current and assure continued quality using only qualified staff and contractors (as described in SE Section 3.8.3), the NRC staff concludes that the PRA maintenance process is adequate to maintain the quality of the PRA to support self-approval of future RI changes to the FPP under the NFPA 805 license condition.

3.4.3 Fire Risk Evaluations

For those fire areas for which the licensee used a PB approach to meet the NSPC, the licensee used FREs in accordance with NFPA 805, Section 4.2.4.2 to demonstrate the acceptability of the plant configuration. In accordance with the guidance in RG 1.205 (Reference 4), Section C.2.2.4, "Risk Evaluations," the licensee used an RI approach to justify acceptable alternatives to comply with NFPA 805 deterministic criteria. The NRC staff reviewed the following information during its evaluation of the BFN FREs: LAR Section 4.5.2, "Performance Based Approaches"; LAR Attachment C, "NEI 04-02 Table B-3 – Fire Area Transition"; and LAR Attachment W, "Fire PRA Insights"; as well as associated supplemental information.

Plant configurations that did not meet the deterministic requirements of NFPA 805, Section 4.2.3.1 were considered VFDRs. VFDRs that will be brought into deterministic compliance through plant modifications do not require a risk evaluation. The licensee identified the VFDRs that it does not intend to bring into deterministic compliance in LAR Attachment C. For these VFDRs that will be retained and become part of the licensing basis, the licensee used the RI approach, in accordance with NFPA 805, Section 4.2.4.2 to demonstrate that the increased risk from the retained VFDRs is acceptable.

As discussed in LAR Attachment W, Section W.2.1, “Methods Used to Determine Changes in Risk,” all of the VFDRs evaluated by the FPRA were separation issues. The separation-related VFDRs can generally be categorized into the following four types of plant configurations: (1) inadequate separation resulting in fire-induced damage of process equipment or associated cables required for the identified success path; (2) inadequate separation resulting in fire-induced spurious operation of equipment that may defeat the identified success path; (3) inadequate separation resulting in fire-induced failure of process monitoring instrumentation or associated cables required for the identified success path; and (4) combinations of the above configurations.

In LAR Attachment W, the licensee described how it performed an FRE for VFDRs. The licensee explained that the change-in-risk associated with each fire area is obtained by calculating the difference between the core damage frequency (CDF) and large early release frequency) LERF of a compliant plant configuration and the post-transition plant configuration. The total change-in-risk was obtained by summing the change-in-risk for each fire area and comparing the total for each unit to the RG 1.174 acceptance guidelines. The licensee further explained that some risk reduction modifications (i.e., non-VFDR modification) are planned that do not resolve a VFDR but instead reduce risk.

The post-transition plant is modeled with fire-induced component failures included for retained VFDRs with all RAs at their nominal values, and with all modifications (i.e., both non-VFDR modifications and modifications within the scope of the FPRA that bring VFDRs into deterministic compliance) incorporated into the FPRA. VFDRs are removed from the compliant plant by assuming that the components and cables that are required to resolve a VFDR are not affected by a fire or that RAs that effectively mitigate the failures associated with a VFDR always succeed. Non-VFDR modifications are not included in the compliant case. In its response to PRA RAI 18.b (Reference 24), the licensee clarified that for cases where the FPRA did not model equipment associated with a VFDR as identified in the NSCA, higher level functions were conservatively assumed to be free of fire damage in the compliant case. For those VFDRs that are considered to have no change-in-risk based on qualitative evaluation, the change-in-risk is not estimated with the FPRA but rather designated as having no risk impact.

In PRA RAI 20 (Reference 31), the NRC staff noted that the post-transition plant PRA uses a number of existing, non-fire-specific operator actions that are not used in the compliant plant PRA, even if unaffected by fire. In its response to PRA RAI 20 (Reference 15), PRA RAI 20.01 (Reference 21), and PRA RAI 24 (Reference 24), the licensee indicated that it updated the FPRA to credit existing, non-fire-specific actions in both the post-transition and compliant plant PRAs. In its response to PRA RAI 24, the licensee confirmed that the revised treatment of non-fire-specific actions was incorporated in the integrated analysis. The NRC staff concludes that this issue is resolved because the transition change-in-risk estimates submitted by the licensee on December 17, 2014 (Reference 24), include credit for existing, non-fire-specific operator actions in both the post-transition and compliant plant FPRA models, and thereby, more properly model the as-operated plant.

In PRA RAI 19.b.01 (Reference 34), the NRC staff noted that the risk-significant scenarios for the compliant plant identified in the licensee's response to PRA RAI 19.b (Reference 12) and (Reference 14) suggested that the licensee's treatment of junction box fires, cable fires caused by welding and cutting, and self-ignited cable fires was overly conservative and potentially led to non-conservative estimates of delta risk. In its response to PRA RAI 19.b.01.a and PRA RAI 24 (Reference 24), the licensee refined the FPRA model's treatment of these ignition sources using methods discussed in SE Section 3.4.2.2 and stated that treatment of these ignition sources does not yield overly conservative risk estimated that would lead to non-conservative estimates of delta risk. In its response to PRA RAI 24, the licensee indicated that it incorporated the revised treatment in the integrated analysis. The NRC staff concludes that this issue is resolved because the FPRA transition change-in-risk estimates, submitted by the licensee on December 17, 2014 (Reference 24), are no longer based on overly conservative risk estimates (made by the FPRA model's treatment of junction box fires, cable fires caused by welding and cutting, and self-ignited cable fires) that would lead to non-conservative estimates of delta-risk.

The NRC staff concludes that the licensee's methods for calculating the change-in-risk associated with VFDRs are acceptable because they are consistent with RG 1.205, Section 2.2.4.1, "Fire Risk Evaluations (Including Recovery Actions) by Fire Area," and FAQ 08-0054 (Reference 80). The NRC staff further concludes that the results of these calculations for each fire area, which are summarized in LAR Attachment W, Tables W-8, W-9, and W-10, as supplemented, demonstrate that the difference between the risk associated with implementation of the deterministic requirements and that of the VFDRs meets the risk acceptance criteria described in NFPA 805, Section 2.4.4.1.

3.4.4 Additional Risk Presented by Recovery Actions

The NRC staff reviewed LAR Attachment C, "NEI 04-02 Table B-3 – Fire Area Transition"; LAR Attachment G, "Recovery Actions Transition"; and LAR Attachment W, "Fire PRA Insights," during its evaluation of the additional risk presented by the NFPA 805 RAs. SE Section 3.2.5 describes the identification and evaluation of RAs.

The licensee used the guidance in RG 1.205, Revision 1, and FAQ 07-0030 (Reference 72) for addressing RAs, which included the definition of primary control station (PCS) and recovery action (RA). Accordingly, any actions required to transfer control to the PCS or operate equipment from the PCS were not considered RAs per the RG 1.205 guidance and in accordance with NFPA 805. Conversely, any operator manual actions required to be performed outside the CR to resolve a VFDR to meet risk criteria and not at the PCS were considered RAs.

The licensee identified the RAs required to meet risk and DID criteria in LAR Attachment G, Table G-1, thus indicating which RAs were required to meet risk criteria and which were required for DID only. As indicated in LAR Attachment W, DID RAs are retained in the procedures but not modeled in the FPRA. Operator actions that are performed at the PCS following MCR abandonment are also identified in LAR Attachment G, Table G-1, but as explained above, they are considered PCS actions and not RAs.

The additional risk of RAs for each fire area is presented in LAR Attachment W, as supplemented by the licensee's letter dated December 17, 2014 (Reference 24). In LAR Attachment W, Section W.2.1, the licensee clarified that the additional risk of RAs associated with each fire area is obtained by calculating the difference in risk between the post-transition plant configuration with all RAs at their nominal values and this same configuration with all RAs necessary to demonstrate the availability of a success path for the NSPC assumed to always succeed. The total additional risk of RAs was obtained by summing the additional risk for each fire area.

According to LAR Attachment W (Reference 24), as supplemented, the additional risk of RAs is an increase in CDF of 1.43E-05/reactor-year and an increase in LERF of 1.02E-06/reactor-year for Unit 1; an increase in CDF of 2.11E-05/reactor-year and an increase in LERF of 1.12E-06/reactor-year for Unit 2; and an increase in CDF of 2.14E-05/reactor-year and an increase in LERF of 1.21E-06/reactor-year for Unit 3. (In the licensee's letter dated August 18, 2015 (Reference 28), the licensee indicated that removal of a proposed modification and two other minor changes to the PRA changed the LERF values a few percent, but had a negligible effect on the change in CDF values, and therefore the values provided by the licensee in its letter dated December 17, 2014 (Reference 24), regarding the additional CDF recovery action risk estimates can be used). These values are above the acceptance guidelines in RG 1.174. RG 1.205, RP 2.2.4.2 states that, "[i]f the additional risk associated with previously approved [recovery actions] is greater than the acceptance guidelines in RG 1.174, then the net change in total plant risk incurred by any proposed alternatives to the deterministic criteria in NFPA 805, Chapter 4 (other than the previously approved [recovery actions]), should be risk-neutral or represent a risk decrease." Application of this guidance to RAs in general (i.e., not solely to previously approved RAs) indicates that the proposed additional risk of RAs is acceptable because the licensee has reported a net total risk decrease for transition to NFPA-805. On a fire area basis, a review of the detailed results in LAR Attachment W, Tables W-8 through W-10 indicates that for Units 2 and 3, the additional risk of RAs for fire area 16 is also above the RG 1.174 acceptance guidelines for CDF; however, a similar application of RG 1.205 guidance on a fire area basis indicates that the proposed additional risk of RAs is acceptable because the licensee reported a total risk decrease in fire area 16 for each unit.

Per LAR Attachment G, the licensee reviewed all of the RAs for adverse impact on plant risk per FAQ 07-0030 and stated that no RAs listed in LAR Attachment G, Table G-1 were found to have an adverse impact. Furthermore, all RAs listed in LAR Attachment G were evaluated against the feasibility criteria provided in NEI 04-02 (Reference 7), FAQ 07-0030, and RG 1.205. LAR Attachment S, Table S-3, Implementation Items 27 through 31 and 33, include actions that will update the post-fire shutdown procedures and incorporate the results of the RA feasibility evaluation.

The NRC staff concludes that the licensee evaluated the additional risk of RAs as required by NFPA-805, Section 4.2.4 and that the licensee's methods for evaluating the additional risk are acceptable because they are consistent with RG 1.205, Section 2.2.4.1 and FAQ 07-0030. Furthermore, the license reported a net total risk decrease for transition to NFPA 805, and therefore, the additional risk of RAs reported by the licensee is consistent with RG 1.205, RP 2.2.4.2 and acceptable.

3.4.5 Risk-Informed or Performance-Based Alternatives to Compliance with NFPA 805

The licensee did not use any RI or PB alternatives to comply with NFPA 805.

3.4.6 Cumulative Risk and Combined Changes

In LAR Attachment S, Table S-2, as supplemented, the licensee identified planned NFPA 805 transition modifications that decrease risk and for which the licensee takes credit during the assessment of the cumulative risk impact of the transition to NFPA 805. The licensee included additional non-VFDR modifications not associated with bringing the facility into compliance with the deterministic requirements of NFPA 805. The licensee credited non-VFDR modifications by including them in the post-transition risk but not the compliant plant risk. The NRC staff concludes that the licensee's application to transition to an RI/PB FPP is, therefore, a combined change request per Section 1.1, "Combined Change Requests," of RG 1.174, Revision 2.

The total plant CDF and LERF are estimated by adding the risk assessment results for internal events, internal flooding, fire, seismic, and other external hazard events. RG 1.174 does not require a total CDF and LERF when the total change in CDF and LERF for an application is less than 1.00E-6/year and 1.00E-7/year, respectively. Although there is a net risk decrease in the transition to an RI/PB FPP for all three units, the licensee provided an estimate of contributors to the total CDF and LERF in the supplemented LAR Attachment W (Reference 24), which is summarized below in SE Table 3.4.6-1 for Units 1, 2 and 3, respectively. Final total fire risk values were provided by the licensee in its letter dated August 18, 2015 (Reference 28). In LAR Attachment W, the licensee explained that the seismic and external events CDF and LERF were developed using a bounding assessment rather than a PRA. The NRC staff found that the seismic CDF estimates are equivalent to the NRC staff's safety/risk assessment for IN 2010-18, Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants" (Reference 118).

Table 3.4.6-1: CDF and LERF for BFN after Transition to NFPA 805

	UNIT 1		**UNIT 2**		**UNIT 3**	
Hazard Group	**CDF (/reactor-year)**	**LERF (/reactor-year)**	**CDF (/reactor-year)**	**LERF (/reactor-year)**	**CDF (/reactor-year)**	**LERF (/reactor-year)**
Internal Events/ Internal Flooding	5.64E-06	9.50E-07	4.97E-06	9.19E-07	5.96E-06	9.66E-07
External Floods/ High Winds/ Tornadoes/Other	1.00E-06	Negligible	1.00E-06	Negligible	1.00E-06	Negligible
Seismic	3.70E-06	Negligible	5.40E-06	Negligible	5.40E-06	Negligible
Fire	5.05E-05	5.77E-06	5.68E-05	5.78E-06	5.93E-05	5.12E-06
TOTAL	6.08E-05	6.72E-06	6.82E-05	6.70E-06	7.17E-05	6.09E-06

The licensee provided the delta (∆) CDF and ∆LERF estimated for each fire area that is not deterministically compliant in accordance with NFPA 805, Section 4.2.3, "Deterministic Approach." In the letter dated December 17, 2014 (Reference 24), the licensee responded to PRA RAI 24 and provided a supplement to LAR Attachment W that reports change-in-risk estimates based on the FPRA after implementing a number of FPRA model and method refinements to use methods accepted by the NRC. The risk estimates for these fire areas address the completed and planned modifications and administrative controls that will be implemented as part of the transition to NFPA 805, as well as RAs to reduce VFDR risk.

In its response to PRA RAIs 19.a.01 and 19.b.01.c (Reference 24), the licensee stated that the estimated risk of retained (or unresolved) VFDRs was calculated as the risk of the post-transition plant minus the risk of a compliant plant that not only removes all VFDRs from the PRA model but also credits the non-VFDR modifications. In the licensee's letter dated August 18, 2015 (Reference 28), the licensee provided the results of a sensitivity study, which estimated the new change in risk values caused by deleting a modification from the PRA while also implementing a recently accepted PRA methodology and some additional operator actions in the PRA. These values are summarized in SE Table 3.4.6-2.

Table 3.4.6-2: ∆CDF and ∆LERF for BFN from Transition to NFPA 805

		UNIT 1		**UNIT 2**		**UNIT 3**	
		CDF (/reactor-year)	**LERF (/reactor-year)**	**CDF (/reactor-year)**	**LERF (/reactor-year)**	**CDF (/reactor-year)**	**LERF (/reactor-year)**
Risk Increase from Unresolved VFDRs		2.36E-05	2.42E-06	3.29E-05	3.09E-06	3.19E-05	2.86E-06
Risk Decrease from Non-VFDR Modifications		-1.63E-04	-2.44E-05	-1.43E-04	-2.08E-05	-1.53E-04	-2.14E-05
Net Change-in-Risk from Transition		-1.39E-04	-2.20E-05	-1.10E-04	-1.77E-05	-1.21E-04	-1.85E-05

The reported change-in-risk values indicate that the licensee could achieve a large risk reduction by bringing the plant into deterministic compliance but has proposed, instead, to achieve an even larger risk reduction by implementing the selected non-VFDR modifications. The flexibility to select modifications based on risk in lieu of deterministic compliance is a central element of NFPA-805, and therefore, the NRC staff considers this an acceptable approach. Although the risk increase associated with the combined change request is greater than the acceptable risk increases in RG 1.174, the net change-in-risk is a substantial risk decrease compared to bringing the plant into deterministic compliance. Similar change-in-risk values are estimated for some individual fire areas, but depending on the unit, only five to ten of the 45 areas have a net positive risk increase.

The largest fire area risk increases are:

- 2.01E-07/reactor-year and 1.31E-07/reactor-year for Unit 1 CDF and LERF, respectively;
- 2.59E-07/reactor-year and 2.19E-07/reactor-year for Unit 2 CDF and LERF, respectively; and
- 9.90E-08/reactor-year and 1.33E-07/reactor-year for Unit 3 CDF and LERF, respectively.

Such estimates are well below the RG 1.174 acceptance guidelines. Based on the results of the licensee's fire risk assessments, the cumulative change-in-risk estimates for all fire areas subject to PB approaches, as detailed in the licensee's letter dated December 17, 2014 (Reference 24), are within the RG 1.174 risk acceptance guidelines. The licensee did not provide changes to the fire area risk results in its August 18, 2015, letter (Reference 28), therefore, the risk increases stated above are from the licensee's December 17, 2014, letter (Reference 24). In its August 18, 2015, letter the licensee indicated that the total risk results changed by a maximum of only a few percent.

The NRC staff concludes that the risk associated with the proposed alternatives to compliance with the deterministic criteria of NFPA 805 is acceptable and in accordance with NFPA 805, Section 2.4.4.1. The NRC staff also concludes that the licensee has satisfied RG 1.174, Section 2.4 and NUREG-0800, Section 19.2 regarding acceptable risk.

3.4.7 Uncertainty and Sensitivity Analyses

The licensee evaluated key sources of uncertainty and sensitivity in response to NRC RAIs.

In the LAR (Reference 8), the licensee used the updated fire bin frequencies provided in NUREG/CR-6850, Supplement 1 (Reference 54). In LAR Attachment V, as supplemented (Reference 24), the licensee provided the results of a sensitivity analysis using the fire ignition frequency values in NUREG/CR-6850 (Reference 53) for those ignition frequency bins having an alpha factor from Electric Power Research Institute Technical Report (EPRI TR)-1016735 (Reference 119) less than or equal to one. The sensitivity analysis is based on the FPRA after implementing a number of FPRA model and method refinements as described in the licensee's response to PRA RAI 24 (Reference 23) (Reference 24), to use methods accepted by the NRC. The NRC staff concludes that the risk results for the sensitivity analysis continue to meet the acceptance guidelines in RG 1.174, because the change in total CDF and total LERF is a net negative change, considering the contributions of retained VFDRs and plant changes as previously described.

In its response to PRA RAI 01.r.01.01 (Reference 26), the licensee reported on a sensitivity study to demonstrate that apportioning the frequency of junction box fire scenarios in PAU 25-1 and the CSR portion of PAU 16-A based on cable tray length instead of identifying the location of the junction boxes has an insignificant impact on the FPRA risk results with respect to both the transition and the self-approval risk acceptance guidelines. The NRC staff concludes that the current approach is acceptable for both transition and post-transition because the licensee demonstrated that the deviation from accepted guidance is negligible with respect to the acceptance guidelines.

In its letter dated August 18, 2015 (Reference 28), the licensee indicated that LAR Attachment S, Table S-2, Modification Item 93 would not be completed. The licensee stated that this modification, and its subsequent removal, primarily affected the LERF scenarios at the plant. The licensee performed a sensitivity analysis to evaluate the new LERF values using an additional RA instead of the modification. In addition to these changes to the FPRA, the LERF sensitivity analysis incorporated changes to the conditional probability values associated with spurious operation duration given in NUREG/CR-7150 (Reference 114), for alternating current (AC) and direct current (DC) control circuits. The acceptability of this guidance is discussed in a letter from the NRC to NEI dated April 23, 2014, "Supplemental Interim Technical Guidance on Fire-induced Circuit Failure Mode Likelihood Analysis" (Reference 120), and in Section 7 of NUREG/CR-7150, Volume 2. The licensee also estimated new CDF values by removing the modification, which resulted in a bounding estimate because the other two changes decrease risk. The NRC staff accepts the results of the sensitivity study as the best estimate available for the final risk values in support of the transition to NFPA 805 and has used these values in this SE. The NRC staff accepts a sensitivity study to support transition because all fire PRA models and methods will be included in the final re-evaluation of the risk and the net total change-in-risk results as described in LAR Attachment S, Table S-3, Implementation Items 32 and 33.

3.4.8 Conclusion for Section 3.4

Based on the information provided by the licensee in the LAR, as supplemented, regarding the fire risk assessment methods, tools, and assumptions used to support transition to NFPA 805, the NRC staff concludes that:

- The licensee's PRA used to perform the risk assessments in accordance with NFPA 805, Section 2.4.4, "Plant Change Evaluation," and Section 4.2.4.2, "Use of Fire Risk Evaluation," is of sufficient quality to transition to NFPA 805. The NRC staff concludes that the PRA approach, methods, tools, and data are acceptable in accordance with NFPA 805, Section 2.4.3.3.

- The licensee stated that it completed the changes to the baseline PRA model, which replaces unacceptable approaches, data, and methods identified during the LAR review with acceptable approaches, data, and methods as described. Therefore, the NRC staff concludes that the baseline PRA model may be used to support post-transition self-approval of FPP changes following completion of all implementation items because acceptable methods will be used until and unless replaced by other acceptable methods.

- LAR Attachment S, Table S-3, Implementation Items 32 and 33 state that the licensee will reevaluate the risk and the net total change-in-risk results after completion of all modifications, procedure updates, and training. If the RG 1.174 risk acceptance guidelines are exceeded after the reevaluation, the licensee will inform the NRC and perform additional analytical efforts, procedure changes, and/or plant modifications to assure the risk acceptance guidelines are met.

- The licensee's PRA maintenance process is adequate to support self-approval of future RI changes to the FPP.

- The transition process included a detailed review of fire protection DID and safety margin as required by NFPA 805. The NRC staff concludes that the licensee's evaluation of DID and safety margin is acceptable. The licensee's process followed the NRC-endorsed guidance in NEI 04-02, Revision 2 and is consistent with the approved NRC staff guidance in RG 1.205, Revision 1, which provides an acceptable approach for meeting the requirements of 10 CFR 50.48(c).

- The changes in risk (i.e., ΔCDF and ΔLERF) associated with the proposed alternatives to compliance with the deterministic criteria of NFPA 805 (FREs) are acceptable, and the licensee has satisfied the guidance contained in RG 1.205, Revision 1; RG 1.174, Section 2.4; and NUREG-0800, Section 19.2, regarding acceptable risk. By meeting the guidance contained in these approved documents, the NRC staff has concluded that the changes in risk are acceptable and meet the requirements of NFPA 805.

- The risk presented by the use of RAs is in accordance with NFPA 805, Section 4.2.4 and the guidance contained in RG 1.205, Revision 1. The NRC staff concludes that the additional risk associated with the NFPA 805 RAs is acceptable because the risk for each fire area that relies on a RA is below the acceptance guidelines in RG 1.174, and therefore, meets the acceptance criteria in RG 1.205, Revision 1.

- The licensee did not utilize any RI or PB alternatives to compliance to NFPA 805, which fall under the requirements of 10 CFR 50.48(c)(4).

- The licensee's application to transition to NFPA 805 is a combined change as defined by RG 1.205, Revision 1, which combines risk increases identified in the FREs with risk decreases resulting from non-VFDR modifications; the licensee has separately reported the increases and decreases as described in RG 1.174. Based on the combination of these risk values, the changes associated with NFPA 805 meet the guidance contained in RG 1.205, RP 3.2.5 related to meeting the requirements for cumulative risk and combined plant changes.

3.5 Nuclear Safety Capability Assessment Results

NFPA 805 (Reference 3), Section 2.2.3, "Evaluating Performance Criteria," states:

> To determine whether plant design will satisfy the appropriate performance criteria, an analysis shall be performed on a fire area basis, given the potential fire exposures and damage thresholds, using either a deterministic or performance-based approach.

NFPA 805, Section 2.2.4, “Performance Criteria,” states:

> The performance criteria for nuclear safety, radioactive release, life safety, and property damage/business interruption covered by this standard are listed in Section 1.5 and shall be examined on a fire area basis.

NFPA 805, Section 2.2.7, “Existing Engineering Equivalency Evaluations,” states:

> When applying a deterministic approach, the user shall be permitted to demonstrate compliance with specific deterministic fire protection design requirements in Chapter 4 for existing configurations with an engineering equivalency evaluation. These existing engineering evaluations shall clearly demonstrate an equivalent level of fire protection compared to the deterministic requirements.

3.5.1 Nuclear Safety Capability Assessment Results by Fire Area

NFPA 805, Section 2.4.2, “Nuclear Safety Capability Assessment,” states:

> The purpose of this section is to define the methodology for performing a nuclear safety capability assessment. The following steps shall be performed:
>
> (1) Selection of systems and equipment and their interrelationships necessary to achieve the nuclear safety performance criteria in Chapter 1
>
> (2) Selection of cables necessary to achieve the nuclear safety performance criteria in Chapter 1
>
> (3) Identification of the location of nuclear safety equipment and cables
>
> (4) Assessment of the ability to achieve the nuclear safety performance criteria given a fire in each fire area

This safety evaluation (SE) section addresses the last topic regarding the ability of each fire area to meet the nuclear safety performance criteria (NSPC) of NFPA 805. SE Section 3.2.1 addresses the first three topics.

NFPA 805, Section 2.4.2.4, “Fire Area Assessment,” also states:

> An engineering analysis shall be performed in accordance with the requirements of Section 2.3 for each fire area to determine the effects of fire or fire suppression activities on the ability to achieve the nuclear safety performance criteria of Section 1.5.

In accordance with the above, the process defined in NFPA 805, Chapter 4 provides a framework to select either a deterministic or a performance-based (PB) approach to meet the NSPC. Within each of these approaches, additional requirements and guidance provide the information necessary for the licensee to perform the engineering analyses necessary to determine which fire protection systems and features are required to meet the NSPC of NFPA 805.

NFPA 805, Section 4.2.2, “Selection of Approach,” states:

> For each fire area either a deterministic or performance-based approach shall be selected in accordance with Figure 4.2.2. Either approach shall be deemed to satisfy the nuclear safety performance criteria. The performance-based approach shall be permitted to utilize deterministic methods for simplifying assumptions within the fire area.

This SE section evaluates the approach used to meet the NSPC on a fire area basis, as well as what fire protection features and systems are required to meet the NSPC.

The NRC staff reviewed license amendment request (LAR) (Reference 8) Section 4.2.4, “Fire Area Transition”; LAR Section 4.8.1, “Results of the Fire Area Review”; LAR Attachment C; LAR Attachment G; LAR Attachment S; and LAR Attachment W, during its evaluation of the ability of each fire area to meet the NSPC of NFPA 805.

Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) is a three unit boiling water reactor (BWR) with 45 individual fire areas including the Yard (which includes external areas, Off Gas Building and Off Gas Stack, Standby Gas Treatment Building, Cooling Towers, and Diesel Fire Pump Building), and each fire area is composed of one or more fire zones. Based on the information provided by the licensee in the LAR, as supplemented, the licensee performed the NSCA on a fire area basis. LAR Attachment C provides the results of these analyses on a fire area basis and also identified the fire zones within the fire areas.

SE Table 3.5.1 identifies those fire areas that were analyzed using either the deterministic or PB approach in accordance with NFPA 805, Chapter 4 based on the information provided in LAR Attachment C, Table B-3, “Fire Area Transition.”

Table 3.5-1: Fire Areas and Compliance Strategy Summary

		NFPA 805 Compliance		
Fire Area	**Description**	**U1 Compliance**	**U2 Compliance**	**U3 Compliance**
01-01	Unit 1, RB EL 519'-565', from R1 to a line 10' east of R4	Performance Based	Performance Based	Performance Based
01-02	Unit 1, RB EL 519'-565', from R7 to a line 10' west of R4, and the Elevator/Stairwell enclosure EL 593'-664	Performance Based	Performance Based	Performance Based
01-03	Unit 1, RB EL 593', north of column line R	Performance Based	Performance Based	Performance Based
01-04	Unit 1, RB EL 593', south of column line Q and EL 565'-593' RHR HX Rooms	Performance Based	Performance Based	Performance Based
01-05	Unit 1, RB EL 621', EL 639' north of column line R, and the stairwell enclosure EL 664'	Performance Based	Performance Based	Performance Based
01-06	Unit 1, RB EL 639' south of column line R and the stairwell enclosure EL 664'	Performance Based	Performance Based	Performance Based
02-01	Unit 2, RB EL 519'-565', from R8 to a line 10' east of R11	Performance Based	Performance Based	Performance Based
02-02	Unit 2, RB EL 519'-565', from R14 to a line 10' west of R11	Performance Based	Performance Based	Performance Based
02-03	Unit 2, RB EL 593', north of column line R	Performance Based	Performance Based	Performance Based
02-04	Unit 2, RB EL 593', south of column line Q and EL 565'-593' RHR HX Rooms	Performance Based	Performance Based	Performance Based
02-05	Unit 2, RB EL 621', EL 639' north of column line R, and the stairwell enclosure EL 664'	Performance Based	Performance Based	Performance Based
02-06	Unit 2, RB EL 639', south of column line R	Performance Based	Performance Based	Performance Based
03-01	Unit 3, RB EL 519'-565', from R15 to a line 10' east of R18, RB EL 639', south of column line R, and the Elevator/Stairwell enclosures EL 593', 621' and 664'	Performance Based	Performance Based	Performance Based
03-02	Unit 3, RB EL 519'-565', from R21 to a line 10' west of R18	Performance Based	Performance Based	Performance Based
03-03	Unit 3, RB EL 593' and EL 565'-593' RHR HX Rooms	Performance Based	Performance Based	Performance Based
03-04	Unit 3, RB EL 621', EL 639' north of column line R, and the stairwell enclosure EL 664'	Performance Based	Performance Based	Performance Based
4	Unit 1, Electrical Board Room 1B EL 593'	Performance Based	Performance Based	Performance Based
5	Unit 1, Electrical Board Room 1A and 250V Battery Rooms EL 621'	Performance Based	Performance Based	Performance Based

6	Unit 1, 480V Board Room 1A EL 621'	Performance Based	Performance Based	Performance Based
7	Unit 1, 480V Board Room 1B EL 621'	Performance Based	Performance Based	Performance Based
8	Unit 2, Electrical Board Room 2B EL 593'	Performance Based	Performance Based	Performance Based
9	Unit 2, Electrical Board Room 2A and 250V Battery Rooms EL 621'	Performance Based	Performance Based	Performance Based
10	Unit 2, 480V Board Room 2A EL 621'	Performance Based	Performance Based	Performance Based
11	Unit 2, 480V Board Room 2B EL 621'	Performance Based	Performance Based	Performance Based
12	Unit 3, Electrical Board Room 3B EL 593'	Performance Based	Performance Based	Performance Based
13	Unit 3, Electrical Board Room 3A EL 621'	Performance Based	Performance Based	Performance Based
14	Unit 3, 480V Board Room 3A EL 621'	Performance Based	Performance Based	Performance Based
15	Unit 3, 480V Board Room 3B EL 621'	Performance Based	Performance Based	Performance Based
16	Control Building EL 593', 606', 617' and 635'	Performance Based	Performance Based	Performance Based
17	Unit 1, Battery and Battery Board Room, Control Building EL 593'	Performance Based	Performance Based	Performance Based
18	Unit 2, Battery and Battery Board Room, Control Building EL 593'	Performance Based	Performance Based	Performance Based
19	Unit 3, Battery and Battery Board Room, Control Building EL 593'	Performance Based	Performance Based	Performance Based
20	Unit 1,2 Diesel Generator Building EL 565'-583'	Performance Based	Performance Based	Performance Based
21	Unit 3 Diesel Generator Building EL 565'-583'	Performance Based	Performance Based	Performance Based
22	Unit 3, 4 kV Shutdown Board Rooms 3EA & 3EB and Mechanical Equipment Room 'A' EL 565'-595'	Performance Based	Performance Based	Performance Based
23	Unit 3, 4 kV Shutdown Board Rooms 3EC & 3ED and Mechanical Equipment Room 'B' EL 565'-595'	Performance Based	Performance Based	Performance Based
24	Unit 3, 4 kV Bus Tie Board Room, Diesel Generator Building EL 565'	Deterministic Based	Deterministic Based	Performance Based
25-01	EL 550' of the Intake Pumping Station (IPS), EL 565' CCW Pump Deck, RHRSW Compartments B and D, and the EL 550' Cable Tunnel to Fire Door 440	Performance Based	Performance Based	Performance Based
25-02	IPS RHRSW Compartment A EL 565'	Deterministic Based	Deterministic Based	Performance Based
25-03	IPS RHRSW Compartment C EL 565'	Deterministic Based	Deterministic Based	Performance Based
26	Turbine Building (all elevations) - Including EL 546'-595' Radwaste, EL 565' East Access Facility, EL 682' TB	Performance Based	Performance Based	Performance Based

	Roof, EL 550' Pipe Tunnel, EL 565' Main Steam Valve Vaults and the EL 550' Cable Tunnel to Door 440			
27	Unit 1, 2 “A” and “B” Chillers EL 595'	Performance Based	Performance Based	Performance Based
Refuel	RB Refueling floor EL 664', RB pools EL 621'-664', Control Bay Vent Towers EL 639'-734', and RB Roof EL 717'	Performance Based	Performance Based	Performance Based
Switch	161 kV and 500 kV Switchyard	Deterministic Based	Deterministic Based	Deterministic Based
Yard	External Areas (excluding Switch)	Performance Based	Performance Based	Performance Based

LAR Attachment C provides the results of these analyses on a fire area basis. For each fire area, the licensee documented the following:

- The approach used in accordance with NFPA 805 (i.e., the deterministic approach in accordance with NFPA 805, Section 4.2.3 or the PB approach in accordance with NFPA 805, Section 4.2.4);
- The structures, systems, and components (SSCs) required in order to meet the NSPC;
- Fire Protection Systems and Features required to meet the NSPC;
- An evaluation of the effects of fire suppression activities on the ability to achieve the NSPC; and
- The disposition of each variance from deterministic requirement (VFDR) using either modifications (completed or committed) or the performance of an fire risk evaluation (FRE) in accordance with NFPA 805, Section 4.2.4.2.

3.5.1.1 Fire Detection and Suppression Systems Required to Meet the NSPC

A primary purpose of NFPA 805, Chapter 4 is to determine, by analysis, what fire protection features and systems need to be credited to meet the NSPC. Four sections of NFPA 805, Chapter 3 have requirements dependent upon the results of the engineering analyses performed in accordance with NFPA 805, Chapter 4: They are as follows: (1) fire detection systems, in accordance with Section 3.8.2; (2) automatic water-based fire suppression systems, in accordance with Section 3.9.1; (3) gaseous fire suppression systems, in accordance with Section 3.10.1; and (4) passive fire protection features in accordance with Section 3.11. The features/systems addressed in these sections are only required when the analyses performed in accordance with NFPA 805, Chapter 4 indicate the features and systems are required to meet the NSPC.

The licensee performed a detailed analysis of fire protection features and identified the fire suppression and detection systems required to meet the NSPC for each fire area. LAR Attachment C, Table C-2, “NFPA 805 Required Fire Protection Systems, and Features,” lists the fire areas and identifies the fire suppression and detection systems installed in these areas as required to meet criteria for separation, defense-in-depth (DID), risk, licensing actions, or existing engineering equivalency evaluations (EEEEs).

The NRC staff reviewed each fire area in LAR Attachment C to ensure the fire detection and suppression systems met the principles of DID in regard to the planned transition to NFPA 805. The NRC staff concludes that the licensee has adequately identified the fire detection and suppression systems and fire protection features required to meet the NFPA 805 NSPC on a fire area basis.

3.5.1.2 Evaluation of Fire Suppression Activities Effects on Nuclear Safety Performance Criteria

Each fire area of LAR Attachment C includes a discussion of how the licensee met the requirement to evaluate the fire suppression effects on the ability to meet the NSPC.

The licensee indicated that for each fire area, damage to plant areas and equipment from the water release as a result of automatic fire protection systems or manual firefighting will not damage redundant trains of SSD equipment. The licensee further indicated that if redundant equipment could be damaged, then alternative shutdown capability is provided, and therefore, fire suppression activities will not adversely affect achievement of the NSPC.

The NRC staff concludes that the licensee's evaluation of the suppression effects on the NSPC is acceptable because the licensee evaluated the fire suppression effects on meeting the NSPC and determined that fire suppression activities will not adversely affect achievement of the NSPC.

3.5.1.3 Licensing Actions

Based on the information provided in the LAR Attachment C, as supplemented, the licensee identified exemptions from the deterministic requirements for each fire area that were previously approved by the NRC and that will be transitioned with the NFPA 805 FPP. Each of these exemptions is summarized in LAR Attachment C on fire area basis and described in further detail in LAR Attachment K.

The licensee does not have any elements of the current fire protection program (FPP) for which NRC clarification is needed. The licensing actions being transitioned are summarized in Table 3.5-2.

Table 3.5-2 Previously Approved Licensing Actions Being Transitioned

Licensing Action Description	**Applicable Fire Areas**	**NRC Staff Evaluation**
Appendix R Exemption from Automatic Fire Suppression Systems in the residual heat removal (RHR) Pump/Heat Exchanger Rooms (III.G.2.b Criteria)	RB Unit 1 01-01, 01-02, 01-04 RB Unit 2 02-01, 02-02, 02-04 RB Unit 3 03-01, 03-02, 03-03	As described in LAR Attachment K, the basis for approval is: 1. The RHR pump rooms and heat exchanger rooms are constructed of reinforced concrete. 2. Open metal grating exists at elevations 541 and 565 feet of the RHR pump rooms, which will permit some heat to dissipate to the 621 foot elevation where the volume of space is large relative to the volume and fire load of the RHR pump rooms. 3. The distance between the unprotected openings of the two RHR pump rooms for each unit is about 70 feet with no significant intervening combustibles. 4. Fire protection coverage for the RHR pump and heat exchanger rooms is in the form of hose stations and portable fire extinguishers. 5. The licensee committed to provide cross-zoned fire detectors on the ceilings of the RHR pump rooms. 6. The licensee installed a water curtain and draft stop to separate the RHR heat exchanger rooms and the fire zone on elevation 593 feet. 7. The general area at elevation 593 feet is protected by fire detection and automatic fire suppression systems. 8. One of the RHR pump rooms for each unit is adjacent to a high pressure coolant injection system room, which has automatic fire suppression and detection systems that protect the lube oil tank fire hazards located there. Based on the previous staff approval of this exemption in a safety evaluation report (SER) dated 10/21/1988 (Reference 121), and the justification provided by the licensee for the continued validity of the basis of the prior NRC staff approval, the NRC staff concludes that this licensing action is acceptable.
Appendix R Exemption from Intervening Combustibles within a	RB Unit 1 01-01, 01-02, 01-03, 01-04, 01-05, 01-06	There are two exemptions related to 20-foot separation in the Reactor Building. Exemption 1 was approved on 10/21/1988

20-Foot Separation Space Between Redundant Safe Shutdown System Components in the Reactor Building (III.G.2.b Criteria)	RB Unit 2 02-01, 02-02, 02-03, 02-04, 02-05, 02-06 RB Unit 3 03-01, 03-02, 03-03, 03-04	(Reference 121). Exemption 2, which supplements, but does not supersede Exemption Request 1, was approved on 3/29/2007 (Reference 91). As described in LAR Attachment K, the basis for approval for Exemption 1 is: 1. The locations within the reactor buildings having less than 20 foot separation with intervening combustibles between redundant safe shutdown trains have no other in-situ fire hazards or fire loads except for the cable insulation. 2. The cables and trays have been liberally coated with flamastic. 3. The licensee committed that any new cable additions to the trays will conform to the fire resistance properties of Institute of Electrical and Electronics Engineers (IEEE) Standard 383. 4. The reactor buildings are constructed of reinforced concrete and the ceilings are 20 to 30 feet high. 5. Area wide fire detection and sprinkler systems are available coupled with local supplemental sprinkler coverage and manual extinguishers and hose stations are provided to protect the intervening cables in the affected areas. 6. Where sprinkler system coverage does not exist, the licensee committed to provide additional sprinklers as necessary and to provide additional sprinkler coverage to mitigate the effects of a floor level and transient exposure fire. 7. There is no significant fire loading on the floor except for the possibility of a transient exposure fire. Exemption 2, which was issued to allow intervening combustibles in the 20-foot separation zone and was a revision to Exemption 1, because it was identified that the 20-foot separation zone included combustibles that were not specifically addressed in Exemption 1. As described in LAR Attachment K, the basis for approval for Exemption 2 is: 1. The FM performed by the licensee provides

		reasonable assurance that redundant safe-shutdown trains will be maintained free of fire damage because the estimated heat flux from the maximum exposure fire is less than the critical heat flux for ignition for non-qualified IEEE-383 cable or Thermo-Lag 330-1 electrical raceway fire barrier (ERFB) material. 2. In the event of a postulated fire in the Units 1, 2, and 3 reactor buildings, all units can safely shut down using the alternate shutdown panel located outside each reactor building. 3. A significant fire is unlikely due to control of transient combustibles near the redundant trains. 4. Reactor building volume and height would dissipate heat from a cabinet fire and not threaten redundant trains. 5. All electrical cabinets in the area of concern are enclosed with no ventilation openings. 6. A fire originating in a low voltage cabinet exposing intervening combustibles/targets (cable trays located at radial distance of approximately 7 feet, conduits located at the bottom of the duct approximately 9 feet above the top of the cabinet (17 feet above floor), and Thermo-Lag 330-1 wrapped conduit located approximately 7 feet from the edge of the cabinet) would be slow to develop. 8. The licensee indicated that all fire zones discussed previously are protected with fire detection and automatic pre-action sprinkler systems, manual fire extinguishers, and hose stations. Based on the previous staff approval of these exemptions in SERs dated 10/21/1988 (Reference 121), and 03/29/2007 (Reference 91), and the justification provided by the licensee for the continued validity of the basis of the prior NRC staff approval, the NRC staff concludes that these licensing actions are acceptable.

In fire protection engineering (FPE) request for additional information (RAI) 08 (Reference 31), the NRC staff requested that the licensee provide clarification with regard to the scope of transitioning exemption request in LAR Attachment K, “Appendix R Exemption from Automatic Fire Suppression Systems in the RHR Pump/Heat Exchanger Rooms.” Specifically, the draft stop was described as part of the original exemption and appeared not to be included as a fire protection feature in LAR Attachment C, Table C-2. In its response to FPE RAI 08 (Reference 13), the licensee stated that it considered the draft stop to be part of the water curtain, and therefore, did not include the draft stop as a separate item. The licensee further stated that to be consistent, LAR Attachment C, Tables C-1 and C-2 will be updated to reflect draft stops as well as water curtains. The licensee included revised pages of the appropriate LAR Tables C-1 and C-2 in its letter. The licensee further stated that the credited water curtains and draft stops associated with the RHR exemptions are located in Fire Areas 01-01, 01-02, 01-04, 02-01, 02-02, 02-04, 03-01, 03-02, and 03-03 and that there are no other locations where water curtains and draft stops are credited to meet NFPA 805 requirements. The NRC staff concludes that the licensee’s response to the RAI is acceptable because the licensee provided sufficient and appropriate changes to the LAR Attachment C, Tables C-1 and C-2.

The NRC staff reviewed the exemptions presented in LAR Attachment K from the pre-NFPA 805 licensing basis identified in SE Table 3.5-2, including the description of the previously approved exemption from the deterministic requirements, the basis for continuing validity of the exemption, and the NRC staff’s original evaluation or basis for approval of the exemption (Reference 121) and (Reference 91). The licensee stated that in each licensing action listed in LAR Attachment K, the review of these existing licensing actions included a determination of the basis of acceptability and a determination that the basis of acceptability was still valid.

The NRC staff concludes that the licensing actions are identified by applicable fire area and remain valid to support the proposed license amendment because the licensee utilized the process described in NEI 04-02 (Reference 7) as endorsed by RG 1.205 (Reference 4), which requires a determination of the basis of acceptability and a determination that the basis is still valid.

The NRC staff concludes that the engineering evaluations that form the basis for acceptability of the exemptions being carried forward supporting the NFPA 805 transition, as identified in SE Table 3.5-2, are acceptable because the licensee provided justification for the continued validity of the basis of the prior NRC staff approval. See SE Section 2.5 for further discussion.

Since the exemptions are either compliant with 10 CFR 50.48(c) or no longer necessary, the licensee requested that the exemptions listed in LAR Attachment K be rescinded as part of the LAR process. The rescinded exemptions are included in LAR Attachment O. See SE Section 2.5 for further discussion.

The licensee does not have any elements of the current FPP for which NRC clarification is needed.

3.5.1.4 Existing Engineering Equivalency Evaluations

The EEEEs that support compliance with NFPA 805, Chapter 4 were reviewed by the licensee using the methodology contained in NEI 04-02. The methodology for performing the EEEE review included the following determinations:

- The EEEE is not based solely on quantitative risk evaluations,
- The EEEE is an appropriate use of an engineering equivalency evaluation,
- The EEEE is of appropriate quality,
- The standard license condition is met,
- The EEEE is technically adequate,
- The EEEE reflects the plant as-built condition, and
- The basis for acceptability of the EEEE remains valid.

In LAR Section 4.2.2, the licensee stated that the guidance in RG 1.205, RP 2.3.2, and FAQ 07-0054 (FAQ 08-0054 - (Reference 80)) was followed and EEEEs that demonstrate a fire protection system or feature is "adequate for the hazard" are to be addressed in the LAR as follows:

- If not requesting specific approval for an "adequate for the hazard" EEEE, then the EEEE is referenced where required and a brief description of the evaluated condition is provided.

- If requesting specific NRC approval for an "adequate for the hazard" EEEE, then the EEEE is referenced where required to demonstrate compliance and is included in LAR Attachment L for NRC review and approval.

The licensee identified and summarized the EEEEs for each fire area in LAR Attachment C, as applicable. The licensee did not request the NRC staff to review and approve any of these EEEEs.

Based on the NRC staff's review of the licensee's methodology for review of EEEEs and identification of the applicable EEEEs in LAR Attachment C, the NRC staff concludes that the licensee's use of EEEEs is acceptable because the process meets the requirements of NFPA 805 and the guidance of RG 1.205 and FAQ 08-0054.

3.5.1.5 Variances from Deterministic Requirements

For those fire areas where deterministic criteria were not met, VFDRs were identified and evaluated using PB methods. VFDR identification, characterization, and resolutions were identified and summarized in LAR Attachment C for each fire area. Documented variances were all represented as separation issues. The following strategies were used by the licensee in resolving the VFDRs:

- An FRE determined that applicable risk, DID, and safety margin criteria were satisfied without further action;

- An FRE determined that applicable risk, DID, and safety margin criteria were satisfied with a credited RA;

- An FRE determined that applicable risk, DID, and safety margin criteria were satisfied with a DID-RA; or

- An FRE determined that applicable risk, DID, and safety margin criteria were satisfied with a plant modification(s) as identified in LAR, as supplemented.

For all fire areas where the licensee used the PB approach to meet the NSPC, each VFDR and the associated disposition has been described in LAR Attachment C. Based on the NRC staff review of the VFDRs and associated resolutions as described in LAR Attachment C, as supplemented, the NRC staff concludes that the licensee's identification and resolution of the VFDRs is acceptable because the licensee identified, characterized, and resolved all VFDRs as summarized in LAR Attachment C for each fire area.

3.5.1.6 Recovery Actions

LAR Attachment G lists the RAs identified in the resolution of VFDRs in LAR Attachment C for each fire area. The RAs identified include both actions considered necessary to meet risk acceptance criteria, as well as actions relied upon as DID (see SE Section 3.5.1.7 below). While most RAs are listed against a specific VFDR in LAR Attachment G, Table G-1, some RAs provide a risk reduction for the fire area and are not associated with a particular VFDR. These RAs are designated as "Fire PRA Risk Action" in LAR Attachment G, Table G-1.

The licensee stated in LAR Attachment G that the set of RAs necessary to demonstrate the availability of a success path for the NSPC (i.e., Risk-RAs listed against a VFDR) listed in LAR Attachment G, Table G-1 were evaluated for additional risk using the process described in NEI 04-02, FAQ 07-0030, and RG 1.205 and compared against the guidelines of RG 1.174 and RG 1.205. The NRC staff's evaluation of the licensee's process for identifying RAs and assessing their feasibility is provided in SE Section 3.2.5, "Establishing Recovery Actions." The NRC staff's evaluation of the additional risk of RAs credited to meet the risk acceptance guidelines is provided in SE Section 3.4.4 which concluded that the licensee's methods for evaluating the additional risk are acceptable because they are consistent with RG 1.205, Section 2.2.4.1 and FAQ 07-0030 and that the licensee reported a net total risk decrease for transition to NFPA 805, and therefore, the additional risk of RAs reported by the licensee is consistent with RG 1.205, RP 2.2.4.2 and is acceptable.

3.5.1.7 Recovery Actions Credited for Defense-in-Depth

On a fire area basis, all VFDRs were identified in the LAR Attachment C, Table C-1. Each VFDR not brought into compliance with the deterministic approach was evaluated using the PB approach of NFPA 805, Section 4.2.4. For most fire areas, the PB evaluations resulted in the need for RAs to meet the risk acceptance criteria or maintain a sufficient level of DID. The licensee identified RAs relied upon for DID and listed those in LAR Attachment G, Table G-1.

The nuclear safety and radioactive release performance goals, objectives, and criteria of NFPA 805, including the risk acceptance guidelines, are met without these actions. However, RAs required for DID are retained to meet the requirements to maintain a sufficient level of DID and are, therefore, considered part of the RI/PB FPP, which necessitates that these actions would be subject to a PCE if subsequently modified or removed.

The licensee indicated in LAR Attachment G that each of the feasibility criteria in FAQ 07-0030 were assessed for the RAs listed in LAR Attachment G, Table G-1 and that each action identified in LAR Attachment G, Table G-1 is feasible.

The NRC staff reviewed LAR Section 4.2.1.3, “Establishing Recovery Actions,” and LAR Attachment G to evaluate whether the licensee meets the associated requirements for the use of RAs per NFPA 805. The NRC staff’s evaluation of the licensee’s process for identifying RAs and assessing their feasibility is provided in SE Section 3.2.5, “Establishing Recovery Actions,” and concluded that the licensee followed the endorsed guidance of NEI 04-02 and RG 1.205 to identify and evaluate RAs in accordance with NFPA 805, and that the feasibility criteria applied to RAs are acceptable because the criteria conforms with the endorsed guidance contained in NEI 04-02 and because the licensee will be in compliance with the regulation upon completion of implementation items that are required by the proposed license condition.

3.5.1.8 Plant Fire Barriers and Separations

With the exception of ERFBS, passive fire protection features include the fire barriers used to form fire area boundaries (and barriers separating SSD trains) that were established in accordance with the plant’s pre-NFPA 805 deterministic FPP. For the transition to NFPA 805, the licensee decided to retain the previously established fire area boundaries as part of the RI/PB FPP.

Fire area boundaries are established for those areas described in LAR Attachment C, as modified by applicable EEEEs that determine the barriers are adequate for the hazard or otherwise disposition differences in barrier design and performance from applicable criteria. The acceptability of fire barriers and separations is also evaluated as part of the NRC staff’s review of LAR Attachment A, Table B-1 process and as such are addressed in SE Section 3.1.

3.5.1.9 Electrical Raceway Fire Barrier Systems

The licensee stated that the ERFBS used at BFN comply with the deterministic requirements of NFPA 805, Chapter 3, Section 3.11.5 using EEEEs. Each fire area using ERFBS is identified in LAR Attachment C. In fire areas with PB compliance, the ERFBS were analyzed using the PB approach in accordance with NFPA 805, Section 4.2.4. Each PB fire area utilizing ERFBS, as identified in LAR Attachment C, included a discussion of any VFDR analysis used to evaluate the acceptability of this feature.

In FPE RAI 05 (Reference 31) the NRC staff noted that LAR Attachment V, “Fire PRA Quality,” Section V.2.5 stated that some 1-hour rated ERFBS was to be evaluated as “adequate for the hazard” where automatic sprinklers were not installed. Specifically, the NRC staff requested that the licensee provide additional information and clarification with regard to the compliance strategy for these sections of ERFBS. In its response to FPE RAI 05 (Reference 12) (Reference 24), the licensee stated that there are four locations involving 1-hour ERFBS (FA 12, 13, 21, and 23) and that it has reconsidered the use of EEEEs for this application and decided not to disposition 1-hour ERFBS without automatic suppression as adequate for the hazard. The licensee further stated that the current plan for these applications is to install 1-hour ERFBS and to resolve the VFDRs using the FRE process. There are VFDRs identified in the RAI tracking the resolution of this issue.

The licensee further stated that separation issues and resolutions that involve ERFBS are documented in the FREs for each fire area and that LAR Attachment C, Table C-2 identifies that credit will be taken for a modification to install ERFBS as a fire protection feature and identifies resolution by denoting the ERFBS modification as "Separation" or "Risk." The licensee submitted changes to the affected sections in LAR Attachment V to reflect this change in compliance strategy. Revisions to LAR Attachment V are further reviewed in SE Section 3.4. The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee decided to install 1-hour ERFBS and to resolve the VFDRs using the FRE process and because the licensee included these actions in LAR Attachment S, Table S-2, modifications 14, 17, and 91, which are required by the proposed license condition. In a letter dated June 19, 2015 (Reference 27), the licensee stated it had completed the installation of modifications 14 and 17 and deleted them from LAR Attachment S, Table S-2.

3.5.1.10 Conclusion for Section 3.5.1

As documented in LAR Attachment C, for those fire areas that used a deterministic approach in accordance with NFPA 805, Section 4.2.3, the NRC staff concludes that each of the fire areas analyzed using the deterministic approach meet the associated criteria of NFPA 805, Section 4.2.3. This conclusion is based on:

- The licensee's documented compliance with NFPA 805, Section 4.2.3;
- The licensee's assertion that the success path will be free of fire damage without reliance on RAs;
- The licensee's assessment that the suppression systems in the fire area will have no impact on the ability to meet the NSPC; and
- The licensee's appropriate determination of the automatic fire suppression and detection systems required to meet the NSPC.

For those fire areas that used the PB approach in accordance with NFPA 805, Section 4.2.4, the NRC staff concludes that each fire area has been properly analyzed, and compliance with the NFPA 805 requirements demonstrated as follows:

- Exemptions from the pre-NFPA 805 fire protection licensing basis that were transitioned to the NFPA 805 licensing basis were reviewed for applicability, as well as continued validity, and found acceptable.
- VFDRs were evaluated and either found to be acceptable based on an integrated assessment of risk, DID, and safety margins, or modifications or RAs were identified and actions planned or implemented to address the issue.
- RAs used to demonstrate the availability of a success path to achieve the NSPC were evaluated and the additional risk of their use determined, reported, and found to be acceptable.

- The licensee's analysis appropriately identified the fire protection SSCs required to meet the NSPC, including fire suppression and detection systems.

- Fire area boundaries (ceilings, walls, and floors) such as fire barriers, fire barrier penetrations, and through penetration fire stops were found to be acceptable.

- ERFBS credited were documented on a fire area basis, verified to be installed consistent with tested configurations and rated accordingly. ERFBS not deterministically compliant were evaluated using an FRE that demonstrated the ability to meet the applicable acceptance criteria for risk, DID, and safety margins.

Accordingly, the NRC staff concludes that each fire area utilizing the deterministic or PB approach meets the applicable requirements of NFPA 805, Section 4.2.

3.5.2 Clarification of Prior NRC Approvals

As stated in LAR Attachment T, "Clarification of NRC Prior Approvals," there are no elements of the current FPP for which NRC clarification is needed.

3.5.3 Fire Protection During Non-Power Operational Modes

NFPA 805, Section 1.1, "Scope," states:

> This standard specifies the minimum fire protection requirements for existing light water nuclear power plants during all phases of plant operation, including shutdown, degraded conditions, and decommissioning.

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

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

The NRC staff reviewed LAR Section 4.3, "Non-Power Operational Modes," and LAR Attachment D, "NEI 04-02 Non-Power Operational Modes Transition," to evaluate the licensee's treatment of potential fire impacts during non-power operational modes. The licensee used the process described in NEI 04-02, as modified by FAQ 07-0040 (Reference 76), for demonstrating that the NSPC are met for higher risk evolutions (HREs) during non-power operations (NPOs) modes.

3.5.3.1 NPO Strategy and Plant Operating States

In LAR Section 4.3 and LAR Attachment D, the licensee stated that the process used to demonstrate that the NSPC are met during NPO modes is consistent with the guidance contained in FAQ 07-0040. As described in LAR Attachment D, the normal FPP DID actions are credited for addressing the risk impact of those fires that potentially impact one or more trains of equipment that provide a key safety function (KSF) required during NPOs but would not be expected to cause the total loss of that KSF. HREs are outage activities, plant configurations, or conditions during shutdown where the plant is more susceptible to an event causing the loss of a KSF. The strategy contains specific actions to address reduced inventory conditions that consider short time to boil, limited methods for decay heat removal, and low reactor coolant system inventory.

As described in LAR Section 4.3.2, components were identified for each unit to accomplish the KSFs of Decay Heat Removal; Inventory Control including Operations, which have the Potential for Draining the Reactor Vessel Isolation; and Power Availability. The selection of equipment was further subdivided based on consideration of KSF success paths. The selected components were logically combined using analysis software to allow fire separation analysis to identify pinch points within a fire area. For those components not already in the database or which had a different functional state for NPOs from that in the SSA, cable selection and routing was performed using the same methodology as the nuclear safety capabilities assessment (LAR Section 4.2.1.1 and LAR Attachment B). The resulting information was entered into the database and the fire separation analysis was performed.

In SSA RAI 08 (Reference 31) the NRC staff requested that the licensee describe changes to outage management procedures, risk management tools, and any other documents resulting from incorporation of KSFs identified as part of NFPA 805 transition for NPO for high risk periods. The NRC staff requested that the licensee include changes to any administrative procedures such as control of combustibles, hot work, fire system operability, staffing, and ignition sources, and to address the MCR NPO analysis. In its response to SSA RAI 08 (Reference 11), the licensee stated that as part of the NFPA 805 amendment implementation, it will revise fleet level shutdown risk management procedures and associated site-specific procedures for managing risk during NPOs and that these documents will provide departments and organizations that plan outage related work with shutdown and risk management guidance that include:

- Definition and criteria for specifying HREs.

- Identification of KSFs affected by fire damage or removal of credited equipment from service.

- Proposed options to reduce fire risk in those locations where fire can result in loss of one or more KSFs during HREs. These would include:

    — Pre-positioning of a component during HREs to ensure the component is in its required position for NPO KSF success (this may also require power disabling the component to prevent spurious operation once it is placed in its desired position).
    — Restriction of hot work in areas during periods of increased vulnerability.
    — Restriction of combustible loading.
    — Restriction of transient combustible materials in areas during periods of increased vulnerability.

— Provision of additional fire rounds at periodic intervals or other appropriate compensatory measures (such as surveillance cameras during increased vulnerability).
— Reschedule the work to a period with a lower risk or higher DID.
— Housekeeping.
— Presence of functional fire detection and suppression equipment.

The licensee further stated that the procedures that currently implement shutdown risk and the essential work planning and implementing process will be revised as necessary to implement the changes and requirements as a result of the NFPA 805 implementation. The licensee further stated that the revisions will follow the guidance of FAQ 07-0040 (Reference 76). The licensee further stated that a qualitative NPO analysis was performed for the Control Bay Complex (Fire Area 16), including the MCR. The licensee stated that the MCR is typically a pinch point for all KSFs because some portion of most of the control circuits for the KSF components pass through the MCB sections, or through the plant instrument cabinets, and are in close proximity to one another; therefore, it used a qualitative approach to analyze the Control Bay Complex, and identified that Fire Area 16 is a "pinch point" for all KSFs. The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee stated that the procedures implementing shutdown risk, work planning, and the implementing process will be revised and that the revisions will follow the guidance of FAQ 07-0040 (Reference 76), and also because the licensee included an action to revise the procedures in LAR Attachment S, Table S-3, Implementation Item 26, which would be required by the proposed license condition.

3.5.3.2 NPO Analysis Process

The licensee stated that its goal is to ensure that contingency plans are established when the plant is in an HRE and it is possible to lose a KSF due to fire. LAR Section 4.3 and LAR Attachment D, as supplemented, discuss these additional controls and measures. The licensee stated that during low-risk periods, normal risk management controls, as well as fire prevention/protection processes and procedures, will be used.

3.5.3.3 NPO Key Safety Functions, Pinch Point Resolutions, and SSCs Used to Achieve Performance

LAR Attachment D defines the KSFs and the licensee's calculation entitled, "NFPA 805 Transition – Non-Power Operation Modes Analysis," identifies the success paths to achieve the KSFs, and the components required for the success paths

Pinch points refer to a particular location in an area where the damage from a single fire scenario could result in failure of multiple components or trains of a system such that the maximum detriment on that system's performance would be realized from the single fire scenario. Typically, this involves close vertical proximity of cables that support redundant components or trains of a system such that all such cables can be damaged by just one fire scenario.

BFN has 48 fire areas that cover each of three units, fire areas common to multiple units, and the MCR. The 48 fire areas are consistent with the 45 fire areas analyzed under the nuclear safety capability assessment (NSCA) and an additional 3 fire areas (each unit's drywell) since the drywells are no longer inert and contain NPO equipment. The results of the licensee's analyses are summarized below:

- A pinch point has been identified for each unit in every fire area. Administrative controls or fire prevention practices are recommended for each fire area.
- The MCR has been qualitatively analyzed and determined to be a pinch point for all KSFs. Recommendations to utilize the most stringent fire prevention practices during HREs are proposed.
- Limited RAs have been proposed to facilitate recovery of electrical power, process cooling, and switch operation to restore shutdown cooling.
- RAs consist of transferring control power sources to alternate sources, aligning 250 VDC reactor motor operated valve boards to alternate power supply, manually washing emergency equipment cooling water (EECW) strainers, aligning an air cooling unit to its alternate EECW cooling header, and remote operation of RHR suction valve permissive control switches.

Based on its review of the information provided in the LAR, as supplemented, the NRC staff concludes that the licensee used methods consistent with the guidance provided in FAQ 07-0040 and RG 1.205 to identify the equipment required to achieve and maintain the fuel in a safe and stable condition during NPO modes. Furthermore, the NRC staff concludes that the licensee has a process in place to ensure that fire protection DID measures will be implemented to achieve the KSFs during plant outages and that any required actions will be completed through implementation items identified in LAR Attachment S, Table S-3, which are required by the proposed license condition.

3.5.3.4 NPO Program Implementation

The licensee identified power-operated components needed to support an NPO KSF that required additional circuit analysis. The selected components were evaluated to determine if they existed in the SSA. If the component was part of the SSA, that component was further evaluated to determine if its functional state remained the same between SSD and NPOs. Components with different functional states or which were not in the SSA had cable selection and routing performed. The information from this evaluation was entered and stored using the system assurance and fire protection engineering (SAFE) software for retention and subsequent evaluation.

NFPA 805 requires that the NSPC be met during any operational mode or condition, including NPO. As described above, the licensee has performed the following engineering analyses to demonstrate that it meets this requirement:

- Identified the KSFs required to support the NSPC during NPOs.

- Identified the plant operating states where further analysis is necessary during NPOs.

- Identified the SSCs required to meet the KSFs during the plant operating states analyzed.

- Identified the location of these SSCs and their associated cables.

- Performed analyses on a fire area basis to identify pinch points where one or more KSFs could be lost as a direct result of fire-induced damage.

- Planned/implemented modifications to appropriate procedures in order to employ a fire protection strategy for reducing risk at these pinch points during HREs.

Accordingly, based on the information provided in the LAR, as supplemented, the NRC staff concludes that the licensee will provide reasonable assurance that the NSPC are met during NPO modes and HREs because evaluations of power-operated components needed to support NPO KSF have been performed and revisions to procedures in order to employ a fire protection strategy for reducing risk at these pinch points during HREs have already been made or are included in LAR Attachment S, Table S-3 and are required by the proposed license condition.

3.5.4 Conclusion for Section 3.5

The NRC staff reviewed the licensee's RI/PB FPP as described in the LAR and its supplements to evaluate the NSCA results. The licensee used a combination of the deterministic approach and the PB approach in accordance with NFPA 805, Sections 4.2.3 and 4.2.4.

For those fire areas that utilized a deterministic approach, the NRC staff confirmed the following:

- The engineering evaluations for exemptions from the existing FPP were evaluated and found to be valid and acceptable for meeting the requirements of NFPA 805, as allowed by NFPA 805, Section 2.2.7.

- Fire suppression effects were evaluated and found to have no adverse impact on the ability to achieve and maintain the NSPC for each fire area.

- The required automatic fire suppression and automatic fire detection systems were appropriately documented for each fire area.

Accordingly, the NRC staff concludes that there is reasonable assurance that each fire area utilizing the deterministic approach does so in accordance with NFPA 805, Section 4.2.3.

For those fire areas that utilized a PB approach, the NRC staff confirmed the following:

- The engineering evaluations for exemptions from the existing FPP were evaluated and found to be valid and acceptable for meeting the requirements of NFPA 805, as allowed by NFPA 805, Section 2.2.7.

- Fire suppression effects were evaluated and found to have no adverse impact on the ability to achieve and maintain the NSPC for each fire area.

- All VFDRs were evaluated using the FRE PB approach (in accordance with NFPA 805, Section 4.2.4.2) to address risk impact, DID, and safety margin, and found to be acceptable.

- All RAs necessary to demonstrate the availability of a success path (i.e., Risk-RAs listed against a VFDR) were evaluated with respect to the additional risk presented by their use and found to be acceptable in accordance with NFPA 805, Section 4.2.4.

- All DID-RAs were properly documented for each fire area.

- The required automatic fire suppression and automatic fire detection systems were appropriately documented for each fire area.

Accordingly, the NRC Staff concludes that there is reasonable assurance that each fire area utilizing the PB approach does so in accordance with NFPA 805, Section 4.2.4.

The NRC staff's review of the licensee's analysis and outage management process during NPO modes concludes that the licensee provided reasonable assurance that the NSPC will be met during NPO modes and HREs, and that the licensee's methods will be consistent with the guidance provided in RG 1.205 and FAQ 07-0040. The NRC staff's review also concludes that limited RAs are required to facilitate recovery of electrical power, process cooling, and switch operation to restore shutdown cooling during NPO modes and that the licensee's overall approach for fire protection during NPO modes is acceptable.

3.6 Radioactive Release Performance Criteria

3.6.1 Method of Review

NFPA 805, Chapter 1 defines the radioactive release goals, objectives, and performance criteria that must be met by the fire protection program (FPP) in the event of a fire at a nuclear power plant (NPP) in any plant operational mode as follows:

> Radioactive Release Goal.
>
> The radioactive release goal is to provide reasonable assurance that a fire will not result in a radiological release that adversely affects the public, plant personnel, or the environment.
>
> Radioactive Release Objective.

Either of the following objectives shall be met during all operational modes and plant configurations.

(1) Containment integrity is capable of being maintained.

(2) The source term is capable of being limited.

Radioactive Release Performance Criteria.

Radiation release to any unrestricted area due to the direct effects of fire suppression activities (but not involving fuel damage) shall be as low as reasonably achievable and shall not exceed applicable 10 CFR Part 20 limits.

The NRC staff has endorsed (with certain exceptions) the guidance in nuclear energy institute (NEI) 04-02 as providing methods acceptable to the staff for adopting an FPP consistent with NFPA 805 and 10 CFR 50.48(c) in RG 1.205. As described in the LAR, the licensee has assessed its FPP against the NFPA 805 requirements for fire suppression related radioactive release using the methodology contained in NEI 04-02 and frequently asked question (FAQ) 09-0056 (Reference 81).

The NRC reviewed the LAR to determine if the planned modifications to the FPP would provide an acceptable transition to meet the radioactive release performance criteria requirements of a risk-informed/performance-based (RI/PB) FPP in accordance with 10 CFR 50.48(a) and (c), using the guidance in regulatory guide (RG) 1.205 and NUREG-0800, Section 9.5.1.2. The results of the NRC staff evaluation are provided below.

3.6.2 Scope of Review

An evaluation of the capability of the fire protection program to meet the goals, objectives, and performance criteria of NFPA 805 was performed by the licensee for all plant operating modes (including power and non-power operations (NPOs)) and for all plant areas. The potential for effluent release was determined through evaluations of the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) fire emergency response organization (FERO) pre-fire plans and the training materials. The licensee's review determined that the fire suppression activities as defined in the pre-fire plans and fire brigade firefighting standard operating procedures were written and valid for any plant operating mode. The NRC staff concludes that the scope of the licensee's assessment was adequate because the review included all modes of plant operation and all plant areas.

3.6.3 Identification of Plant Areas Containing Radioactive Materials and Providing Containment During Fire Fighting Operations

The licensee reviewed the physical layout, design features, and engineering controls for each fire area. The fire areas and the respective pre-fire plans were reviewed to determine the fire areas with the potential to contain radioactive or contaminated materials. Compartments in the radiologically controlled area (RCA) were reviewed and either "screened in" (i.e., affects radioactive release) or "screened out" (cannot affect radioactive release). Engineering controls in those compartments were reviewed to determine if the controls in place would contain and monitor a potential gaseous or liquid effluent release during a fire event.

The results of the compartment review are documented in LAR, Attachment E. The fire areas where there was no possibility of radioactive materials being present were identified and eliminated from further review. Each fire area that had the potential for generation of radioactive effluents created by firefighting activities was identified and screened in for further evaluation.

For each screened in fire area, the licensee's review identified the existing engineering controls that were sufficient to contain gaseous and liquid effluent. The licensee's review identified the plant areas such as the Reactor Building, Turbine Building, Radwaste Building, and Low Level Radwaste Storage Modules that used engineered controls for containment of gaseous and liquid effluent. The plant's engineering controls are identified and documented in LAR Attachment E. The NRC staff concludes that the engineering controls for these plant areas are adequate because they provide sufficient capacity to contain the gaseous and liquid effluents generated as a direct result of fire suppression activities.

The licensee's review also identified other plant areas where radioactive materials were present where there were minimal or no engineered controls for containment of effluents. These areas include the Service Building, East Access Building, South Access Building, Outage Rad Materials Warehouse, Standby Gas Treatment Building, Off-gas Building and Off-gas Stack, Yard-RCA, and Low Level Radwaste Tool Warehouse.

The NRC staff concludes that the licensee's identification of potentially affected areas is an adequate assessment because the review incorporated all plant areas, and identified potentially affected areas with and without engineering controls in accordance with the guidance in NEI 04-02 as endorsed by RG 1.205.

3.6.4 Pre-Fire Plans

The licensee reviewed the existing FERO pre-fire plans to determine whether the plans were adequate to ensure that gaseous and liquid radioactive effluents generated as a direct result of fire suppression activities would be contained. The results of the licensee's review are documented in LAR Attachment E. This review included the following steps:

- Identification of applicable documentation, including pre-fire plans, procedures, and support drawings.

- Review of current documentation to identify whether the current procedures and training documents discuss the objectives of containment and monitoring of potential contamination involving fire suppression activities.

- Review of engineering controls for gaseous effluents to determine in which areas the gaseous effluents are contained (for example, contaminated smoke and related particulates).

- Review of engineering controls for liquid effluents to determine in which areas the liquid effluents are contained (for example, automatic or manual fire-fighting water, sumps, tanks, storm drains).

- An identification of those documents needing revision such as to provide for monitoring and containment of fire suppression agents and radioactive release.

The NRC staff reviewed the licensee's evaluation and concluded that the licensee's evaluation of the pre-fire plans is adequate because the review was comprehensive and was performed in accordance with the guidance in NEI 04-02, Appendix G, as endorsed by RG 1.205.

3.6.5 Gaseous Effluent Controls

In areas where engineering controls exist for containment, filtering, and monitoring of gaseous effluent, the engineering controls were determined to provide adequate containment because the effluent was either contained or filtered to remove radioactive materials and subsequently monitored prior to discharge. The NRC staff concludes that NFPA 805 radioactive release goals, objectives, and performance criteria will be met in these areas because the radioactive release will be adequately contained.

For other areas without engineering controls, the licensee will develop administrative controls to limit radioactive release. The licensee will modify pre-fire plans to aid the Incident Commander in avoiding radioactive release by identifying potential escape (release) paths. Standard operating procedures will be developed to support FERO actions to prevent radioactive release. In areas where there are no pre-fire plans, the licensee will develop new pre-fire plans.

Administrative controls may also employ the use of metal containers with tight fitting closures and/or covers to store radioactive material. Where it is not practical to contain stored radioactive materials in tight fitting metal containers, a source term evaluation will be completed to establish appropriate administrative controls to ensure that a fire involving radioactive material will not exceed 10 CFR Part 20, "Limits." This evaluation will consider various input parameters such as type and quantity of fire loading, type of firefighting suppression, levels of loose (dispersible) radioactive contamination available for release, and the effluent dispersion and dilution factors as needed based on the specific configuration of the analyzed areas.

Actions to implement the results of the radioactive release review are listed in LAR Attachment S, Table S-3, Implementation Items 1.a through 1.h, and the NRC staff concludes that these actions are acceptable because they will result in compliance with NFPA 805 and because the actions are required by the proposed license condition.

The NRC staff concludes that upon completion of the implementation items, the gaseous effluent potentially released during a fire would not exceed the radiological release performance criteria of NFPA 805 and the public dose limits of 10 CFR 20 because potential releases are either contained, or administrative controls will be established, to limit a potential release.

3.6.6 Liquid Effluent Controls

The licensee identified those areas where sufficient engineering controls exist for containment of liquid effluent (e.g., floor drains routed to sumps and tanks). The NRC staff reviewed those engineering controls and determined that those controls provided adequate containment because the effluent is collected, stored, processed and monitored prior to discharge.

The licensee's review also identified those areas where potential liquid effluents released during firefighting activities were minimal or have no engineered controls. For these areas, the licensee will add an appendix to the pre-fire plans for building sump drainage and site storm drains. To mitigate potential releases, the licensee will revise the BFN FERO pre-fire plan, standard operating procedures, and training programs, to monitor and use administrative controls to control a potential liquid effluent release.

Administrative controls may also employ the use of metal containers with tight fitting closures and/or covers to store radioactive material. Where it is not practical to store radioactive materials in tight fitting metal containers, the licensee will also complete a source term evaluation to determine and establish appropriate administrative controls to ensure that a fire involving radioactive material will not exceed 10 CFR Part 20 limits. This evaluation will consider various input parameters such as type and quantity of fire loading, type of firefighting suppression, levels of loose (dispersible) radioactive contamination available for release, and the effluent dispersion and dilution factors as needed based on the specific configuration of the analyzed areas.

Actions to implement the results of the radioactive release review are listed in LAR Attachment S, Table S-3, Implementation Items 1.a through 1.h, and the NRC staff concludes that these actions are acceptable because they will result in compliance with NFPA 805 and because the actions are required by the proposed license condition.

The NRC staff reviewed the licensee's evaluation and concludes that upon completion of the implementation items, the licensee will be able to adequately contain liquid effluents. The licensee will be able to either contain liquid effluent and use administrative controls such as to not exceed the radiological release performance criteria of NFPA 805 and the public dose limits of 10 CFR 20.

3.6.7 Fire Brigade Training Materials

The licensee reviewed and revised the fire brigade training to incorporate radiation release objectives into the fire brigade membership course. The objectives are to ensure fire brigade members consider the potential impact of fire suppression activities on airborne release and water runoff.

Actions to implement the results of the radioactive release review are listed in LAR Attachment S, Table S-3, Implementation Items 1.a through 1.h. In Implementation Item 1.h, the licensee stated that each fire brigade member will be provided training to identify potential points for radioactive release and the actions that can be taken to mitigate radioactive release; to support the training, guidance will be provided in pre-fire plans and standard operating procedures to outline these expectations and actions. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

The NRC staff reviewed the licensee's evaluation of training materials and concludes that the training materials are adequate to ensure the fire brigade staff will implement the fire protection program because the fire brigade will be informed and capable of taking actions to limit the public dose to within the radiological release performance criteria of NFPA 805.

3.6.8 Conclusion for Section 3.6

The NRC staff's evaluation is based on:

(1) Information and analyses provided in the LAR and RAI responses;
(2) Use of engineered controls and administrative controls to contain potential releases;
(3) Use of pre-fire plans, and
(4) Use of revised fire brigade response procedures and training procedures.

Based on the above, the NRC staff concludes that the licensee's RI/PB fire protection program provides reasonable assurance that radiation releases to any unrestricted area resulting from the direct effects of fire suppression activities are as low as reasonably achievable and are not likely to exceed the radiological release performance criteria of NFPA 805 and the radiological dose limits in 10 CFR 20. The NRC staff, therefore, concludes that the licensee's fire protection program complies with the requirements specified in NFPA 805, Sections 1.3.2, 1.4.2, and 1.5.2, and that this approach is acceptable.

3.7 <u>NFPA 805 Monitoring Program</u>

3.7.1 Monitoring Program

For this SE section, the following requirements from NFPA 805 (Reference 3), Section 2.6 are applicable to the NRC staff's review of the LAR (Reference 8):

NFPA 805, Section 2.6, "Monitoring," states:

> A monitoring program shall be established to ensure that the availability and reliability of the fire protection systems and features are maintained and to assess the performance of the fire protection program in meeting the performance criteria. Monitoring shall ensure that the assumptions in the engineering analysis remain valid.

NFPA 805, Section 2.6.1, "Availability, Reliability, and Performance Levels," states:

> Acceptable levels of availability, reliability, and performance shall be established.

NFPA 805, Section 2.6.2, “Monitoring Availability, Reliability, and Performance,” states:

> Methods to monitor availability, reliability, and performance shall be established. The methods shall consider the plant operating experience and industry operating experience.

NFPA 805, Section 2.6.3, “Corrective Action,” states:

> If the established levels of availability, reliability, or performance are not met, appropriate corrective actions to return to the established levels shall be implemented. Monitoring shall be continued to ensure that the corrective actions are effective.

The NRC staff reviewed LAR Section 4.6, “Monitoring Program,” which the licensee developed to monitor availability, reliability, and performance of the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) fire protection program (FPP) systems and features after transition to NFPA 805. The focus of the NRC staff review was on critical elements related to the monitoring program, including the selection of FPP systems and features to be included in the program, the attributes of those systems and features that will be monitored, and the methods for monitoring those attributes. Implementation of the monitoring program will occur on the same schedule as the NFPA 805 risk-informed/performance-based (RI/PB) FPP implementation, which the NRC staff concludes is acceptable.

The licensee stated that it will develop an NFPA monitoring program consistent with frequently asked question (FAQ) 10-0059 (Reference 82). Development of the monitoring program will include a review of existing surveillance, inspection, testing, and compensatory measures for adequacy. The review will examine adequacy of the scope of structures, systems, and components (SSCs) within the existing plant programs, performance criteria for availability and reliability of SSCs, and the adequacy of the plant corrective action program. The monitoring program will incorporate phases for scoping, screening using risk criteria, risk target value determination, and monitoring implementation; the scope of the program will include fire protection systems and features, nuclear safety capability assessment (NSCA), non-power operations (NPO), and fire probabilistic risk assessment (FPRA) equipment, SSCs relied upon to meet radioactive release criteria, and FPP programmatic elements.

As described above, NFPA 805, Section 2.6 requires that a monitoring program be established in order to ensure that the availability and reliability of fire protection systems and features are maintained, as well as to assess the overall effectiveness of the FPP in meeting the performance criteria. Monitoring should ensure that the assumptions in the associated engineering analysis remain valid.

Based on the information provided in the LAR, as supplemented, the NRC staff concludes that the licensee’s NFPA 805 monitoring program development and implementation process is acceptable and assures that the licensee will implement an effective program for monitoring risk-significant fires because it:

- Establishes the appropriate scope of SSCs to be monitored;

- Utilizes an acceptable screening process for determining the SSCs to be included in the program;

- Establishes availability, reliability, and performance criteria for the SSCs being monitored; and

- Requires corrective actions when SSC availability, reliability, or performance criteria targets are exceeded to bring performance back within the required range.

However, since the final values for availability and reliability, as well as the performance criteria for the SSCs being monitored, have not been established for the NFPA 805 monitoring program as of the date of this safety evaluation (SE), completion of the licensee's NFPA 805 monitoring program is an implementation item addressed in LAR Attachment S, Table S-3, Implementation Item 3. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

Completion of the monitoring program will occur on the same schedule as the implementation of NFPA 805, which the NRC staff concludes is acceptable.

3.7.2 Conclusion for Section 3.7

The NRC staff reviewed the licensee's RI/PB FPP and concludes that there is reasonable assurance that the licensee's monitoring program meets the requirements specified in NFPA 805, Sections 2.6.1, 2.6.2, and 2.6.3, because the licensee identified an action to revise plant documents to monitor and trend the FPP and included that action as an implementation item that would be required by the proposed license condition.

3.8 Program Documentation, Configuration Control, and Quality Assurance

For this safety evaluation (SE) section, the requirements from NFPA 805 (Reference 3), Section 2.7, "Program Documentation, Configuration Control and Quality," are applicable to the NRC staff's review of the LAR in regard to the appropriate content, configuration control, and quality of the documentation used to support the Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, fire protection program (FPP) transition to NFPA 805.

NFPA 805, Section 2.7.1.1, "General," states:

> The analyses performed to demonstrate compliance with this standard shall be documented for each nuclear power plant (NPP). The intent of the documentation is that the assumptions be clearly defined and that the results be easily understood, that results be clearly and consistently described, and that sufficient detail be provided to allow future review of the entire analyses. Documentation shall be maintained for the life of the plant and be organized

> carefully so that it can be checked for adequacy and accuracy either by an independent reviewer or by the authority having jurisdiction (AHJ).

NFPA 805, Section 2.7.1.2, “Fire Protection Program Design Basis Document,” states:

> A fire protection program design basis document shall be established based on those documents, analyses, engineering evaluations, calculations, and so forth that define the fire protection design basis for the plant. As a minimum, this document shall include fire hazards identification and nuclear safety capability assessment, on a fire area basis, for all fire areas that could affect the nuclear safety or radioactive release performance criteria defined in Chapter 1.

NFPA 805, Section 2.7.1.3, “Supporting Documentation,” states:

> Detailed information used to develop and support the principal document shall be referenced as separate documents if not included in the principal document.

NFPA 805, Section 2.7.2.1, “Design Basis Document,” states:

> The design basis document shall be maintained up-to-date as a controlled document. Changes affecting the design, operation, or maintenance of the plant shall be reviewed to determine if these changes impact the fire protection program documentation.

NFPA 805, Section 2.7.2.2, “Supporting Documentation,” states:

> Detailed supporting information shall be retrievable records. Records shall be revised as needed to maintain the principal documentation up-to-date.

NFPA 805, Section 2.7.3.1, “Review,” states:

> Each analysis, calculation, or evaluation performed shall be independently reviewed.

NFPA 805, Section 2.7.3.2, “Verification and Validation,” states:

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

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 verification and validation. These engineering methods shall only be applied within the scope, limitations, and assumptions prescribed for that method.

NFPA 805, Section 2.7.3.4, “Qualification of Users,” states:

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

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.

3.8.1 Documentation

The NRC staff reviewed LAR (Reference 8), Section 4.7.1, “Compliance with Documentation Requirements in Section 2.7.1 of NFPA 805,” to evaluate the FPP design basis document and supporting documentation.

The FPP design basis is a compilation of multiple documents (i.e., fire safety analyses, calculations, engineering evaluations, nuclear safety capability assessments (NSCAs), etc.), databases, and drawings, which are identified in LAR Figure 4-9, “NFPA 805 Transition – Planned Post-Transition Documentation Relationships.” The licensee stated that the analyses conducted to support the NFPA 805 transition were performed in accordance with Tennessee Valley Authority’s (TVA’s) quality assurance (QA) program or an approved vendor QA program, which meet the requirements for documentation outlined in NFPA 805, Section 2.7.1.

Specifically, the licensee’s design analysis and calculation procedures provide the methods and requirements to ensure that design inputs and assumptions are clearly defined, results are easily understood by being clearly and consistently described, and that sufficient detail is provided to allow future review of the entire analysis. The process includes provisions for appropriate design and engineering review and approval. In addition, the approved analyses are considered controlled documents and are accessible via the BFN document control system. Being analyses, they are also subject to review and revision consistent with the other plant calculations and analyses as required by the plant design change process.

The LAR also stated that the documentation associated with the FPP will be maintained for the life of the plant and organized in such a way to facilitate review for accuracy and adequacy by independent reviewers, including the NRC staff.

Based on the content of the FPP design basis and supporting documentation as described in the LAR, as supplemented, and taking into account the licensee’s plans to maintain this documentation throughout the life of the plant, the NRC staff concludes that the licensee’s approach for meeting the requirements of NFPA 805, Sections 2.7.1.1, 2.7.1.2, and 2.7.1.3, regarding adequate development and maintenance of the FPP design basis documentation is acceptable.

3.8.2 Configuration Control

The NRC staff reviewed LAR Section 4.7.2, "Compliance with Configuration Control Requirements in Sections 2.7.2 and 2.2.9 of NFPA 805," in order to evaluate the configuration control process for the new NFPA 805 FPP.

To support the many other technical, engineering and licensing programs, the licensee has existing configuration control processes and procedures for establishing, revising, or utilizing program documentation. Accordingly, the licensee is integrating the new FPP design basis and supporting documentation into these existing configuration control processes and procedures. These processes and procedures require that all plant changes be reviewed for potential impact on the BFN licensing programs, including the FPP.

The LAR stated that the configuration control process includes provisions for appropriate design, engineering reviews and approvals, and that approved analyses are considered controlled documents available through the document control system. The LAR also stated that analyses based on the probabilistic risk assessment (PRA) program, which includes the fire risk evaluations (FREs), are issued as formal analyses subject to these same configuration control processes and are additionally subject to the PRA peer review process specified in the American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) PRA Standard (Reference 47).

Configuration control of the existing FPP during the transition period is maintained by the change evaluation process as defined in existing configuration management and configuration control procedures. The licensee stated that it will revise these procedures as necessary for application to the NFPA 805 FPP and included the action to do so in LAR Attachment S, Table S-3, Implementation Item 24, to update configuration control procedures to reflect the new NFPA 805 licensing bases requirements.

The NRC staff's review of the licensee's process for updating and maintaining the FPRA in order to reflect plant changes made after completion of the transition to NFPA 805 is included in SE Section 3.4.

Based on the description of the licensee's configuration control process, which indicates that the new FPP design basis and supporting documentation will be controlled documents and that plant changes will be reviewed for impact on the FPP, the NRC staff concludes that there is reasonable assurance that the requirements of NFPA 805, Sections 2.7.2.1 and 2.7.2.2 will be met.

3.8.3 Quality

The NRC staff reviewed LAR Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," to evaluate the quality of the engineering analyses used to support transition of the FPP to NFPA 805 based on the requirements outlined above. The individual sections of this SE provide the NRC staff's evaluation of the application of the NFPA 805 quality requirements to the licensee's FPP, as appropriate.

3.8.3.1 Review

NFPA 805 requires that each analysis, calculation, or evaluation performed be independently reviewed. The licensee stated that its procedures require independent review of analyses, calculations, and evaluations, including those performed in support of compliance with 10 CFR 50.48(c). The LAR also stated that the transition to NFPA 805 was independently reviewed, and that analyses, calculations, and evaluations to be performed post-transition will be independently reviewed as required by existing procedures.

Based on the licensee's description of the process for performing independent reviews of analyses, calculations, and evaluations, the NRC staff concludes that the licensee's approach for meeting the quality requirements of NFPA 805, Section 2.7.3.1 is acceptable.

3.8.3.2 Verification and Validation

NFPA 805 requires that each calculational model or numerical method used be verified and validated through comparison to test results or other acceptable models. The licensee stated that the calculational models and numerical methods used in support of the transition to NFPA 805 were verified and validated and that the calculational models and numerical methods used post-transition will be similarly verified and validated. As an example, the licensee provided extensive information related to the verification and validation (V&V) of fire models used to support the development of the FREs. The NRC staff's evaluation of this information is discussed below.

3.8.3.2.1 General

NUREG-1824, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," Volumes 1-7 (Reference 59), documents the V&V of five selected fire models commonly used to support applications of RI/PB fire protection at NPPs. The seven volumes of this NUREG-series report provide technical documentation concerning the predictive capabilities of a specific set of fire dynamics calculation tools and fire phenomenological models that may be used for the analysis of fire hazards in postulated NPP scenarios. When used within the limitations of the fire models and considering the identified uncertainties, these models may be employed to demonstrate compliance with the requirements of 10 CFR 50.48(c) as part of an approved PB approach in accordance with NFPA 805, Chapter 4.

Accordingly, for those fire modeling (FM) elements performed by the licensee using the V&V applications contained in NUREG-1824 to support the transition to NFPA 805, the NRC staff concludes that the use of these models is acceptable, provided that the intended application is within the appropriate limitations as identified in NUREG-1824.

In LAR Attachment J, the licensee also identified the use of some empirical correlations that are not addressed in NUREG-1824. The NRC staff reviewed these correlations, as well as the related material provided in the LAR, in order to determine whether the licensee adequately demonstrated alignment with specific portions of the applicable NUREG-1824 guidance.

SE Table 3.8-1, "V&V Basis for Fire Modeling Correlations Used at Browns Ferry," in SE Attachment A and SE Table 3.8-2, "V&V Basis for Other Fire Models and Related Calculations

Used at Browns Ferry," in SE Attachment B, identify these empirical correlations and algebraic models, respectively, as well as a staff disposition for each.

The NRC staff concludes that the theoretical bases of the models and empirical correlations used in the FM calculations that were not addressed in NUREG-1824 were identified and described in authoritative publications (Reference 115) (Reference 116) (Reference 122) (Reference 123) (Reference 124) (Reference 125) (Reference 126) (Reference 127) (Reference 128) (Reference 129) (Reference 130) (Reference 131) (Reference 132). SE Table 3.8-1 summarizes the additional fire models and the NRC staff's evaluation of the acceptability of each.

The FM employed by the licensee in the development of the FREs used empirical correlations that provide bounding solutions for the zone of influence (ZOI) and conservative input parameters, which produced conservative results for the FM analysis. See SE Section 3.4.2.3 for further discussion of the licensee's FM method.

3.8.3.2.2 Discussion of RAIs

In a letter dated November 19, 2013 (Reference 31), the NRC staff sought additional information (RAIs) concerning the FM conducted to support the FPRA. In letters dated December 20, 2013 (Reference 11); January 10, 2014 (Reference 12); January 14, 2014 (Reference 13); February 13, 2014 (Reference 14); March 14, 2014 (Reference 15); and December 17, 2014 (Reference 24), the licensee responded to the RAIs. In a letter dated May 21, 2014 (Reference 33), the NRC staff sent additional RAIs to the licensee. By a letter dated June 13, 2014 (Reference 17), the licensee provided a response to the additional RAIs.

- In FM RAI 03.a (Reference 31), the NRC staff requested that the licensee explain how the fire modeling workbooks (FMWBs) that were developed to calculate the ZOI and hot gas layer (HGL) temperatures were verified.

  In its response to FM RAI 03.a (Reference 12), the licensee explained that the FMWB used to calculate the ZOI and HGL temperatures was verified based on a comparison of its results for a representative number of cases to the output from the corresponding fire dynamic tools (FDT^s) in NUREG-1805.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the results produced by the FMWB have been shown to match the output from NUREG-1805, and the latter was V&V in NUREG-1824.

- In FM RAI 03.b (Reference 31) the NRC staff requested that the licensee explain how Beyler's method to estimate the HGL temperature in closed compartments was used in the multi-compartment analysis (MCA). Since there is no discussion of this model in LAR Attachment J, "Fire Modeling Verification and Validation (V&V)," the NRC staff requested that the licensee provide the following:

  (i) An explanation of how Beyler's method was verified;
  (ii) A description of the validation basis for the method; and

(iii) Technical details to demonstrate that the method has been applied within the validated range of input parameters, or justification for using the application outside the validated range reported in the V&V basis documents.

In its response to FM RAI 03.b.i (Reference 15), the licensee explained that Beyler's method to estimate the HGL temperature in closed compartments was used in the MCA in accordance with NUREG-1805, FDT 2.3, "Predicting Hot Gas Layer Temperature in a Room Fire with Door Closed." The licensee further stated that this FDT is discussed in NUREG-1805, Section 2.6 and verified and validated in NUREG-1824, Volume 3, Section 3.1.2 and that the correlation was applied using verified methods within the validation range and limitations, or the use was justified as acceptable.

In its response to FM RAI 03.b.ii (Reference 12), the licensee explained that Beyler's method is described in Section 3, Chapter 6 of the 4th edition of the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, summarized the discussion in NUREG-1824 pertaining to the validation of the model, and discussed the assumptions and limitations in applying Beyler's method for the HGL temperature calculations.

In its response to FM RAI 03.b.iii (Reference 12), the licensee explained that Beyler's model was generally used in the MCA within the NUREG-1824 validated range, and provided technical details to justify the use of the model in those cases in which it was applied outside the range.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee updated LAR Attachment J, Table J-1 to include a discussion of the V&V of Beyler's model, and provided acceptable technical justification for the cases in the MCA in which the model was used outside its validated range.

- In FM RAI 03.c (Reference 31), the NRC staff requested that the licensee provide technical details to demonstrate that the Smoke Detection Actuation correlation (Method of Heskestad and Delichatsios) has been applied within the validated range of input parameters, or to justify the application of the correlation outside the validated range reported in the V&V basis documents.

  In its response to FM RAI 03.c (Reference 12), the licensee explained that the method of Heskestad and Delichatsios is based on Alpert's ceiling jet temperature correlation, and that the latter was applied within the validated range reported in NUREG-1824. The licensee further explained that the 10 °C temperature rise surrogate for smoke detector actuation was developed based on data from tests involving fuels that have smoke properties similar to the fires modeled at BFN.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee provided technical details demonstrating that the model was applied within the validated range and for fires that involve the types of fuels that were used in the creation of the correlation.

3.8.3.2.3 Post-Transition

The licensee stated that it will revise the appropriate processes and procedures to include NFPA 805 quality requirements for use during the performance of post-transition FPP changes, including those for V&V. Revision of the applicable post-transition processes and procedures to include NFPA 805 requirements for V&V is included in LAR, Attachment S, Table S-3, Implementation Item 24. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

3.8.3.2.4 Conclusion for Section 3.8.3.2

Based on the licensee’s description of the process for V&V of calculational models and numerical methods and their continued use post-transition, the NRC staff concludes that the licensee’s approach to meeting the requirements of NFPA 805, Section 2.7.3.2 is acceptable because the models are consistent with approved uses in NRC guidance or other authoritative publications and the licensee has identified actions that will result in compliance with NFPA 805 and those actions are required by the proposed license condition.

The NRC staff concludes that the licensee’s approach provides reasonable assurance that the FM used in the development of the fire scenarios for FPRA is appropriate, and thus acceptable for use in transition to NFPA 805 because the V&V of the empirical correlations used by the licensee were consistent with either NUREG-1824, the SFPE Handbook of Fire Protection Engineering, or other authoritative publications.

3.8.3.3 Limitations of Use

NFPA 805 requires that acceptable engineering methods and numerical models only be used for applications to the extent that these methods have been subject to V&V and that they are applied within the scope, limitations, and assumptions prescribed for that method. The licensee stated that the engineering methods and numerical models used in support of the transition to NFPA 805 were subject to the limitations of use outlined in NFPA 805, Section 2.7.3.3 and that the engineering methods and numerical models used post-transition will be subject to these same limitations of use.

3.8.3.3.1 General

The NRC staff assessed the acceptability of each empirical correlation or other fire model in terms of the limits of its use. SE Table 3.8-1 in SE Attachment A and SE Table 3.8-2 in SE Attachment B summarizes the fire models used, how each was applied in the FREs, the V&V basis for each, and the NRC staff evaluation for each.

3.8.3.3.2 Discussion of RAIs

In a letter dated November 19, 2013 (Reference 31), the NRC staff sought additional information (RAIs) concerning the FM conducted to support the FPRA. In letters dated December 20, 2013 (Reference 11); January 10, 2014 (Reference 12); January 14, 2014 (Reference 13); February 13, 2014 (Reference 14); March 14, 2014 (Reference 15); and December 17, 2014 (Reference 24), the licensee responded to the RAIs. In a letter dated May 21, 2014 (Reference 33), the NRC staff sent additional RAIs to the licensee. By a letter dated June 13, 2014 (Reference 17), the licensee provided a response to the additional RAIs.

- In FM RAI 04 (Reference 31), the NRC staff requested that the licensee identify uses of (a) algebraic models, (b) consolidated fire and smoke transport model (CFAST), and (c) fire dynamics simulator (FDS) outside their limits of applicability, and for those cases, explain how this was justified.

  In its response to FM RAI 04 (Reference 14), the licensee explained that the analyst verified for each fire model application that the normalized parameters were within the range of applicability and that automatic checks in the FMWB facilitated this process for the algebraic models. The licensee further explained that the analyst either conservatively modified input parameters identified to be out of the range of applicability to bring them within range, or, if this was not possible, justified the use of a model outside its validated range either qualitatively or by quantitative sensitivity analyses.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee used a systematic approach to identify and justify potential fire model applications outside the range of applicability.

3.8.3.3.3 Post-Transition

The licensee also stated that it will revise the appropriate processes and procedures to include the NFPA 805 quality requirements for use during the performance of post-transition FPP changes, including those for limitations of use. Revision of the applicable post-transition processes and procedures to include NFPA 805 requirements for limitations of use are identified in LAR Attachment S, Table S-3 as Implementation Item 24. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

3.8.3.3.4 Conclusion for Section 3.8.3.3

Based on the licensee's statements that the fire models used to support development of the FREs were used within their limitations and the description of the licensee's process for placing limitations on the use of engineering methods and numerical models, the NRC staff concludes that the licensee's approach to meeting the requirements of NFPA 805, Section 2.7.3.3 is acceptable because the models are consistent with approved uses in NRC guidance or other authoritative publications and the licensee has identified actions that will result in compliance with NFPA 805 and those actions are required by the proposed license condition.

3.8.3.4 Qualification of Users

NFPA 805 requires that personnel performing engineering analyses and applying numerical methods (e.g., FM) shall be competent in that field and experienced in the application of these methods as they relate to NPPs, NPP fire protection, and power plant operations. LAR Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805 Fire Protection Quality," states:

> …Post-transition, for personnel performing fire modeling or Fire PRA development and evaluation, Browns Ferry will develop and maintain qualification requirements for individuals assigned various tasks. Position Specific Guides will be developed to identify and document required training and mentoring to ensure individuals are appropriately qualified per the requirements of NFPA 805 Section 2.7.3.4 to perform assigned work…

3.8.3.4.1 General

LAR Section 4.7.3 states that cognizant personnel who use and apply engineering analysis and numerical methods in support of demonstrating compliance with 10 CFR 50.48(c) are competent and experienced as required by Section 2.7.3.4 of NFPA 805.

LAR Section 4.7.3 further states that during the transition to 10 CFR 50.48(c), TVA will continue to perform work in accordance with the quality requirements of Section 2.7.3 of NFPA 805 and that personnel who use and apply 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.

Specifically, these requirements are being addressed for post-transition through the implementation of an engineering qualification process. LAR Section 4.7.3 states that post-transition, for personnel performing FM or FPRA development and evaluation, TVA will develop and maintain qualification requirements for individuals assigned various tasks. Position specific guides will be developed to identify and document required training and mentoring to ensure individuals are appropriately qualified per the requirements of NFPA 805, Section 2.7.3.4 to perform assigned work. The licensee included this action in LAR Attachment S, Table S-3, Implementation Item 23, and the NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

3.8.3.4.2 Discussion of RAIs

In a letter dated November 19, 2013 (Reference 31), the NRC staff sought additional information (RAIs) concerning the FM conducted to support the FPRA. In letters dated December 20, 2013 (Reference 11); January 10, 2014 (Reference 12); January 14, 2014 (Reference 13); February 13, 2014 (Reference 14); March 14, 2014 (Reference 15); and December 17, 2014 (Reference 24), the licensee responded to the RAIs. In a letter dated May 21, 2014 (Reference 33), the NRC staff sent additional RAIs to the licensee. By a letter dated June 13, 2014 (Reference 17), the licensee provided a response to the additional RAIs.

- In FM RAI 05.a (Reference 31), the NRC staff requested that the licensee describe the requirements to qualify personnel for performing FM calculations in the NFPA 805 transition.

  In its response to FM RAI 05.a (Reference 12), the licensee explained that FM to support the LAR and FPRA development was performed by contract personnel who were chosen based on their experience and expertise in FM commensurate with their specific assigned role in the analyses. The licensee further explained more specifically what the qualification requirements for personnel performing the FM and staff providing support entailed, and stated that during and after transition, it will continue to utilize qualified personnel.

- In FM RAI 05.b (Reference 31), the NRC staff requested that the licensee describe the process for ensuring that the FM personnel meet the qualifications, not only before the transition, but also during and following the transition.

  In its response to FM RAI 05.b (Reference 12), the licensee explained that contractor personnel who performed the FM and supporting activities used their companies' procedures and QA programs. The licensee further explained that it will develop qualification requirements for its engineers to perform FM during and after the transition, and that current processes will be followed until Position Specific Qualification Guides and Task Qualifications are developed and implemented via site training program procedures. The licensee included this action in LAR Attachment S, Table S-3, Implementation Item 23. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

- In FM RAI 05.c (Reference 31), the NRC staff requested that the licensee explain how proper communication between the FM and FPRA personnel is ensured.

  In its response to FM RAI 05.c (Reference 12), the licensee explained that during the development of the FPRA, the personnel performing FM and the PRA engineers maintained frequent communications and were active participants on the project team. The licensee further stated that the team participated in various re-iterative analyses to support final issuance of the approved FM and FPRA documentation.

The NRC staff concludes that the licensee's responses to the RAIs are acceptable because the licensee demonstrated that appropriately competent and experienced personnel developed the FREs, including the supporting FM calculations and the additional documentation for models and empirical correlations not identified in previous NRC approved V&V documents, and because the licensee developed an action to develop qualification requirements and included that action as an implementation item which would be required by the proposed license condition.

3.8.3.4.3 Post-Transition

The post-transition qualification training program will be implemented to include NFPA 805 requirements for qualification of users and is included in LAR Attachment S, Table S-3 as Implementation Item 23. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

3.8.3.4.4 Conclusion for Section 3.8.3.4

Based on the licensee's description of the procedures for ensuring personnel who use and apply engineering analyses and numerical methods are competent and experienced, the NRC staff concludes that the licensee's approach for meeting the requirements of NFPA 805, Section 2.7.3.4 is acceptable.

3.8.3.5 Uncertainty Analysis

NFPA 805 requires that an uncertainty analysis be performed to provide reasonable assurance that the performance criteria have been met. (Note: 10 CFR 50.48(c)(2)(iv) states that an uncertainty analysis performed in accordance with NFPA 805, Section 2.7.3.5 is not required to support calculations used in conjunction with a deterministic approach.) The licensee stated that an uncertainty analysis was performed for the analyses used in support of the transition to NFPA 805, and that an uncertainty analysis will be performed for post-transition analyses.

3.8.3.5.1 General

The industry consensus standard for PRA development (i.e., the ASME/ANS PRA Standard) (Reference 47) includes requirements to address uncertainty. Accordingly, the licensee addressed uncertainty as a part of the development of the FRE. The NRC staff's evaluation of the licensee's treatment of these uncertainties is discussed in SE Section 3.4.7.

NUREG-1855, Volume 1, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making" (Reference 61), discusses three types of uncertainty associated with FM calculations as follows:

(1) Parameter Uncertainty: Input parameters are often chosen from statistical distributions or estimated from generic reference data. In either case, the uncertainty of these input parameters affects the uncertainty of the results of the FM analysis.

(2) Model Uncertainty: Idealizations of physical phenomena lead to simplifying assumptions in the formulation of the model equations. In addition, the numerical solution of equations that have no analytical solution can lead to inexact results. Model uncertainty is estimated via the processes of V&V. An extensive discussion of quantifying model uncertainty can be found in NUREG-1934, "Nuclear Power Plant Fire Modeling Application Guide (NPP FIRE MAG)" (Reference 63).

(3) Completeness Uncertainty: This refers to the fact that a model is not a complete description of the phenomena it is designed to simulate. Some consider this a form of model uncertainty because most fire models neglect certain physical phenomena that are not considered important for a given application. Completeness uncertainty is addressed by the description of the algorithms found in the model documentation. It is addressed, indirectly, by the same process used to address the Model Uncertainty.

3.8.3.5.2 Discussion of Fire Modeling RAIs

In a letter dated November 19, 2013 (Reference 31), the NRC staff sought additional information (RAIs) concerning the FM conducted to support the FPRA. In letters dated December 20, 2013 (Reference 11); January 10, 2014 (Reference 12); January 14, 2014 (Reference 13); February 13, 2014 (Reference 14); March 14, 2014 (Reference 15); and December 17, 2014 (Reference 24), the licensee responded to the RAIs. In a letter dated May 21, 2014 (Reference 33), the NRC staff sent additional RAIs to the licensee. By a letter dated June 13, 2014 (Reference 17), the licensee provided a response to the additional RAIs.

- In FM RAI 06.a (Reference 31), the NRC staff requested that the licensee describe how it addressed the uncertainty associated with the FM input parameters in the calculations.

  In its response to FM RAI 06.a (Reference 12), the licensee explained that it addressed the parameter uncertainty by using conservative FM inputs that resulted in substantial safety margin. The licensee provided the following examples of conservative modeling assumptions that provide safety margin:

  - The majority of fire scenarios involving electrical equipment, including the electrical split fraction of pump fires, utilize the 98th percentile HRR for the severity factor;
  - The fire elevation in most cases is at the top of the cabinet or pump body;
  - The radiant fraction utilized is 0.4, while the convective fraction utilized is maintained at 0.7;
  - For transient fire impacts, a large bounding transient zone assumes all targets within its ZOI are affected by a fire and time to damage is calculated based on the closest target;
  - For HGL calculations, no equipment or structural steel is credited as a heat sink;
  - Cable trays are assumed to be filled to capacity;
  - As the fire propagates to secondary combustibles, the fire is modeled as one single fire;
  - For most scenarios, target damage is assumed to occur when the exposure environment meets or exceeds the damage threshold;
  - The fire elevation for transient fires is 2 feet;
  - Oil fires are analyzed as both unconfined and confined spills with 20-minute duration;

- High energy arcing fault (HEAF) scenarios are assumed to be at peak fire intensity for 20 minutes from time zero; and
- For many scenarios, fire brigade intervention was not credited prior to 85 minutes.

The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee's conservative modeling assumptions adequately address the uncertainty associated with the fire model input parameters.

- In FM RAI 06.b (Reference 31), the NRC staff requested that the licensee describe how the "model" and "completeness" uncertainties were addressed in the FM analyses.

  In its response to FM RAI 06.b (Reference 12), the licensee explained that model uncertainty is based primarily on comparisons of model predictions with experimental measurements as documented in NUREG-1824 and other model validation studies. The licensee further explained in detail up to what extent the following FM calculations fall within the experimental uncertainty reported in NUREG-1824:

  - HGL Temperature using FDTs;
  - HGL Height and Temperature using FDS;
  - HGL Temperature and Height using CFAST;
  - Ceiling Jet Temperature using Alpert Correlation;
  - Plume Temperature using FDTs;
  - Plume Temperature using FDS;
  - Flame Height using FDTs;
  - Smoke Concentration using FDS;
  - Radiant Heat Flux using FDTs; and
  - Radiant Heat Flux using FDS.

  The licensee concluded that the results of the FM calculations are within, or very near, the experimental uncertainty. The licensee further explained that the discussion of "model" uncertainty, as well as the conservative approaches discussed in the response to FM RAI 06.a, address "completeness" uncertainty as well. The licensee included discussion of a number of assumptions in the HGL calculations that offset the effect of ignoring the reduction of the effective volume of a compartment due to the volume occupied by its contents.

  The NRC staff concludes that the licensee's response to the RAI is acceptable because the licensee used only validated fire models in support of the FPRA, any FM uses outside the validated range were justified, and "completeness" uncertainty is addressed indirectly and partly offset by simplifying and/or conservative assumptions.

3.8.3.5.3 Post-Transition

The licensee stated that it will revise the appropriate processes and procedures to include the NFPA 805 quality requirements for use during the performance of post-transition FPP changes, including those regarding uncertainty analysis. Revision of the applicable post-transition processes and procedures to include NFPA 805 requirements regarding uncertainty analysis are identified in LAR Attachment S, Table S-3, Implementation Item 24; the NRC staff considers this action acceptable because the action is included as an implementation item that would be required by the proposed license condition.

3.8.3.5.4 Conclusion for Section 3.8.3.5

Based on the licensee's description of the process for performing an uncertainty analysis, the NRC staff concludes that the licensee's approach for meeting the requirements of NFPA 805, Section 2.7.3.5 is acceptable because the licensee's conservative modeling assumptions adequately address the uncertainty associated with the FM input parameters, because the licensee used only validated fire models in support of the FPRA, and because completeness uncertainty is addressed indirectly and partly offset by simplifying and/or conservative assumptions.

3.8.3.6 Conclusion for Section 3.8.3

The NRC staff concludes that the RI/PB fire protection QA program is acceptable because the program adequately addresses each of the requirements of NFPA 805, Section 2.7.3, which include conducting independent reviews, performing V&V, limiting the application of acceptable methods and models to within prescribed boundaries, ensuring that personnel applying acceptable methods and models are qualified, and performing uncertainty analyses.

3.8.4 Fire Protection Quality Assurance Program

GDC 1 of Appendix A to 10 CFR Part 50 requires the following:

> Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

The guidance in NEI 04-02 (Reference 7), Appendix C, suggests that the LAR include a description of how the existing fire protection quality assurance (QA) program will be transitioned to the new NFPA 805 RI/PB FPP.

The licensee stated that it will maintain the existing fire protection QA program and that during the transition to 10 CFR 50.48(c), it will continue to perform work in accordance with the quality requirements of NFPA 805, Section 2.7.3. The LAR described how the fire protection QA program meets the applicable requirements of NFPA 805, Sections 2.7.3.1 through 2.7.3.5, but indicated that the QA program would be updated to meet the applicable requirements of NFPA 805, Section 2.7.3.4. In LAR Attachment S, Table S-3, Implementation Item 23, the licensee included an action to develop position specific guides 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. The NRC staff concludes that this action is acceptable because it will incorporate the provisions of NFPA 805 in the FPP and would be required by the proposed license condition.

Based on its review and the above explanation, the NRC staff concludes that the licensee's fire protection QA program is acceptable, subject to completion of the implementation item, because it provides reasonable assurance that the requirements of NFPA 805, Sections 2.7.3.1 through 2.7.3.5 are met.

3.8.5 Conclusion for Section 3.8

The NRC staff reviewed the licensee's RI/PB FPP and RAI responses and concludes that upon completion of the associated implementation items, the licensee's approach for meeting the requirements specified in NFPA 805, Section 2.7 is acceptable.

3.9 Elimination of Containment Accident Pressure Credit

LAR Attachment X, "Elimination of Containment Accident Pressure Credit," describes the licensee's proposal for eliminating the containment accident pressure (CAP) credit for calculating the net positive suction head (NPSH) available for the residual heat removal (RHR) pumps that draw water from the suppression pool during a fire event.

3.9.1 Regulatory Evaluation

The NRC staff used the guidance in RG 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," Revision 4 (Reference 71), and SECY-11-0014 (Reference 133) during its review of the proposed change.

RG 1.82, Revision 4, Section C 1.3.1.1 states, in part:

> The design of the emergency core cooling and containment heat removal systems should ensure that sufficient available net positive suction head (NPSH) is provided to the system pumps, assuming the maximum expected temperature of the pumped fluid and no increase in containment pressure from that present before the postulated LOCA.

RG 1.82, Revision 4, Section C 1.3.1.2 states:

> For certain operating reactors in which it is not practicable to alter the design, conformance with Section C 1.3.1.1 may not be possible. In these cases, the determination of available NPSH should not include containment pressure above that which is necessary to preclude pump cavitation. The calculation of available containment pressure and sump/pool water temperature as a function of time should underestimate the expected containment pressures and overestimate the sump/pool water temperatures when determining available NPSH for this situation.

SECY-11-0014, Enclosure 1, Section 3.2, states:

> Several other postulated boiling water reactor (BWR) accidents are also considered. These are the plant response to a fire postulated according to the requirements of Title 10 of the Code of Federal Regulations (10 CFR) Section 50.48, "Fire Protection," and Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (hereafter referred to as the "Appendix R Fire").

Following the guidance in the regulatory guide (RG) 1.82, Revision 4, Section C 1.3.1.1, and SECY-11-0014, Enclosure 1, the licensee proposed to eliminate the use of CAP credit assumptions in the nuclear safety capability assessment (NSCA).

3.9.2 Precedents

There are no precedents identified for the proposed change in LAR Attachment X.

3.9.3 Technical Evaluation

Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) are General Electric BWRs/4 with Mark I type containments. As described in the final safety analysis report (FSAR), each unit employs a pressure suppression containment that houses the reactor vessel, the reactor coolant recirculating loops, and other branch connections of the reactor primary system. The pressure suppression system consists of a drywell; a pressure suppression chamber (alternatively referred to as the torus or wetwell), which stores a large volume of water; a connecting vent system between the drywell and the pressure suppression chamber; isolation valves; containment cooling systems; equipment for establishing and maintaining a pressure differential between the drywell and pressure suppression chamber; and service equipment.

3.9.3.1 Background

The licensee's 10 CFR 50, Appendix R event safe shutdown (SSD) containment NPSH analysis credited CAP, or pressure higher than that present before the event, to provide a positive NPSH margin for the RHR pumps. The NPSH margin is a measure of the pump's ability to avoid excessive cavitation so that it can perform its safety function(s). In calculating NPSH margin, the inclusion of some or all of the pressure developed in the containment during an accident or special event is referred to as CAP credit. As a part of BFN transition to NFPA 805, the licensee proposes to eliminate the assumed CAP credit for calculating the NPSH available (NPSHa) for the RHR pumps during a fire event using the guidance in RG 1.82, Revision 4.

3.9.3.2 RHR Heat Exchanger Fouling Resistance for CAP Elimination

For eliminating CAP credit, the licensee proposes to increase the NPSHa by lowering the amount of vapor pressure at the pump inlet that can be accomplished by lowering the suppression pool temperature response. The method used for lowering the suppression pool temperature response is by improving the thermal performance of the RHR heat exchangers.

The licensee is proposing a new acceptance criterion for the RHR heat exchangers that increases the k-factor from 223 British thermal unit (BTU)/sec- °F to 265 BTU/sec-°F using the projected heat transfer at the most limiting conditions. In its response to Containment and Ventilation Branch (SCVB)-RAI-1c (Reference 17), the licensee stated that it determined a k-factor of at least 265 BTU/sec- °F to be sufficient to eliminate the need for CAP credit in the loss of containment accident (LOCA) containment NPSH analysis. In its response to SCVB-RAI-1d (Reference 17), the licensee explained the limiting conditions refer to the state point condition associated with the current LOCA containment NPSH analysis, which are: RHR flow of 6500 gpm, residual heat removal service water (RHRSW) flow of 4000 gallons per minute (gpm), RHRSW temperature of 95 °F, 4.57 percent RHR heat exchanger tube plugging, and suppression pool temperature of 187.4 °F. In its response to SCVB-RAI-1e (Reference 17), the licensee stated that the projected limiting heat transfer rate (Q) based on the LOCA state point condition and k-factor of 265 BTU/sec-°F is:

- Q = k-factor x (maximum temperature difference between hot and cold fluids).
- Q = (265 BTU/sec- °F) (187.4 °F – 95 °F) x 3600 sec/hour.
- Q = 8.82E+07 BTU/hour.

Using the conventional heat exchanger effectiveness equations for a k-factor of 265 BTU/sec-°F at the LOCA state point condition, the licensee calculated the corresponding overall fouling resistance of 0.001517 hr-ft.^{2}-°F/BTU.

3.9.3.3 RHR Heat Exchanger Performance Test for Measuring Worst Fouling Resistance

The licensee performed RHR heat exchanger performance tests to measure the actual fouling resistances and to determine if using higher k-factors for LOCA containment analyses and for special events such as the NFPA 805 event is justified. NRC GL 89-13, “Service Water System Problems Affecting Safety-Related Equipment” (Reference 134), recommends testing of heat exchangers at a minimum of every 5 years. In lieu of testing, the licensee stated in its response to RAI SCVB-RAI-1b (Reference 17), that the BFN GL 89-13 heat exchanger program requires inspection and cleaning of RHR heat exchangers every five years and that in practice, the heat exchangers are inspected and cleaned on a 4-year schedule. To validate the increase in the heat exchanger k-factor and the 4-year cleaning frequency, the licensee performed individual thermal performance testing of the Unit 3 RHR heat exchangers 3A and 3C. In its response to SCVB-RAI-1b (Reference 17), the licensee stated that the representative Unit 3 heat exchangers 3A and 3C were selected from the 12 RHR heat exchangers of BFN, Units 1, 2, and 3, based on their operating history. Heat exchanger 3A was in service for 2 years and 3C was in service for 4 years since their last inspection and cleaning, thereby testing one heat exchanger halfway through its service cycle and the other near the end of its 4-year service cycle. The licensee conducted the tests with the RHR system operating in its suppression pool cooling mode during a scheduled reactor core isolation cooling (RCIC) system quarterly flow surveillance test (Reference 24). The testing during RCIC surveillance facilitated in the heat-up and maintaining stable suppression pool temperature from the RCIC turbine exhaust steam that improved test accuracy. In its response to SCVB-RAI-1a (Reference 24), the licensee stated that the test followed the guidelines of Electric Power Research Institute Technical Report (EPRI TR)-107397, “Service Water Heat Exchanger Testing Guidelines,” dated March 1998 (Reference 135), and EPRI NP-7552, “Heat Exchanger Performance Monitoring Guidelines,” dated December 1991 (Reference 136), which have been previously accepted by the NRC in regards to GL 89-13 heat exchanger performance testing. The licensee measured the RHR and the RHRSW flows, inlet and outlet fluid temperatures, using a test instrumentation and data collection system and recording multiple data points during the period of stable operation. From the test data, by calculating the heat transfer rate from the heat balance across the two sides of the heat exchanger, using the measured flows, and using data from the heat exchanger manufacturer's data sheet, the licensee calculated the overall fouling resistance to be 0.0005164 hr-ft.^{2}- °F/BTU for heat exchanger 3A and 0.000674 hr-ft.^{2}- °F/BTU for heat exchanger 3C.

In SCVB-RAI-11 (Reference 35), the NRC staff referred to the potential requirement in GL 89-13, which states:

> Conduct, on a regular basis, performance testing of all heat exchangers, which are cooled by the service water system and which are needed to perform a safety function, to verify heat exchanger heat transfer capability.

The NRC staff requested that the licensee provide the frequency of the RHR heat exchanger performance testing, the RHR heat exchanger performance testing method, and the previous (prior to 2012 test) heat transfer capability results, along with the worst fouling factor results, for the heat exchanger tests performed at the end of service cycle.

In its response to SCVB-RAI-11 (Reference 24), the licensee stated that in its response to GL 89-13, dated March 16, 1990 (Reference 137), it proposed regular inspection and cleaning, which was accepted by the NRC as an alternative to heat exchanger performance testing. The licensee referred to previous testing done in October 1994 and March 2001 for measuring RHR heat exchanger performance. The licensee stated that results from these tests were not used for establishing the heat exchanger performance for safety analysis; however, they show consistency with the present test results performed in January 2012. In the October 1994 and March 2001 tests, the licensee used temporary test instrumentation for accurately measuring the heat exchanger inlet and outlet water temperatures and used data collection devices to obtain data from the temperature and permanent flow instrumentation while testing the heat exchangers with the RHR system operating in the shutdown cooling mode during a plant outage. From the data collected, the licensee calculated the heat transfer rates and the overall fouling factors. Table 3.9-1, which is taken from the licensee's response to SCVB-RAI-11(c) (Reference 24), provides a comparison of the fouling factors determined from the October 1994, March 2001, and January 2012 performance tests.

Table 3.9-1

Test Date	**Heat Exchanger**	**Calculated Fouling Factor ($hr\text{-}ft^2\text{-}{}^oF/BTU$)**	**Approximate Time Since Last Cleaning (years)**
October 1994	RHR 2C	0.00083	1.5
March 2001	RHR 2D	0.00068	2
January 2012	RHR 3A	0.000516	2
January 2012	RHR 3C	0.000674	4

3.9.3.4 Comparison of Tested and Assumed Worst Case RHR Heat Exchanger Fouling Resistances

Comparing the assumed worst fouling resistance of 0.001517 hr-ft.^{2}-°F/BTU (corresponding to a k-factor of 265 BTU/sec- °F) at the LOCA state point condition with the measured worst fouling resistance of 0.000674 hr-ft.^{2}- °F/BTU for RHR heat exchanger 3C (tested at the end of its 4-year service cycle) demonstrates a substantial margin of 55.6 percent. The licensee stated that the margin is significantly large to account for the uncertainty associated with having only two performance test results.

3.9.3.5 NFPA 805 Containment NPSH Analysis

The purpose of the licensee's proposed NFPA 805 containment NPSH analysis is to calculate the NPSHa for the RHR system pumps for the limiting post-fire shutdown scenario. The NPSHa is then compared to the RHR pump NPSH required (NPSHr) for demonstrating NPSH margin to ensure that RHR pumps can perform their required safety functions. As stated in SECY-11-0014, Enclosure 1, the NPSHr for a special event such as a fire event, can be assumed to be the hydraulic institute (HI) standard value at which the pump dynamic head is degraded by 3 percent for a given flow.

In its response to SCVB-RAI-6 (Reference 17), the licensee stated that it used the same methodology using the General Electric Hitachi computer code super HEX (SHEX) for the Appendix R fire and the NFPA 805 containment NPSH analyses. For calculating the piping head loss and the NPSHa at the RHR pump suction, the licensee used the same multiflow hydraulic flow balance software for the NFPA 805 analysis as used in the Appendix R analysis.

The heat exchanger operating conditions assumed in the NFPA 805 containment NPSH analysis is different than the LOCA state point condition. In its response to SCVB-RAI-3a (Reference 17), the licensee provided the following limiting state point conditions associated with the NFPA 805 containment NPSH analysis: RHR flow of 7500 gpm, RHRSW flow of 4400 gpm, RHRSW temperature of 92 °F, and 4.57 percent RHR heat exchanger tube plugging. The corresponding k-factor using the worst fouling resistance of 0.001517 hr-ft^2-°F/BTU at the NFPA 805 conditions is 284.5 BTU/sec- °F, and therefore, the heat transfer rate would be greater. For the purpose of comparison, in its response to SCVB-RAI-3b (Reference 17), the licensee provided the estimated value of the k-factor to be 372 BTU/sec- °F for a clean RHR heat exchanger (i.e., zero fouling and no tubes plugged at the limiting NFPA-805 analysis state point conditions).

In SCVB-RAI-3d (Reference 32), the NRC staff requested that the licensee confirm that the k-factor of 284.5 BTU/sec- °F is based on the most conservative values of the RHR and RHR service water (RHRSW) flows of 7500 gpm and 4400 gpm respectively, and to confirm that for any of the RHR operating modes, the k-factor will not be less than 284.5 BTU/sec- °F. In its response to SCVB-RAI-3d (Reference 17), the licensee stated that for RHRSW flow, quarterly RHRSW pump surveillance testing is conducted to demonstrate that each pump can deliver a flow of at least 4500 gpm. The licensee further stated that its flow calculations show that a flow of 4500 gpm is achievable based on the most limiting RHRSW pump alignment when two RHRSW pumps are supplying a single RHRSW header. However, as stated above, the k-factor of 284.5 BTU/sec-°F is conservatively based on RHRSW flow of 4400 gpm. For the RHR system flow, the licensee stated that the system is credited in the following two operating modes for the NFPA 805 containment NPSH analyses: (1) alternate shutdown cooling (ASDC) mode, and (2) suppression pool cooling (SPC) mode. The licensee conducts the RHR pump surveillance in the SPC mode to verify the flow is ≥ 9000 gpm. The licensee's calculated maximum RHR flow rate in the ASDC mode is 9100 gpm. Therefore the RHR flow of 7500 gpm is justified to be within the system capability for an RHR pump operating in the SPC and ASDC modes. In conclusion, the licensee confirmed and the NRC staff finds it acceptable, that the k-factor of 284.5 BTU/sec- °F is based on the conservative RHR and RHRSW flows of 7500 gpm and 4400 gpm respectively, and will not be less than 284.5 BTU/sec- °F for the NFPA 805 containment NPSH analysis with the RHR operating in the SPC or ASDC mode.

In its response to SCVB-RAI-6 (Reference 17), the licensee stated that it did not credit CAP for calculating NPSHa (i.e., wetwell assumed to be at atmospheric pressure). However, in the Appendix R fire NPSHa calculations, the licensee did not credit water velocity head at the inlet of the RHR pump; whereas the NFPA 805 NPSHa calculation included the water velocity head, resulting in a small NPSHa increase of 0.5 feet at the NFPA 805 state point condition.

3.9.3.5.1 NFPA 805 Containment NPSH Analysis Cases

The licensee analyzed the three NFPA 805 post-fire shutdown cases and determined the NPSHa as a function of time. The licensee's description for these cases is as follows:

Case 1 – NFPA-805 - Early Reactor Depressurization with Alternate Shutdown Cooling

- No spurious operation of plant equipment;
- Reactor depressurization begins at 25 minutes using three main steam relief valves (MSRVs); and
- One RHR pump is aligned in the low pressure coolant injection (LPCI) mode during the reactor depressurization. One RHR heat exchanger is in service and one RHRSW pump is initiated at 2 hours.

Case 2 – NFPA-805 - High Pressure Systems Available and Delayed Reactor Depressurization:

- Reactor cooldown is initiated at 10 minutes at 100 °F/hr using MSRVs until reactor pressure is 65 pounds per square inch gauge (psig);
- High pressure injection isolates at 150 psig;
- Following isolation of high pressure injection, the vessel inventory is maintained using low pressure system pumping from the suppression pool; and,
- One RHR pump in suppression pool cooling. One RHRSW pump in service at 2 hours.

Case 3 - NFPA 805 - Condensate System Available

- Reactor depressurization begins at 25 minutes using three MSRVs,
- As the reactor is depressurized, condensate pumps replenish reactor inventory until condensate inventory is used up; and
- After condensate is secured, one RHR pump is aligned into LPCI/ASDC mode. One RHR heat exchanger in service and one RHRSW pump is initiated at 2 hours.

For Cases 1 and 2, the licensee used a RHR heat exchanger k-factor of 270 BTU/sec- °F and the RHRSW initiation time of 2.0 hours from the initiation of the event. For Case 3, the licensee used a k-factor of 289 BTU/sec- °F and the RHRSW initiation time of 1.5 hours from the initiation of the event in the SHEX model. In SCVB-RAI-12(a) (Reference 35), the NRC staff requested that the licensee explain the reason of using a higher value of k-factor for Case 3. In its response to SCVB-RAI-12(a) (Reference 24), the licensee stated:

> At the time of the SHEX analysis, TVA had initially predicted that in order to obtain an acceptable peak suppression pool temperature result, it would be necessary to reduce the conservatism for two of the Case 3 SHEX inputs (i.e., k-factor and RHRSW initiation time, relative to the assumptions used for Cases 1 and 2. Therefore, a k-factor of 289 BTU/sec- °F was used versus 270 BTU/sec- °F and an RHRSW initiation time of 1.5 hours was used versus 2.0 hours. During the subsequent review process for the final calculation, TVA determined that it did not need this reduction in conservatism and that all NFPA 805 analysis cases should be done using the same input assumptions (i.e., k-factor of 270 BTU/sec- °F and an RHRSW initiation time of 2.0 hours. To accomplish this, the SHEX results were adjusted for these changes using a TVA suppression pool heat balance calculation model (i.e., the TVA Model) as discussed in Part c [Response to SCVB-RAI-12(c)] of this RAI response.

In the above response, the licensee proposed to adjust Case 3 NPSHa results obtained with k-value 289 BTU/sec- °F to 270 BTU/sec- °F using a new methodology called “TVA Model” instead of using the NRC accepted SHEX model. The licensee stated that the TVA Model results have been benchmarked against the SHEX model results. Since Case 3 was the most limiting case with the least NPSH margin, in SCVB-RAI-12(b) through -12(d) (Reference 35), and SCVB-RAI-13 (Reference 36), the NRC staff requested additional information regarding the TVA model because it did not use the model previously in the licensing basis analysis. The licensee was also given the option to re-analyze NFPA 805, Case 3 with the SHEX code while using the same inputs and assumptions in Cases 1 and 2, RHR heat exchanger k- factor of 270 BTU/sec- °F, and RHRSW initiation time of 2 hours. In its response to SCVB-RAI-13 (Reference 25), consistent with Cases 1 and 2 analyses, the licensee opted to re-analyze Case 3 with the SHEX code, RHR k-factor of 270 BTU/sec- °F, and RHRSW initiation time of 2 hours. The peak suppression pool temperature and NPSH margin results for the three NFPA 805 cases are shown in Table 3.9-2 below.

Table 3.9-2

NFPA 805 Case #	Model	k-factor BTU/sec-°F	RHRSW Initiation Time (hrs)	Peak Pool Temperature (°F)	Minimum NPSHa (ft)	NPSHr (ft)	Margin NPSHa-NPSHr (ft)
1	SHEX	270	2.0	202.0	18.9	16	2.9
2	SHEX	270	2.0	195.3	22.6	16	6.6
3	SHEX	270	2.0	205.7	16.65	16	0.65
3	SHEX	289	1.5	199.1	20.67	16	4.67

While reviewing the values of the input parameters for the three NFPA cases, the NRC staff noted inconsistencies between those listed in LAR Attachment X and those in Enclosure 1 of a letter from TVA dated April 10, 2009 (Reference 138). In SCVB-RAI-8 (Reference 32), the NRC staff requested that the licensee justify or remove the inconsistencies within the three NFPA 805 cases analyzed as listed in Table 3.9-3 below.

Table 3.9-3

Parameter	Cases 1 & 3	Case 2	Reference 136, Enclosure 1
Initial suppression pool volume corresponding to minimum suppression pool level	122,940 ft^3	122,940 ft^3	121,500 ft^3 (page E1-6, item 3.a.1)
Initial wetwell airspace volume	127,860 ft^3	127,860 ft^3	129,300 ft^3 (page E1-7, item 3.c.2)
Initial drywell pressure	15.5 psia	17 psia	17 psia (page E1-5, item 2.b.6)
Initial drywell relative humidity	50%	20%	20% (page E1-5, item 2.d.5)
Initial wetwell pressure	14.4 psia	15.9 psia	15.9 psia (page E1-7, item 3.d.6)

In SCVB-RAI-9 (Reference 32), the NRC staff requested that the licensee explain why the following input parameters for the cases analyzed are conservative for minimizing NPSHa for the RHR pumps: (a) initial suppression pool volume corresponding to minimum suppression pool level, (b) initial drywell pressure, (c) initial drywell temperature, (d) initial drywell relative humidity, (e) initial wetwell pressure, (f) initial wetwell temperature, and (g) initial wetwell relative humidity.

In its response to SCVB-RAI-8 (Reference 17), the licensee stated that its letter dated April 10, 2009 (Reference 138), transmitted the parameter values for the design basis LOCA containment analysis for the extended power uprate (EPU). The special events analyses such as the Appendix R fire and the NFPA 805 analyses use realistic values for some of the input parameters as allowed in SECY-11-0014, Enclosure 1. The licensee's EPU applications were submitted by letter dated June 25, 2004 (Reference 139), for Units 2 and 3, and by letter dated June 28, 2004 (Reference 140), for Unit 1, which the NRC did not approve.

In its response to SCVB-RAI-9 (Reference 17), the licensee stated that because CAP credit is not taken, the NPSHa depends on the calculated peak suppression pool temperature, which is sensitive only to the initial suppression pool volume and temperature. Even though the remaining parameters are not important in calculating the peak suppression pool temperature, the licensee still assigned their initial values to minimize CAP.

For the input parameters listed in its responses to SCVB-RAI-8 and SCVB-RAI-9 (Reference 17), the licensee provided the following explanation for the differences in their values and justification for them being conservative:

Initial Suppression Pool Volume Corresponding to Minimum Suppression Pool Level

The licensee used a conservatively smaller pool volume value of 121,500 $ft.^3$ in the LOCA analyses. However, for the Appendix R and the NFPA 805 analysis, Cases 1, 2, and 3, the licensee used an initial suppression pool volume of 122,940 $ft.^3$ with a minimum drywell-to-wetwell pressure differential of 1.1 pounds per square inch (psi). This initial suppression pool volume corresponds to TS minimum suppression pool level. The minimum initial suppression pool volume is conservative because it would result in higher peak suppression pool temperature response.

Initial Wetwell Airspace Volume

For the Appendix R and the NFPA 805 analyses, Cases 1, 2, and 3, the 127,860 $ft.^3$ wetwell airspace volume is the total suppression chamber volume minus the 122,940 $ft.^3$ initial suppression pool volume corresponding to the technical specification (TS) minimum pool level. The 129,300 $ft.^3$ wetwell airspace volume used in the LOCA analyses is the total suppression chamber volume minus the conservatively smaller initial pool volume of 121,500 $ft.^3$ used in the LOCA containment analyses.

Initial Drywell Pressure

The Appendix R and NFPA 805 analyses, Cases 1 and 3 initial drywell pressure corresponds to the minimum assumed wetwell pressure of 14.4 pounds per square inch absolute (psia) plus the minimum 1.1 psi drywell-to-wetwell differential pressure. The minimum initial drywell and wetwell pressures were used to minimize non-condensable gases in the containment and minimize wetwell pressure for NPSHa. However, the NPSHa calculation is not affected because CAP is not credited. In the licensee's letter dated April 10, 2009 (Reference 138), the licensee used the higher initial drywell pressure of 17 psia for LOCA containment analyses to conservatively maximize the containment pressure and show that the peak pressure and temperature do not exceed the containment design limits.

The NFPA 805 analysis, Case 2 used the higher initial drywell pressure of 17 psia to maximize drywell temperature and pressure. However, this case is not limiting for the suppression pool temperature and does not affect the NPSHa calculation because CAP is not credited.

Initial Drywell Relative Humidity

The Appendix R and NFPA 805 analyses, Cases 1 and 3 initial relative humidity (RH) value of 50 percent is based on licensee's parametric study that determined the maximum of 45.5 percent drywell RH will condense steam that do not exceed the TS allowable unidentified leakage limit. The maximum initial drywell RH minimizes containment non-condensable wetwell pressure for NPSHa. However, the NPSHa calculation is not affected because CAP is not credited. In the licensee's letter dated April 10, 2009 (Reference 138), the licensee used a low initial RH of 20 percent for LOCA containment analyses to conservatively maximize containment pressure. A low RH increases the initial amount of non-condensable gases in the containment and conservatively maximizes the containment pressure and shows that the peak pressure and temperature do not exceed the containment design limits.

The NFPA 805, Case 2 used the lower initial RH of 20 percent to maximize the drywell temperature and pressure. However, this case is not limiting for the suppression pool temperature and does not affect the NPSHa calculation because CAP is not credited.

Initial Wetwell Pressure

The Appendix R and NFPA 805 analyses, Cases 1 and 3 initial drywell pressure corresponds to the minimum assumed wetwell pressure of 14.4 psia. The minimum initial drywell and wetwell pressures were used to minimize non-condensable gases in the containment and minimize wetwell pressure for NPSHa. However, the NPSHa calculation is not affected because CAP is not credited.

In the licensee's letter dated April 10, 2009 (Reference 138), the licensee used the higher initial wetwell pressure of 15.9 psia for LOCA containment analyses to conservatively maximize the containment pressure and show that the peak pressure and temperature do not exceed the containment design limits.

The NFPA 805 analysis, Case 2 used the higher initial wetwell pressure of 15.9 psia to maximize drywell temperature and pressure. However, this case is not limiting for the suppression pool temperature and does not affect the NPSHa calculation because CAP is not credited.

Initial Drywell Temperature

The licensee used the TS maximum allowed 150 °F as the initial drywell temperature for all three NFPA 805 analysis cases. The higher value of drywell temperature is conservative because the capacity of the drywell components to act as heat sinks is minimized, which, therefore, maximizes the suppression pool temperature response.

Initial Wetwell Temperature

For all three NFPA 805 analysis cases, the licensee assumed the wetwell airspace to be in thermal equilibrium with the suppression pool. Therefore, the initial wetwell airspace temperature is assumed to be 95 °F, which is equal to the TS maximum allowed suppression pool temperature. This is conservative because a high initial wetwell airspace temperature reduces the amount of non-condensable gases and minimizes the containment pressure response. However, it does not affect the NPSHa calculation because CAP is not credited.

Initial Wetwell Relative Humidity

For all three NFPA 805 analysis cases, the licensee assumed initial wetwell RH to be 100 percent because the wetwell airspace is in continuous contact with the suppression pool. This is conservative because higher RH minimizes non-condensable gases and reduces containment pressure response. However, it does not affect the NPSHa calculation because CAP is not credited.

In SCVB-RAI-7 (Reference 32), the NRC staff requested that the licensee provide the basis for selecting each of the Cases A, B, and C identified in LAR Attachment X. The NRC staff also requested that the licensee confirm for other possible (or postulated) NFPA 805 analysis cases that require containment cooling and that those cases use acceptable NPSH margin for the pumps.

In its response to SCVB-RAI-7 (Reference 17), the licensee stated that it performed the NFPA 805 containment analysis to support the NSCA, which establishes the success criteria and timing requirements for the fire safe shutdown (SSD) paths. The fire SSD paths should achieve and maintain the plant in a safe and stable condition. The licensee confirmed that the cases analyzed bound the range of operator actions, action timing, equipment availability, and spurious operation assumed in the nuclear safety capability assessment (NSCA) for all of the fire areas. The containment parameters of interest for fire events are peak suppression pool temperature, drywell temperature, and peak containment pressure. Since CAP credit is not being taken in the NFPA 805 analyses; the calculated wetwell pressure is not a parameter in calculating NPSHa. The suppression pool temperature response is the parameter affecting NPSHa evaluation. The licensee provided the following basis for selecting the three NFPA 805 analysis cases:

NFPA 805, Case 1 - Early Reactor Depressurization with ASDC

Case 1 corresponds to the EPU Appendix R case that resulted in the highest suppression pool temperature and minimum NPSHa for the RHR pumps. Therefore, this case was repeated for NFPA 805 to determine whether it would be limiting at the current licensed thermal power condition.

In the Case 1 analysis scenario, no high pressure injection systems are assumed to be available and the reactor must be depressurized early in the event sequence to allow use of a low pressure injection system (i.e., RHR) to reflood the reactor. Following depressurization, RHR is aligned to the ASDC mode for long-term containment heat removal. In the ASDC mode, suppression pool water is injected into the reactor vessel, the vessel is flooded up to the steam line elevation, and reactor water inventory is returned to the suppression pool via the MSRV lines. The early reactor depressurization and direct mixing of the suppression pool volume with the reactor vessel water inventory in ASDC mode results in an increased suppression pool temperature relative to Case 2 and moderate NPSH pump margin as shown in LAR Attachment X, Table 2.

<u>NFPA 805, Case 2 – High Pressure Systems Available and Delayed Reactor Depressurization</u>

In the Case 2 analysis scenario, high pressure injection remains available, thus the fire SSD procedures use high pressure injection to maintain vessel inventory. Injection of external water inventory (i.e., condensate storage tank water) results in a lower peak suppression pool temperature because the cooler external injection water mixes with the primary system water inventory and the added water mass increases the net heat sink water volume in containment. Because the water supply inventory available to the high pressure systems is limited, a transition to a low pressure system such as RHR will eventually be necessary for long-term reactor inventory makeup. Because Case 2 involves an extended time with the reactor at pressure and temperature, it was specifically analyzed to verify drywell temperature would stay within design limits. As shown in LAR Attachment X, Table 2, Case 2 resulted in a comparatively low peak suppression pool temperature with several feet of RHR pump NPSH margin. Therefore, it was not a limiting NPSH case.

<u>NFPA, 805 Case 3 – Condensate System Available</u>

Case 3 is similar to Case 1 except that the condensate system continues to run after the reactor scram. With high pressure injection not available, as the reactor is depressurized early in the event, it is assumed that the entire feedwater and condenser inventory is injected into the reactor. This assumption results in a higher suppression pool temperature than in Case 1 because the additional injected water inventory is at elevated temperature, thus adding more heat to the containment. After the feedwater and condenser inventory is consumed, RHR operating in ASDC mode is used for core cooling and long-term containment heat removal.

Because Case 3 further maximizes suppression pool temperature, it was selected to calculate NPSH margin. As shown in LAR Attachment X, Table 2, Case 3 resulted in the highest suppression pool temperature and was the limiting NFPA 805 NPSH case.

The licensee used 92 degrees Fahrenheit (°F) as the RHRSW temperature instead of the UHS temperature of 95 °F specified in the TS surveillance requirement 3.7.2.1. In SCVB-RAI-4 (Reference 32), the NRC staff requested that the licensee revise the NFPA 805 analysis using RHRSW temperature of 95 °F, or justify using 92 °F. In its response to SCVB-RAI-4 (Reference 17), the licensee stated that the RHRSW temperature of 95 °F is used in the design basis LOCA containment analyses. SECY-11-0014, Enclosure 1 (Reference 133) allows use of realistic input values for special events analyses such as Appendix R and NFPA 805.

The licensee provided the following justification for UHS or RHRSW temperature of 92 °F as a realistic value:

> The 92 °F is based on the 95% non-exceedance probability from a statistical analysis of 6.1 years of Tennessee River water temperature data between 2000

> and 2005, and serves as an appropriate basis for establishing a realistic upper bound value for UHS temperature. The seasonal variation of river water temperature is consistent; a large amount of historical data is available to make statistical predictions. A probability distribution was developed from the river temperature data and was used to predict the frequency of occurrence as a function of temperature. This probability distribution was previously provided to the NRC in a TVA letter dated July 21, 2006, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Technical Specifications Changes TS-431 and TS-418 - Extended Power Uprate - Response to Round 6 Request for Additional Information" (ADAMS Accession No. ML062090071) (Reference 141). The probability distribution shows that the river temperature is not expected to exceed 92 °F for 95% of the time. No data points in the dataset exceeded 90 °F.

The NRC staff confirmed that SECY-11-0014, Enclosure 1 allows using realistic values of the initial conditions for special event analysis such as NFPA 805. The NRC staff finds the above justification acceptable because the UHS temperature data shows that its temperature is not expected to exceed 92 °F for 95 percent of the time, and that no data points in the temperature dataset exceeded 90 °F.

In SCVB-RAI-10 (Reference 32), the NRC staff requested that the licensee confirm that the heat transfer coefficients and heat sinks modeled in the NFPA 805 analysis cases are the same as in the Appendix R analysis and provide justification in case the conservatism is reduced in the NFPA 805 analysis. In its response to SCVB-RAI-10 (Reference 18), the licensee stated that: (a) it used the SHEX computer model for the current and the NFPA 805 containment NPSH analyses; (b) there are no differences in the drywell and wetwell heat sinks between the current and the NFPA 805 analyses; and (c) the method of modeling heat sinks and the heat transfer coefficients of concern that are between the drywell heat sinks and surroundings, between the wetwell heat sinks and surroundings, and between the wetwell airspace and the suppression pool, are not changed between the current and the NFPA 805 analysis. However, the licensee also stated the following differences between the current and the NFPA 805 analysis: (a) in the current analysis, drywell coolers were assumed to operate for the first 2 hours during the transient for minimizing the CAP contribution to the NPSHa for the RHR pumps. The NFPA 805 analysis assumes the drywell coolers are not operating during the event, which is conservative because the analysis does not take CAP credit, and therefore, the NPSHa for the RHR pumps is not affected. The assumption of drywell coolers not operating during the event introduces further conservatism in the NFPA 805 NPSH analysis, because a conservatively higher suppression pool temperature will result if the drywell coolers are not assumed in operation; and (b) in the current analysis, the licensee modified the control rod drive system piping containment heat source for 30 minutes following the reactor scram to more accurately model the drywell temperature response. The licensee stated that including this heat load did not significantly affect the suppression pool temperature. For the NFPA 805 analysis, since the licensee did not take CAP credit, the NRC staff concludes that the effect on containment pressure resulting from the drywell air space temperature response changes do not affect the NPSHa for RHR pumps.

3.9.3.5.2 NPSH Margin Results

SE Table 3.9-2 shows positive results of the NPSH margin (NPSHa minus NPSHr) for the three NFPA 805 cases analyzed. The margin is based on the NPSHr value, which as defined in the hydraulic institute standard is the NPSH at which the pump dynamic head is degraded by 3 percent at a given flow. The most limiting case is Case 3, which has the least NPSH margin equal to 0.65 feet.

3.9.3.6 RHR Heat Exchanger Performance Monitoring Program

The licensee performed thermal performance testing for only two BFN, Unit 3 RHR heat exchangers. Therefore, in order to detect and correct, in a timely manner, the fouling that could adversely affect the heat exchanger performance, the licensee committed to a performance monitoring for the heat exchangers of all three BFN units. In SCVB-RAI-5 (Reference 32), the NRC staff requested that the licensee describe the performance monitoring program that will assure that fouling factor and tube plugging would not exceed their worst values assumed in calculating k-factor of 284.5 BTU/sec- °F. In its response to SCVB-RAI-5 (Reference 17), the licensee stated that at the current time, the revised performance monitoring program has not been developed. Commitment number 2 in Enclosure 2 to the licensee's letter dated May 16, 2013 (Reference 9), describes the licensee's proposal to revise the RHR heat exchanger performance monitoring program. In this commitment, the licensee intends to include in the program the requirements of periodic heat exchanger inspections and performance testing to ensure that the worst fouling resistance, with measurement uncertainty added, is less than 0.001517 hr-ft.^{2}- °F/BTU, and the worst tube plugging is less than 4.57-percent in all RHR heat exchangers as assumed in the NFPA 805 containment NPSH analysis. In a letter dated October 20, 2015 (Reference 30), the licensee submitted a revised LAR Attachment S, Table S-3, Implementation Item 49 to revise the program that monitors the RHR heat exchanger performance for consistency with the assumptions of the NFPA 805 NPSH analysis. The NRC staff concludes that this action is acceptable because it would be required by the proposed license condition.

3.9.4 Conclusion for Section 3.9

The NRC staff concludes that following the guidance in RG 1.82, Revision 4, Section C1.3.1.1, and SECY-11-0014, Enclosure 1, the licensee eliminated reliance on CAP in calculating the RHR pump NPSHa during the most limiting NFPA 805 event at the current licensed power level.

4.0 FIRE PROTECTION LICENSE CONDITION

The licensee proposed a fire protection program license condition regarding transition to a risk-informed/performance-based (RI/PB) fire protection program under NFPA 805 in accordance with 10 CFR 50.48(c)(3)(i). The new license condition adopts the guidelines of the standard fire protection license condition promulgated in RG 1.205, Revision 1, RP C.3.1, as issued on December 18, 2009 (74 FR 67253). Plant-specific changes were made to the sample license condition; however, the proposed plant-specific fire protection program license condition is consistent with the standard fire protection license condition and incorporates all of the relevant features of the transition to NFPA 805 at BFN, Units 1, 2, and 3, and is, therefore, acceptable.

The following license condition will be included in the renewed BFN, Units 1, 2, and 3, Operating License Nos. DPR-33, DPR-52, and DPR-68, Conditions 2.C.(13), 2.C.(14), and 2.C.(7):

Fire Protection Program

Tennessee Valley Authority shall implement and maintain in effect all provisions of the approved fire protection program that complies with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment request dated March 27, 2013 as supplemented by letters dated May 16, 2013, November 22, 2013, December 20, 2013, January 10, 2014, January 14, 2014, February 13, 2014, March 14, 2014, May 30, 2014, June 13, 2014, July 10, 2014, August 14, 2014, August 29, 2014, September 16, 2014, October 6, 2014, December 17, 2014, March 26, 2015, April 9, 2015, June 19, 2015, August 18, 2015, September 8, 2015, and October 20, 2015, as approved in the SE dated October 28, 2015. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval, the licensee may make changes to the fire protection program without prior approval of the Commission if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied.

Risk-Informed Changes that May Be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at BFN. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

a) Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

b) Prior NRC review and approval is not required for individual changes that result in a risk increase less than $1X10^{-7}$/year (yr) for CDF and less than $1X10^{-8}$/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Other Changes that May Be Made Without Prior NRC Approval

1) Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program

Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to an NFPA 805, Chapter 3, element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

- "Fire Alarm and Detection Systems" (Section 3.8);
- "Automatic and Manual Water-Based Fire Suppression Systems" (Section 3.9);
- "Gaseous Fire Suppression Systems" (Section 3.10); and
- "Passive Fire Protection Features" (Section 3.11).

This License Condition does not apply to any demonstration of equivalency under Section 1.7 of NFPA 805.

2) Fire Protection Program Changes that Have No More than Minimal Risk Impact

Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC SE dated October 28, 2018, to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

1) Before achieving full compliance with 10 CFR 50.48(c), as specified by 2) below, risk informed changes to the licensee's fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in 2) above.

2) The licensee shall implement the modifications to its facility, as described in Table S-2, "Plant Modifications," of Tennessee Valley Authority letter CNL-15-191, dated September 8, 2015, to complete the transition to full compliance with 10 CFR 50.48(c) no later than the end of the second refueling outage (for each unit) following issuance of the license amendment. The licensee shall maintain appropriate compensatory measures in place until completion of these modifications.

3) The licensee shall complete the implementation items as listed in Table S-3, "Implementation Items," of Tennessee Valley Authority letters CNL-15-191, dated September 8, 2015, and CNL-15-224, dated October 20, 2015 within 240 days after issuance of the license amendment unless that date falls within a scheduled refueling outage. Then, implementation will occur within 60 days after startup from that scheduled refueling outage. Implementation items 32 and 33 are associated with modifications and will be completed after all procedure updates, modifications, and training are complete.

5.0 SUMMARY

The NRC staff reviewed the licensee's application, as supplemented by various letters, to transition to a risk-informed/performance-based fire protection program (RI/PB FPP) in accordance with the requirements established by NFPA 805. The NRC staff concludes that, subject to completion of the modifications and implementation items in license amendment request (LAR) Attachment S, the applicant's approach, methods, and data are acceptable to establish, implement and maintain an RI/PB FPP in accordance with 10 CFR 50.48(c).

Accordingly, implementation of the RI/PB FPP in accordance with 10 CFR 50.48(c) is reflected by a new fire protection license condition that identifies the list of implementation items that must be completed in order to support the conclusions made in this safety evaluation (SE) and establishes a date by which full compliance with 10 CFR 50.48(c) must be achieved. Before the licensee is able to fully implement the transition to an FPP based on NFPA 805 and apply the new fire protection license condition to its full extent, the implementation items must be completed within the timeframe specified in the transition License Condition 3.

6.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Alabama State official was notified of the proposed issuance of the amendment. The State official had no comments.

7.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of facility components located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding published in the Federal Register (FR) on August 13, 2013 (78 FR 49302). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

8.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner; (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations; and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

9.0 REFERENCES

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Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Flame Height (Method of Heskestad)	The licensee implemented the Flame Height Correlation in the Fire Modeling Workbook (FMWB). The licensee used the correlation to determine the vertical extension of the flame region as part of the Zone of Influence (ZOI) calculations.	NUREG-1805, Chapter 3, 2004 (Reference 58) NUREG-1824, Volume 3, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 2-1, 2008 (Reference 122)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in NUREG-1824 and the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, the correlation has been applied within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Plume Centerline Temperature (Method of Heskestad)	The licensee implemented the Plume Centerline Temperature correlation in the FMWB. The licensee used the correlation to determine vertical separation distance, based on temperature, to a target in order to determine the vertical extent of the ZOI.	NUREG-1805, Chapter 9, 2004 (Reference 58) NUREG-1824, Volume 3, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 2-1, 2008 (Reference 122)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in NUREG-1824 and the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, the correlation has been applied within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Radiant Heat Flux (Point Source Method)	The licensee implemented the Radiant Heat Flux (Point Source Method) correlation in the FMWB. The licensee used the correlation to determine the horizontal separation distance, based on heat flux, to a target in order to determine the horizontal extent of the ZOI.	NUREG-1805, Chapter 5, 2004 (Reference 58) NUREG-1824, Volume 4, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering 4th Edition, Chapter 3-10, 2008 (Reference 123)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in NUREG-1824 and the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, the correlation has been applied within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.
Plume Radius (Method of Heskestad)	The licensee implemented the Plume Radius (Method of Heskestad) correlation in the FMWB to calculate the horizontal radius, based on temperature, of the plume at a given height.	SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 2-1, 2008 (Reference 122) NUREG-1824, Volume 4, 2007 (Reference 59)	• The licensee provided verification of the FMWB on the basis of a comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in the SFPE Handbook of Fire Protection Engineering. • Since this correlation is derived from Heskestad's plume centerline temperature correlation the same V&V applies to it (Response to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Hot Gas Layer (Method of McCaffrey, Quintiere, and Harkleroad)	The licensee implemented the HGL (Method of McCaffrey, Quintiere, and Harkleroad) correlation the FMWB. The licensee used the correlation to calculate the HGL temperature for a room with natural ventilation.	NUREG-1805, Chapter 2, 2004 (Reference 58) NUREG-1824, Volume 3, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 3-6, 2008 (Reference 124)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in NUREG-1824 and the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, the correlation has been applied within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Responses to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Hot Gas Layer (Method of Beyler)	The licensee implemented the Hot Gas Layer (Method of Beyler) correlation in the FMWB. The licensee used the correlation to calculate the HGL temperature for a room with no ventilation.	NUREG-1805, Chapter 2, 2004 (Reference 58) NUREG-1824, Volume 3, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 3-6, 2008 (Reference 124)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03b (Reference 12)). • The correlation is validated in NUREG-1824 and the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, the correlation has been applied within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 03b (Reference 12)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Ceiling Jet Temperature (Method of Alpert)	The licensee implemented the Ceiling Jet Temperature (Method of Alpert) correlation in the FMWB. The licensee used the correlation to calculate horizontal separation distance, based on temperature at the ceiling of a room, to a target in order to determine the horizontal extent of the ZOI.	NUREG-1824, Volume 4, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 2-2, 2008 (Reference 125)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in NUREG-1824 and the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, the correlation has been applied within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Sprinkler Activation Correlation	The licensee implemented the Sprinkler Activation Correlation in the FMWB. The licensee used the correlation to estimate sprinkler actuation timing based on ceiling jet temperature, velocity, and thermal response of sprinkler.	NUREG-1805, Chapter 10, 2004 (Reference 58) NFPA Handbook of Fire Protection Engineering, 19th Edition, Chapter 3-9, 2003 (Reference 126)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in the NFPA Fire Protection Handbook. • The licensee stated that in most cases, it applied the correlation within the validated range. The licensee provided justification for cases where it used the correlation outside the validated range (Response to FM RAI 04 (Reference 14)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment A: Table 3.8-1, V&V Basis for Fire Modeling Correlations Used at Browns Ferry

Correlation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Smoke Detection Actuation Correlation (Method of Heskestad and Delichatsios)	The licensee implemented the Smoke Detection Actuation correlation (Method of Heskestad and Delichatsios) in the FMWB. The licensee used the correlation to estimate smoke detection timing based on ceiling jet temperature, velocity, and thermal response of detector. The licensee used the method of Heskestad and Delichatsios to calculate the activation time.	NUREG-1805, Chapter 11, 2004 (Reference 58) NUREG-1824, Volume 4, 2007 (Reference 59) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 2-2, 2008 (Reference 125) SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 4-1, 2008 (Reference 127)	• The licensee provided verification of the FMWB on basis of comparison with NUREG-1805 (Response to FM RAI 03a (Reference 12)). • The correlation is validated in the SFPE Handbook of Fire Protection Engineering. • The licensee stated that in most cases, it applied the correlation within the validated range. The licensee provided justification for cases where it used the correlation outside the validated range (Response to FM RAI 03c (Reference 12)). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment B: Table 3.8-2, V&V Basis for Other Fire Models and Related Calculations Used at Browns Ferry

Calculation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Main Control Room Abandonment Time Calculation Fire Dynamics Simulator Version 5	The licensee used Fire Dynamics Simulator (Version 5) to calculate abandonment time for the MCRs based on HGL and smoke concentration.	NUREG-1824, Volume 7, 2007 (Reference 59) NIST SP 1018-5, Volume 2: Verification (Reference 129) NIST SP 1018-5, Volume 3: Validation (Reference 130)	• The modeling technique is validated in NUREG-1824 and authoritative publications of NIST. • The licensee stated that in most cases, it applied the correlation within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the information provided by the licensee, the NRC staff concludes that the use of FDS model in the Browns Ferry application is acceptable.
Temperature Sensitive Equipment Zone of Influence Study Fire Dynamics Simulator Version 5	The licensee used Fire Dynamics Simulator (Version 5) to calculate the radiant heat flux ZOI at which temperature sensitive equipment will reach damage thresholds.	NUREG-1824, Volume 7, 2007 (Reference 59) NIST SP 1018-5, Volume 2: Verification (Reference 129) NIST SP 1018-5, Volume 3: Validation (Reference 130)	• The modeling technique is validated in NUREG-1824 and authoritative publications of NIST. • The licensee stated that in most cases, it applied the correlation within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the information provided by the licensee, the NRC staff concludes that the use of FDS model in the Browns Ferry application is acceptable.

Attachment B: Table 3.8-2, V&V Basis for Other Fire Models and Related Calculations Used at Browns Ferry

Calculation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Plume/Hot Gas Layer Interaction Study Fire Dynamics Simulator Version 5	The licensee used Fire Dynamics Simulator (Version 5) to locate the point where HGL and plume interact and establish limits for plume temperature application.	NUREG-1824, Volume 7, 2007 (Reference 59) NIST SP 1018-5, Volume 2: Verification (Reference 129) NIST SP 1018-5, Volume 3: Validation (Reference 130)	• The modeling technique is validated in NUREG-1824 and authoritative publications of NIST. • The licensee stated that in most cases, it applied the correlation within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the information provided by the licensee, the NRC staff concludes that the use of FDS model in the Browns Ferry application is acceptable.
Hot Gas Layer Calculations CFAST Zone Model Version 6	The licensee used CFAST (Version 6) in the MCA to calculate the upper and lower gas layer temperatures and the layer height in connected compartments.	NUREG-1824, Volume 5, 2007 (Reference 59) NIST SP 1086, 2008 (Reference 128)	• The modeling technique is validated in NUREG-1824 and an authoritative publication of NIST. • The licensee stated that in most cases, it applied the correlation within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the information provided by the licensee, the NRC staff concludes that the use of CFAST model in the Browns Ferry application is acceptable.

Attachment B: Table 3.8-2, V&V Basis for Other Fire Models and Related Calculations Used at Browns Ferry

Calculation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Temperature Sensitive Equipment Hot Gas Layer Study CFAST Zone Model Version 6	The licensee used CFAST (Version 6) to calculate the upper and lower gas layer temperatures for various compartments, and the layer height, for use in assessment of damage to temperature sensitive equipment's.	NUREG-1824, Volume 5, 2007 (Reference 59) NIST SP 1086, 2008 (Reference 128)	• The modeling technique is validated in NUREG-1824 and an authoritative publication of NIST. • The licensee stated that in most cases, it applied the correlation within the validated range reported in NUREG-1824. The licensee provided justification for cases where it used the correlation outside the validated range reported in NUREG-1824 (Response to FM RAI 04 (Reference 14)). Based on its review and the information provided by the licensee, the NRC staff concludes that the use of CFAST model in the Browns Ferry application is acceptable.
Correlation for Heat Release Rates of Cables (Method of Lee)	The licensee used the Method of Lee to correlate bench scale data to HRRs from cable tray fires.	SFPE Handbook of Fire Protection Engineering, 4th Edition, Chapter 3-1, 2008 (Reference 131) NBSIR 85-3195, 1985 (Reference 132)	• The modeling technique is documented in the SFPE Handbook of Fire Protection Engineering and an authoritative publication of NIST. • The licensee stated that the correlation has been applied to cable tray arrangements, cable packing densities, and exposure fires consistent with those reported in NBISR 85-3195, or the model has been qualitatively justified as acceptable (Reference 8). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Attachment B: Table 3.8-2, V&V Basis for Other Fire Models and Related Calculations Used at Browns Ferry

Calculation	Application at Browns Ferry	V&V Basis	NRC Staff Evaluation of Acceptability
Correlation for Flame Spread over Horizontal Cable Trays (FLASH-CAT)	The licensee used the FLASH-CAT method to calculate the growth and spread of a fire within a vertical stack of horizontal cable trays.	NUREG/CR-7010, Section 9, 2012 (Reference 60) NUREG/CR-6850, Volume 2, Appendix R, 2005 (Reference 53)	• The modeling technique is validated in NUREG/CR-7010. • The licensee stated that the model has been applied to configurations consistent with those reported NUREG/CR-7010 or, the model has been qualitatively justified as acceptable (Reference 8). Based on its review and the licensee's explanation, the NRC staff concludes that the use of this correlation in the Browns Ferry application is acceptable.

Abbreviations and Acronyms

ADAMS	Agencywide Documents Access and Management System
AHJ	authority having jurisdiction
AIR	Auxiliary Instrument Room
ANS	American Nuclear Society
ANSI	American National Standards Institute
APCSB	Auxiliary and Power Conversion Systems Branch
ASDC	alternate shutdown cooling
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BFN	Browns Ferry Nuclear Plant, Units 1, 2, and 3
BTP	Branch Technical Position
BTU	British thermal unit
BWR	boiling-water reactor
ºC	degrees Celsius
CAP	containment accident pressure
CC	capability categories
CCDP	conditional core damage probability
CCW	condenser circulating water
CDF	core damage frequency
CFAST	consolidated model of fire and smoke transport
CFP	circuit failure probabilities
CFR	Code of Federal Regulations
CHRISTIFIRE	Cable Heat Release, Ignition, and Spread in Tray Installations During Fire
cm	centimeters
CPT	control power transformer
CR	control room
CSD	cold shutdown
CSR	cable spreading room
CT	current transformer
DC	direct current
DID	defense-in-depth
DID RA	defense-in-depth recovery action
EEEE	existing engineering equivalency evaluation
EOI	Emergency Operating Instruction
EPRI	Electric Power Research Institute
EPU	extended power uprate
ERFBS	electrical raceway fire barrier system
°F	degrees Fahrenheit
F&O	fact and observation
FAQ	frequently asked question
FDS	Fire Dynamics Stimulator
FDT	fire dynamics tool
FERO	fire emergency response organization
FLASH-CAT	Flame Spread over Horizontal Cable Trays
FM	fire modeling
FMWB	Fire Modeling Workbook
FPE	fire protection engineering

FPP	fire protection program
FPRA	fire probabilistic risk assessment
FR	Federal Register
FRE	fire risk evaluation
FSAR	final safety analysis report
GDC	General Design Criterion/Criteria
GL	generic letter
gpm	gallons per minute
HEAF	high-energy arcing fault
HEP	human error probability
HFE	human failure event
HGL	hot gas layer
HI	hydraulic institute
HRA	human reliability analysis
HRE	high risk evolution
HRR	heat release rate
HSD	hot shutdown
IEEE	Institute of Electrical and Electronics Engineers
IEPRA	internal events probabilistic risk assessment
in.	inch
IN	Information Notice
KSF	key safety function
kV	kilovolt
kW	kilowatt
LAR	license amendment request
lb	pound
LERF	large early release frequency
LOCA	loss-of-coolant accident
LPCI	low pressure coolant injection
m	meters
MCA	multi-compartment analysis
MCB	main control board
MCR	main control room
MG	motor generator
mils	1/1000 inch
MOV	motor-operated valve
MSO	multiple spurious operations
MQH	McCaffrey, Quintiere, and Harkleroad's Method
MSRV	main steam relief valves
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NPO	non-power operation
NPP	nuclear power plant
NPSH	net positive suction head
NPSHa	net positive suction head available
NPSHr	net positive suction head required
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation

NSCA	nuclear safety capability assessment
NSPC	nuclear safety performance criteria
P&ID	piping and instrumentation diagram
PAU	physical analysis unit
PB	performance-based
PCE	plant change evaluation
PCS	primary control station
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PVC	polyvinyl chloride
PWR	pressurized-water reactor
QA	quality assurance
RA	recovery action
RAI	request for additional information
RCA	radiologically controlled area
RCIC	reactor core isolation cooling
RCP	reactor coolant pump
RES	Office of Nuclear Regulatory Research
RG	Regulatory Guide
RH	relative humidity
RHR	residual heat removal
RI	risk-informed
RI/PB	risk-informed, performance-based
RPS	reactor protection system
RSW	raw service water
SAMG	Severe Accident Mitigation Guideline
SE	safety evaluation
SER	safety evaluation report
SFPE	Society of Fire Protection Engineers
SISBO	self-induced station blackout
SPC	suppression pool cooling
SR	supporting requirement
SSA	safe shutdown analysis
SSC	structures, systems, and components
SSD	safe shutdown
SSI	safe shutdown instructions
TR	Technical/Topical Report
TS	technical specifications
UFSAR	updated final safety analysis report
V&V	verification and validation
VEWFDS	Very Early Warning Fire Detection Systems
VFDR	variance from deterministic requirements
yr	year
ZOI	zone of influence