FENOC™
FirstEnergy Nuclear Operating Company

Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077

Eric A. Larson
Site Vice President

724-682-5234
Fax: 724-643-8069

June 26, 2015
L-15-188

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

SUBJECT:
Beaver Valley Power Station, Unit Nos. 1 and 2
Docket No. 50-334, License No. DPR-66
Docket No. 50-412, License No. NPF-73
Response to Request for Additional Information Regarding License Amendment Request to Adopt National Fire Protection Association Standard 805 (TAC Nos. MF3301 and MF3302)

By letter dated December 23, 2013 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML14002A086), as supplemented by letter dated February 14, 2014 (ADAMS Accession No. ML14051A499), FirstEnergy Nuclear Operating Company (FENOC) submitted a license amendment request to change the Beaver Valley Power Station, Unit Nos. 1 and 2 fire protection program to one based on the National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition. To complete its review of the license amendment request, the Nuclear Regulatory Commission (NRC) requested additional information in letters dated March 4, 2015 (ADAMS Accession No. ML15049A507) and May 11, 2015 (ADAMS accession No. ML15125A416).

In accordance with Enclosure 2 to the March 4, 2015 letter, the FENOC responses due within 60 days and 90 days were submitted to the NRC in letters dated April 27, 2015 (ADAMS Accession No. ML15118A484) and May 27, 2015 (ADAMS Accession No. ML15147A372), respectively. The response to requests identified as being due within 120 days in Enclosure 2 of the March 4, 2015 letter are provided in Attachment 1. The response to requests in the May 11, 2015 letter are provided in Attachment 2. Responses to probabilistic risk assessment questions 3 and 19 in the March 4, 2015 letter will be submitted at a later date. A supplement to the license amendment request with the changes described in the responses will then be submitted.

There are no regulatory commitments included in this submittal. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager - Fleet Licensing, at (330) 315-6810.

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 26, 2015.

Sincerely,

Eric A. Larson

Attachments:
1 Response to March 4, 2015 Request for Additional Information
2 Response to May 11, 2015 Request for Additional Information

cc: Regional Administrator, NRC Region I
NRC Resident Inspector
NRC Project Manager
Director BRP/DEP (without attachments)
Site BRP/DEP Representative (without attachments)

The Nuclear Regulatory Commission (NRC) staff provided a request for additional information (RAI) to FirstEnergy Nuclear Operating Company (FENOC) in a letter dated March 4, 2015 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML15049A507). The NRC requested information to complete its review of a FENOC license amendment request (LAR) for Beaver Valley Power Station (BVPS), Unit No. 1 (BVPS-1) and Unit No. 2 (BVPS-2). The LAR would change the fire protection program to one based on the National Fire Protection Association NFPA Standard 805 (NFPA 805), "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition. The NRC staff's RAI questions are provided below in bold text followed by the corresponding FENOC response.

Fire Protection Engineering (FPE) Request for Additional Information (RAI) 01

National Fire Protection Association (NFPA) code compliances are referenced in LAR Attachment A, Table B-1 (ADAMS accession No. ML14002A086). LAR Section 4.1 states, in part, that "Beaver Valley fire protection systems were installed based on design documents per NFPA codes and other applicable standards, but they do not have specific NFPA code evaluations." The LAR further states, in part, that "the Attachment A2 records evaluate the fire protection features for each fire compartment using the critical attributes of functionality from the applicable NFPA codes, and provide the detail necessary to meet the requirements of RAI 2-04 (Harris) and RAI 2-09 (Oconee)." It appears from these statements that NFPA code evaluations were not done to the complete code, but were done to only some "critical attributes" for functionality. For each code evaluation that is relied on for compliance with NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," Chapter 3 (e.g., NFPA 13, "Standard for the Installation of Sprinkler Systems"), and for which only critical attributes are identified, provide the following:

a) **Describe the basis and methodology for selecting the elements of the code that are considered critical attributes;**

b) **Confirm that all critical attributes as determined by this methodology are identified in LAR Attachment A, Table B-1; and**

c) Provide additional justification for concluding that compliance with NFPA 805, Chapter 3 is achieved using this methodology.

Response:

a) The basis and methodology for the critical attributes review is not described because an engineering evaluation of BVPS-1 and BVPS-2 detection and suppression systems has been performed to evaluate compliance with NFPA 805 sections 3.8, 3.9.1, and 3.10.1. The critical attribute discussion of each credited fire detection and suppression system will be removed from the LAR Attachment A, Table B-1 records and replaced with the results of the engineering evaluation that performed the associated NFPA code comparison review. Therefore, the methodology and selection of the critical attribute elements of each code is no longer contained within the LAR.

Additionally, as required for NFPA 805 sections 3.8, 3.9.1, and 3.10.1, each credited fire suppression and fire detection system being transitioned was analyzed in the engineering evaluation for compliance with the below applicable NFPA codes:

- NFPA 12, Carbon Dioxide Extinguishing Systems
- NFPA 12A, Halogenated Extinguishing Agent Systems Halon 1301
- NFPA 13, Installation of Sprinkler Systems
- NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection
- NFPA 72D, Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Service, and
- NFPA 72E, Automatic Fire Detectors

The engineering evaluation concluded that the credited fire suppression and detection features for transition to NFPA 805 are acceptable using one or more of the approved compliance statements (that is, Complies, Complies by Previous Approval, Complies with use of EEEE [existing engineering equivalency evaluation], or Will Comply with Use of Commitment).

The BVPS LAR Attachment A, Table B-1 records for NFPA 805 sections 3.8, 3.9.1, and 3.10.1, as listed in Table FPE 01 below, will be revised. Additionally, Section 4.1 will be revised to reference the engineering evaluation. These changes to the LAR will be provided in a future submittal.

b) An engineering evaluation was performed to evaluate compliance with NFPA 805 sections 3.8, 3.9.1, and 3.10.1 and concluded that the credited fire suppression and detection features for transition to NFPA 805 are acceptable using one or more of the approved compliance statements; therefore, the critical attributes discussion was removed from the applicable BVPS LAR Attachment A, Table B-1 records as identified in Table FPE-01 below. The results of the engineering evaluation were inserted into the compliance section of each applicable LAR Attachment, Table B-1 record. A revision to the LAR Attachment A, Table B-1 for the revised records will be provided in a future submittal.

c) The critical attribute methodology in the LAR Attachment A, Table B-1 records for NFPA 805 sections 3.8, 3.9.1, and 3.10.1 were replaced with the results of the applicable NFPA code engineering evaluation comparison review. The applicable fire detection and suppression system NFPA code reviews resulted in a compliance statement of “Complies by EEEE.” A revision to the LAR Attachment A, Table B-1 for the revised records below will be provided in a future submittal.

Table - FPE 01

Record	**Fire Protection System Type**
Fundamental Fire Protection Programs and Design Elements; Section 3.8.1 “Fire Alarm)	Fire Detection Primary and Secondary Power Supply
FIRE FEATURES - Fire Compartment: 1-CR-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-CR-3 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-CR-4 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CR-4 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-CS-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CS-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-CV-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-CV-2 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-CV-3 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-3 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-DG-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-DG-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-DG-2 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-DG-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-ES-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-ES-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-MG-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-NS-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-PA-1A - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 1-PA-1E - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-PA-1E - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 1-QP-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-QP-1 - 3.9.1	Water-Based Suppression

Table - FPE 01	
Record	**Fire Protection System Type**
FIRE FEATURES - Fire Compartment: 1-RC-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 1-RC-1 - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 1-TB-1 - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 3-IS-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 3-IS-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 3-IS-3 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 3-IS-4 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-ASP - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-CB-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-CB-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-CB-6 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-CV-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-CV-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-CV-2 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-CV-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-CV-3 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-CV-3 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-CV-6 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-CV-6 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-DG-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-DG-2 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-PA-3 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-PA-3 - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 2-PA-4 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-PA-5 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-PT-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-RC-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-RC-1 - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 2-SB-1 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-2 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-3 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-SB-3 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-4 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-5 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-6 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-7 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SB-8 - 3.8.2	Detection

Table - FPE 01	
Record	**Fire Protection System Type**
FIRE FEATURES - Fire Compartment: 2-SB-9 - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SG-1N - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SG-1N - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 2-SG-1S - 3.8.2	Detection
FIRE FEATURES - Fire Compartment: 2-SG-1S - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 2-TB-1 - 3.9.1	Water-Based Suppression

FPE RAI 04

NFPA 805, Section 3.3.5.3, requires that electric cable construction comply with a flame propagation test acceptable to the authority having jurisdiction (AHJ). In LAR Table 5-3, the licensee stated that electrical cable construction complies with a flame propagation test found to be acceptable to the NRC as documented in NEI 04-02, Table B-1. In the LAR, the licensee provided several compliance strategies for this NFPA 805 attribute that will require additional information:

a) **The "Compliance Basis" for NFPA 805, Section 3.3.5.3, in LAR Attachment A, Table B-1 states, in part, that "Submit for Approval," for unknown cable identified in the licensee's cable types report and analyzed as a fire initiating from nonqualified fire resistive cable. There is no LAR Attachment L approval request related to this attribute of NFPA 805. Provide an approval request in accordance with 10 CFR 50.48(c)(2)(vii) that describes the performance-based approach to compliance with NFPA 805, Section 3.3.5.3, for which NRC approval is requested or revise the compliance basis.**

b) **The licensee also stated that it "Complies with Clarification" for safety related cables. In LAR Attachment T, "Prior Approval Clarification Request 1," the licensee stated that the original submittal to the NRC in its letter dated October 27, 1976 (ADAMS Accession No. 4005005679) included all cable types used in cables trays, but the NRC Safety Evaluation Report (SER) dated June 6, 1979 (ADAMS Accession No. ML003766286), only addressed safety-related cables. The licensee requested in the clarification that the NRC's previous approval that cites "all safety-related cables" be extended to all cables installed in the plant. Provide the following additional information to support the review of the clarification request:**

i. **Describe the flame propagation tests that were used to support acceptability of the non-safety related cables with thermoplastic or unknown insulation material, and discuss the results of the tests that demonstrate that extensive propagation does not occur.**

ii. **State whether the population of these types of cables and configuration is the same as the configuration provided in the original submittal in the letter to the NRC dated October 27, 1976, or confirm that any configuration changes since the original submittal do not invalidate the basis submitted by the licensee for the original NRC approval.**

c) **In LAR Attachment K, the licensee described Licensing Action #27, which is identified as being transitioned. The licensing action is associated with compliance with NFPA 805, Section 3.3.5.3, but not discussed in the compliance bases in LAR Attachment A. Clarify the applicability of Licensing Action #27 to LAR Attachment A.**

<u>Response:</u>

(a) A LAR Attachment L, Approval Request for NFPA 805, section 3.3.5.3 is not required. An engineering evaluation was performed that analyzed the low population of cables with potentially non-qualified electric cable insulation material installed in electrical raceways at BVPS-1 and BVPS-2 and determined the configuration to be acceptable. NFPA 805 section 3.3.5.3, LAR Table B-1 record will be revised to include the engineering evaluation as a reference, and "Submit for NRC Approval" will be removed from the compliance statement and compliance basis.

A revision to the LAR Attachment A, Table B-1 for this changed item will be provided in a future submittal.

(b) LAR Attachment T, "Prior Approval Clarification Request 1" is not required. An engineering evaluation was performed that analyzed the cables used within the BVPS power block fire compartments for qualified and potentially non-qualified cable insulation. The cables installed at BVPS-1 and BVPS-2 were compared to IEEE 383, "Qualified Electric Cables" as discussed in NEI 04-02, Appendix B, section 3.4 and Appendix D, sections 3.3 and 3.4. IEEE-383 is a recognized flame propagation test accepted in the NRC FAQ 06-022 Rev. 3 closure memo. The engineering analysis determined that the majority of the electric cables used within the power block are equivalent to the requirements of NFPA 805 section 3.3.5.3.

The engineering evaluation also determined that the low population of electric cables with potentially non-qualified electric cable insulation materials installed in electrical raceways at BVPS-1 and BVPS-2 is acceptable. This engineering evaluation will be added to the LAR Attachment A Table B-1, Section 3.3.5.3 record. LAR Attachment A Table B-1 record 3.3.5.3 will be revised to remove the compliance statement "Complies with Clarification." Additionally, the LAR Attachment T, Request 1 will be withdrawn. LAR Section 4.1.2.2 will also be revised to delete the 3.3.5.3 clarification request.

A revision to the LAR for these changed items will be provided in a future submittal.

(c) LAR Attachment K, Licensing Action No. 27 is unnecessary since an engineering evaluation was performed that analyzed the cables within the BVPS power block fire compartments for qualified and potentially non-qualified electrical cable insulation. Therefore, the LAR Attachment A, record 3.3.5.3 does not discuss Licensing Action No. 27 and references the engineering evaluation. LAR Section 4.2.3 will also be updated to remove reference to Licensing Action No. 27.

A revision to the LAR for these changed items will be provided in a future submittal.

FPE RAI 05

LAR Attachment A, Table B-1 uses the compliance strategy "Complies with Clarification" on numerous attributes. The NRC endorsed guidance in NEI 04-02, Section 4.3.1, Revision 2, describes this clarification strategy as items that are not in "literal compliance" with NFPA 805 but should be transitioned. The example given in NEI 04-02 illustrates this strategy is applied in circumstances such as compliance methods that could be considered editorial in nature. There are numerous applications of this compliance strategy in LAR Table B-1 that are not considered by the NRC staff to be of the same nature as an editorial clarification, such as described in NEI 04-02.

a) Provide a more suitable compliance strategy or additional justification for applying the "complies with clarification" strategy for the following attributes based on the issues identified:

i. The compliance basis for NFPA 805, Section 3.3.7.2, in LAR Attachment A, Table B-1, states that the hydrogen storage tanks are positioned so the long axis is pointed at buildings, and clarifies that compliance is achieved because the distance requirements of the applicable NFPA code is met. NFPA codes are not cited as the means of compliance for NFPA 805, Section 3.3.7.2; and therefore, their use is not a clarification.

Response:

For the BVPS-2 outdoor hydrogen storage tank orientation, an existing engineering equivalency evaluation (EEEE) was performed for compliance with NFPA 55, "Compressed Gases and Cryogenic Fluids Code" in accordance with NRC Generic Letter (GL) 86-10, "Implementation of Fire Protection Requirements." The EEEE concluded that the orientation of the tanks is acceptable, and the NFPA 805 LAR Attachment A, Table B-1 Section 3.3.7.2 record will be revised to "Complies with Use of EEEE".

A revision to the LAR Attachment A, Table B-1 for this changed item will be provided in a future submittal.

FPE RAI 05

a) **Provide a more suitable compliance strategy or additional justification for applying the "complies with clarification" strategy for the following attributes based on the issues identified:**

   ii. **The compliance basis for NFPA 805, Section 3.4.1(a), in LAR Attachment A, Table B-1, states that "the station meets the intent of several sections of NFPA 600, as justified within the code compliance report." The use of a code compliance report to establish intent with regard to compliance with NFPA 805 does not appear to be a "clarification".**

Response:

BVPS complies with the provisions of NFPA 805 Section 3.4.1(a) by providing a five-member fire brigade on the site. An EEEE assessed the BVPS fire brigade for compliance with the provisions of NFPA 600, "Standard on Industrial Fire Brigades," and concluded that the fire brigade organization is acceptable.

The applicable portion of LAR Attachment A, Table B-1 Section 3.4.1(a) will be revised to read "Complies with Use of EEEE" and include the results of the applicable fire brigade evaluation. A revision to the LAR will be provided in a future submittal.

FPE RAI 05

a) **Provide a more suitable compliance strategy or additional justification for applying the "complies with clarification" strategy for the following attributes based on the issues identified:**

iii. **The compliance basis for NFPA 805, Section 3.5.5, in LAR Attachment A Table B-1, states that an assessment of fire pump control circuits concluded that the existing control circuits are acceptable for a fire that renders both fire pumps unavailable, considering prompt detection and the availability of alternate water supplies for manual firefighting. The use of an assessment of fire impacts on redundant pump control circuits to demonstrate acceptability of the design in meeting the separation requirements of NFPA 805, Section 3.5.5 does not appear to be a "clarification."**

Response:

The existing fire pump installations and control circuits were evaluated for compliance with NFPA 20-1970, "Centrifugal Fire Pumps" in an EEEE and concluded that the configuration of the BVPS fire pumps installation and separation of control circuits is acceptable.

Applicable portions of LAR Attachment A, Table B-1 Section 3.5.5 record will be revised to "Complies with Use of EEEE" and also include the results of the applicable fire pump separation control circuit engineering evaluation. A revision to the LAR will be provided in a future submittal.

FPE RAI 05

a) **Provide a more suitable compliance strategy or additional justification for applying the "complies with clarification" strategy for the following attributes based on the issues identified:**

iv. **The compliance basis for NFPA 805, Sections 3.5.15 and 3.5.16, in LAR Attachment A, Table B-1, appears to describe compliance issues as opposed to clarifications. Simply describing deviations from the requirement without further justification for the acceptability of the deviations, relative to meeting the requirement, is not considered to be a clarification.**

Response:

The applicable portion of the compliance statement in LAR Attachment A, Table B-1 Section 3.5.15 will be revised to read "Complies with Use of EEEE" and include the results of the applicable fire hydrant evaluation.

The compliance statement in LAR Attachment A, Table B-1 for NFPA 805 Section 3.5.16 will be revised to read "Complies" and the discussion on "water use for other purposes" will be deleted.

BVPS plant procedural controls do not permit the use of fire water supplies for other purposes without a specific assessment of the impact on plant safety. BVPS does not take credit in the NFPA 805 shutdown analysis for alternate use of fire water supplies.

A revision to the LAR for these changed items will be provided in a future submittal.

FPE RAI 05

a) **Provide a more suitable compliance strategy or additional justification for applying the "complies with clarification" strategy for the following attributes based on the issues identified:**

   v. **The compliance bases for NFPA 805, Sections 3.6.1, and 3.6.2, in LAR Attachment A, Table B-1, appear to address the results of code evaluations and previous NRC approval. These bases appear to be compliance strategies associated with engineering evaluations and previous approvals and do not appear to be merely clarifications.**

Response:

An EEEE of the interior BVPS-1 and BVPS-2 standpipe and hose station systems determined that they are equivalent to the requirements of NFPA 14, "Standard for the Installation of Standpipe and Hose Systems." Therefore, the compliance bases for LAR Attachment A, Table B-1, Sections 3.6.1 and 3.6.2 will be revised to "Complies with Use of EEEE" and will identify the applicable EEEE.

A revision to the LAR for these changed items will be provided in a future submittal.

FPE RAI 05

a) **Provide a more suitable compliance strategy or additional justification for applying the "complies with clarification" strategy for the following attributes based on the issues identified:**

   vi. **The compliance basis for NFPA 805, Section 3.7, in LAR Attachment A, Table B-1, appears to justify non-code compliances. Merely describing deviations from the requirement without further justification for the acceptability of the deviations, relative to meeting the requirement, is not considered to be a clarification.**

Response:

The NFPA 805 Section 3.7 requirements for NFPA 10, “Standard for Portable Fire Extinguishers” were analyzed in an EEEE that concluded the number, size, and type of fire extinguishers throughout the power block are equivalent to the requirements of NFPA 805 Section 3.7.

The applicable portion of LAR Attachment A, Table B-1 supplement section 3.7 will be revised to read “Complies with Use of EEEE” and include the results of the applicable fire extinguisher evaluation. A revision to the LAR will be provided in a future submittal.

FPE RAI 05

b) **Based on the above examples, review all other compliance strategies that use the category "Complies with Clarification" and ensure the strategy is suitable in accordance with the guidance of NEI 04-02. Identify any additional changes needed.**

Response:

An extent of condition review was performed of BVPS LAR Attachment A, Table B-1 for records that included a “Complies with Clarification” in its LAR compliance basis and compliance statement. This review determined whether the compliance basis is suitable or should be modified to another compliance statement, such as; Complies, Complies with use of EEEE, Complies by Previous Approval, or Submit for NRC Approval. With the exception of LAR Attachment A, Table B-1 record 3.11.5 for compartment 1-CV-3, which will be withdrawn and the appropriate information added to that compartment’s record 3.11.2, the other identified LAR Attachment A records that used “Complies with Clarification” require revision.

The list in Table 5b below identifies the LAR Attachment A Table B-1 records that contained “Complies with Clarification” as part of their compliance strategy requiring a change and that were not addressed within the FPE RAI 5(a) responses. The compliance basis for each record from LAR Attachment A, Table B-1 identified in Table 5b below will be revised to “Complies” and / or “Complies with Use of EEEE.” Record 3.11.5 for fire compartment 1-CV-3 will be withdrawn from the LAR because the electric cable fire protection covering documented in this record is not an electrical raceway fire barrier system (ERFBS). For those records that are revised to “Complies with Use of EEEE,” the specific engineering evaluation will be added to the “References” section of the record, and the evaluation conclusion will be added under the “Compliance Basis” section of the record. Also, additional information will be added to some of the records to further expand the compliance basis details, make corrections such as adding in a supportive reference, or expand the compliance statement section to ensure alignment with the compliance basis.

A revision to the LAR Attachment A, Table B-1 for the below revised records will be provided in a future submittal.

Table 5b – BVPS-1 and BVPS-2 Revised Records From LAR Attachment A, Table B-1

Record	Title
Ch.3 - Section: 3.3 / Subsection: 3.3.3	Interior Finishes
Ch.3 - Section: 3.3 / Subsection: 3.3.5.3	Electrical Cable Construction
Ch.3 - Section: 3.3 / Subsection: 3.3.6	Roofs
Ch.3 - Section: 3.4 / Subsection: 3.4.2.4	Coordination with Other Plants
Ch.3 - Section: 3.5 / Subsection: 3.5.10	Underground Yard Fire Main Loop
Ch.3 - Section: 3.3 / Subsection: 3.6.4	Manual Fire Suppression
Ch.3 - Section: 3.3 / Subsection: 3.8.1	Fire Alarm
Ch.3 - Section: 3.11 / Subsection: 3.11.1	Building Separation
FIRE FEATURES - Fire Compartment: 1-CR-2 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-CR-2 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-CR-4 - 3.10.7	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CR-4 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-CS-1 - 3.10.5	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-1 - 3.10.5	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-2 - 3.10.5	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-3 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-3 - 3.10.3	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-3 - 3.10.7	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-CV-3 - 3.11.5	ERFBS
FIRE FEATURES - Fire Compartment: 1-DG-1 - 3.10.3	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-DG-1 - 3.10.5	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-DG-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-DG-2 - 3.10.3	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-DG-2 - 3.10.5	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 1-DG-2 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-MG-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1A - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1A - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1C - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1C - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1E - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1E - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1G - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1G - 3.11.3	Passive Protection

Table 5b – BVPS-1 and BVPS-2 Revised Records From LAR Attachment A, Table B-1	
Record	**Title**
FIRE FEATURES - Fire Compartment: 1-PA-1GA - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1GA - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1GB - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1GB - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1GC - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PA-1GC - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PT-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-PT-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-QP-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-QP-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-RC-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-RC-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-S-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-S-1 - 3.11.4	Passive Protection
FIRE FEATURES - Fire Compartment: 1-TB-1 - 3.9.1	Water-Based Suppression
FIRE FEATURES - Fire Compartment: 1-TB-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-TB-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-TB-1 - 3.11.4	Passive Protection
FIRE FEATURES - Fire Compartment: 1-TO-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 1-TO-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 1-TO-1 - 3.11.4	Passive Protection
FIRE FEATURES - Fire Compartment: 3-CR-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 3-CR-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 3-IS-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 3-IS-2 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 3-IS-3 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 3-IS-4 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 3-IS-6 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 2-DG-1 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-DG-1 - 3.10.3	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-DG-2 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-DG-2 - 3.10.3	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-SB-3 - 3.10.1	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-SB-3 - 3.10.3	Gaseous Suppression
FIRE FEATURES - Fire Compartment: 2-TB-1 - 3.9.1	Water-Based Suppression

Table 5b – BVPS-1 and BVPS-2 Revised Records From LAR Attachment A, Table B-1	
Record	**Title**
FIRE FEATURES - Fire Compartment: 2-TB-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 2-TB-1 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 2-TB-2 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 2-TB-2 - 3.11.3	Passive Protection
FIRE FEATURES - Fire Compartment: 2-TR-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 2-TR-2 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 2-TR-3 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 3-CR-1 - 3.11.2	Passive Protection
FIRE FEATURES - Fire Compartment: 3-CR-1 - 3.11.3	Passive Protection

FPE RAI 09

NFPA 805, Section 3.4.1 (c), requires that the fire brigade leader and at least two brigade members have sufficient training and knowledge of nuclear safety systems to understand the effects of fire and fire suppressants on nuclear safety performance criteria. In Section 1.6.4.1, "Qualifications" of RG 1.189, "Fire Protection for Nuclear Power Plants", Revision 2, September 2009 (ADAMS Accession No. ML092580550), the NRC staff has acknowledged the following example for the fire brigade leader as sufficient:

> **The brigade leader should be competent to assess the potential safety consequences of a fire and advise control room personnel. Such competence by the brigade leader may be evidenced by possession of an operator's license or equivalent knowledge of plant systems.**

In LAR Attachment A, the licensee stated that it complies and the compliance basis states that procedures state the Fire Brigade Chief and at least two fire brigade members shall be operations personnel who have sufficient knowledge of safety-related systems to understand the effects of a fire and fire suppressants on the safe shutdown of the unit.

Provide additional detail regarding the training that is provided to the fire brigade leader and members that addresses their ability to assess the effects of fire and fire suppressants on nuclear safety performance criteria.

<u>Response:</u>

Additional detail regarding the training that is provided to the fire brigade leader and members that addresses their ability to assess the effects of fire and fire suppressants on nuclear safety performance criteria is provided as follows.

The BVPS fire brigade chief (fire brigade leader) is provided initial and continuing training regarding the effects of fire on the ability to achieve and maintain post-fire safe shutdown conditions as required by the current licensing basis. Post-fire safe shutdown procedures are used to achieve and maintain post-fire safe shutdown under the current licensing basis and will be used to achieve the nuclear safety performance criteria as delineated in NFPA 805. The BVPS fire brigade administrative procedure designates the fire brigade chief as an operations unit supervisor who, by position, possesses an operating license. Site administrative procedures require licensed operators to complete the operator initial training program. This program includes plant systems and procedures training which provides a sound level of knowledge in the design, operating characteristics, procedures and system interrelationships of the BVPS units. Licensed operators participate in the licensed operator continuing training program which includes specific training on post-fire safe shutdown procedures. Training on post-fire safe shutdown procedures is included in the licensed operator continuing training program at a nominal frequency of at least once every two years.

Operations personnel assigned as fire brigade members may possess an operating license or may be non-licensed operators. Fire brigade members that possess an operating license participate in the licensed operator initial and retraining programs as described above for the fire brigade chief. Non-licensed operator fire brigade members are provided initial and continuing training regarding the effects of fire on the ability to achieve and maintain post-fire safe shutdown conditions as required by the current licensing basis. Post-fire safe shutdown procedures are used to achieve and maintain post-fire safe shutdown under the current licensing basis and will be used to achieve the nuclear safety performance criteria as delineated in NFPA 805. Training on post-fire safe shutdown procedures is included in the non-licensed operator continuing training program at a nominal frequency of at least once every three years.

Members of the fire brigade participate in the fire brigade training program. The fire brigade initial and retraining programs include instruction on the effects of fire suppressants on plant equipment and components including those required to achieve post-fire safe shutdown (nuclear safety performance criteria under NFPA 805). Instruction is in the form of classroom training, practical fire ground training, and fire drills including use of pre-fire plan procedures. The pre-fire plan procedures include guidance on use of fire suppressants and the equipment and components required for post-fire safe shutdown located in the fire area. After initial training, fire brigade members participate in a retraining program conducted every two years.

FPE RAI 11

The compliance basis for NFPA 805, Section 3.4.1(a) in LAR Attachment A, Table B-1, states that the station meets [the] intent of several sections of NFPA 600, "Standard on Industrial Fire Brigades," as justified within the code compliance report. The licensee has stated that the plant complies with NFPA 805, Section

3.4.3(a) requirements. However, the compliance basis states that fire brigade training is performed, and the administrative procedure states that it meets the requirements of Occupational Safety and Health Administration Standard 29 CFR 1910.156(C), 29 CFR 1910.134(g)(4), 10 CFR 50.48, NFPA 27-1976, and the guidelines established in BTP [branch technical position] CMEB 9.5-1.

Describe how complying with these requirements meets the NFPA 600 requirements for brigade training.

Response:

An EEEE assessed BVPS fire brigade training for compliance with NFPA 600, “Standard on Industrial Fire Brigades” and concluded that the fire brigade training is acceptable.

The compliance statement of LAR Attachment A, Table B-1 section 3.4.3(a) will be revised to “Complies with Use of EEEE.” The compliance basis will be revised to state the EEEE conclusion and to remove references to other standards, statutes, and guidelines. A revision to the LAR will be provided in a future submittal.

FPE RAI 12

LAR Attachment L, "Approval Request 1," requests to provide a performance-based evaluation in place of the NFPA 805, Section 3.3.5.1 requirement that wiring above suspended ceiling shall be kept to a minimum 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 LAR stated that the existing non-enclosed or non-plenum rated wiring located above suspended ceilings that may not comply with the requirements of NFPA 805, Section 3.3.5.1. The approval request provides examples of areas with suspended ceilings within the power block areas of BVPS-1 and BVPS-2. The approval request concludes that the existing wiring above suspended ceilings satisfies the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release, safety margins, and fire protection defense-in-depth (DID), and post-fire safe and stable capability.

Provide a complete list of areas in the power block where the licensee requests approval for wiring above the suspended ceiling, and if additional areas are added to the list of examples, provide sufficient justification for all areas being addressed by the performance-based alternative evaluation.

Describe the proximity of these unqualified cables to nuclear safety capability components or cables, and address the likelihood and significance of potential fires adjacent to those nuclear safety capability components or cables.

Response:

Approval of wiring above suspended ceilings is no longer requested and LAR Attachment L, approval request 1 will be withdrawn. An EEEE of the cables above suspended ceilings for conformance to NFPA 805 section 3.3.5.1 was performed.

The EEEE determined the electrical cables above suspended ceilings that were potentially or confirmed-to-be non-qualified do not adversely affect nuclear safety capability components or cables, and are therefore acceptable. In most areas, the evaluation determined that there are no electrical cables located above the suspended ceilings that are required for nuclear safety capability. For the few areas containing electric cables above suspended ceilings required for nuclear safety capability, the evaluation assessed the likelihood and significance of impacts from potential fires involving these potential non-qualified electric cables to nuclear safety capability circuits and considered the proximity to nuclear safety capability circuits. The evaluation concluded the non-qualified electric cables are acceptable.

The NFPA 805 Section 3.3.5.1 record in Attachment A, Table B-1 will be revised to "Complies with the use of EEEE." Since the EEEE concluded that wiring above suspended ceilings is acceptable, LAR section 4.1.2.3 will be revised to remove section 3.3.5.1, and LAR Attachment L approval request 1 will be withdrawn.

A revision to Attachment A, Table B-1, for this changed item, and a revision to Attachment L for this deleted item will be provided in a future submittal.

FPE RAI 14

The regulations in 10 CFR 50.48(c)(2)(vii) state, in part, that performance based methods that are used to evaluate the fundamental fire protection program elements and minimum design requirements of NFPA 805, Chapter 3, must (A) satisfy the performance goals, performance objectives, and performance criteria specified in NFPA 805 related to nuclear safety and radiological release; (B) maintain safety margins; and (C) maintain fire protection DID (fire prevention, fire detection, fire suppression, mitigation, and post-fire safe shutdown capability). In LAR Attachment L, the licensee requested approval in accordance with 10 CFR 50.48(c)(2)(vii) for specific NFPA 805 Chapter 3 sections, and additional information is requested to support the review of the performance-based methods:

a) **For Approval Request 1, provide additional information to demonstrate that the wiring routed above the suspended ceiling satisfies the radiological release performance goals, performance objective and performance criteria of NFPA 805, and provide additional information on how the configuration maintains safety margins and each element of fire protection DID.**

Response:

An engineering evaluation determined that the minimal population of non-enclosed or non-plenum-rated wiring (also referred to as non-qualified cable) above suspended ceilings is acceptable and does not impact the radiological release performance goals, performance objective, or performance criteria of NFPA 805 Section 1.5, and that safety margins and fire protection DID are maintained. The engineering evaluation considered the risk of fires involving non-qualified electrical cables to the proximity of nuclear safety capability assessment (NSCA) circuitry.

Accordingly, the compliance basis for LAR Attachment A, Table B-1, section 3.3.5.1 will be changed from “Submit for NRC Approval” to “Complies with use of EEEE” and will reflect the revised compliance statement and associated evaluation.

The revision to the Attachment A, Table B-1, Attachment A1 Section 3.3.5.1, the withdrawal of Attachment L request 1, and revision to Section 4.1.2.3 will be provided in a future submittal.

FPE RAI 16

In LAR Attachment T, "Clarification of Prior NRC Approvals," Prior Approval Clarification Request 14 for BVPS-2," the licensee requested that the configuration for the BVPS Unit 1 primary and secondary power supply system for the early warning fire detection system be accepted as "prior approval" because a similar power supply arrangement for the BVPS Unit 2 early warning fire detection system was approved by the NRC in an NRC SE as discussed in detail LAR Attachment K, "Licensing Action 26."

BVPS-1 compliance with NFPA 805, Section 3.8.1 is described as "Complies with Clarification" in LAR Attachment A. The power supply arrangement for the fire alarm initiating devices for BVPS-1 does not appear to comply with NFPA 72, and taking credit for a BVPS-2 prior approved licensing action to apply to BVPS-1 is not within the guidance of NEI 04-02 with respect to "Complies with Clarification."

In accordance with RG 1.205, and the guidance of NEI 04-02, where compliance with Chapter 3 requirements cannot be demonstrated or prior NRC approval is not provided or adequately documented, the licensee may choose to comply with

the deterministic requirement of NFPA 805, Chapter 3, comply with use of engineering evaluation or include a performance-based method in accordance with 10 CFR 50.48(c)(2)(vii).

Provide a compliance basis for the BVPS-1 fire alarm power supplies that will meet the requirements of NFPA 805, Section 3.8.1 in accordance with the requirements of 10 CFR 50.48(c) and the guidance of RG 1.205 and NEI 04-02.

Response:

An engineering evaluation of the existing BVPS-1 fire detection/suppression primary and secondary power supply system arrangement concluded that it is equivalent to the requirements in NFPA 72D dated 1973, “Proprietary Protective Signaling Systems.”

The compliance bases for LAR Attachment A, Table B-1 section 3.8.1 will be revised to “Complies with Use of EEEE” and will include the engineering evaluation results of the BVPS-1 power supply system arrangement. In addition, LAR Attachment T request 14 will be withdrawn, and LAR section 4.1.2.2 will be revised to remove reference to NFPA 805 section 3.8.1. A revision to the LAR for items changed in this response will be provided in a future submittal.

Safe Shutdown Analysis (SSD) RAI 04

RG 1.205, Section 2.4, states, in part, that:

> **NFPA 805, Section 4.2.3.1, identifies recovery actions for which the additional risk must be evaluated, as required by NFPA 805, Section 4.2.4. These "success path" recovery actions are operator actions that, if not successful, would lead to the fire-induced failure of the "one success path of required cables and equipment to achieve and maintain the nuclear safety performance criteria." Other operator actions that do not involve the success path may be credited in plant procedures or the fire PRA to overcome a combination of fire-induced and random failures may also be recovery actions, but licensees do not need to evaluate the additional risk of their use.**

In LAR Attachment C, the licensee identified a number of variances from deterministic requirements (VFDRs) that were evaluated in a fire risk evaluation (FRE) and determined that the risk, safety margin, and DID meet the acceptance criteria of NFPA 805, Section 4.2.4 with a RA credited. The licensee, however, did not specify whether the RAs are necessary for risk reduction or for DID in either LAR Attachment C or LAR Attachment G, Tables G-1 and G-2. Provide the following clarifications to address the methodology for evaluating RAs:

a) **Differentiate the RAs identified in LAR Attachment G as those necessary to meet risk criteria, and therefore, included in the FPRA results reported in LAR Attachment W, and those necessary for DID.**

Response:

The differentiation of recovery actions (RAs) in LAR Attachment G, Tables G-1 and G-2, between “necessary for risk reduction” or “necessary for DID” were defined and submitted as part of the 90-day RAI response to PRA RAI 18(b).

As detailed in the response to PRA RAI 18(b), Attachment G, “Recovery Actions Transition” will be revised to identify the specific type of recovery action as part of the response to PRA RAI 03.

SSD RAI 04

b) **In LAR Attachment G, the licensee stated that other RAs, whether credited for DID or credited to overcome a combination of fire-induced and random failures, but not involving the success path,**

are not evaluated for the additional risk of their use. Provide a detailed description of these RAs including:

- **i. How were these RAs originally identified;**
- **ii. What nuclear safety performance goals are associated with these RAs;**
- **iii. What fire safe shutdown functions do these RAs provided[sic];**
- **iv. Which of these RAs are listed in LAR Attachment G;**
- **v. Which of these RAs will remain in the shutdown procedures, and describe the feasibility evaluations performed for these actions;**
- **vi. Provide examples of these types of RAs (that is, the ones described in i. through v. above) and describe how it was determined which RAs are screened out and which are retained in the procedures.**

<u>Response:</u>

The statement "*Other RA's, whether credited for defense in depth, or credited to overcome a combination of fire-induced and random failures but not involving the success path, are not evaluated for the additional risk of their use…."* was included in the LAR Attachment G process as a contingency for how to deal with such actions. After reviewing FREs, VFDRs, and RAs, it was determined that this statement is not applicable. Therefore, for question i, no RA's were identified that meet the criteria. Furthermore, questions ii through vi are no longer applicable.

A revision to LAR Attachment G to remove the above statement will be provided in a future submittal.

SSD RAI 06

RG 1.205, Section 2.2.1, states that a submittal addressing uncertain elements of the current fire protection program should include sufficient detail to allow the NRC to assess whether the licensee's treatment of these elements meet the 10 CFR 50.48(c) requirements.

In LAR Attachment T, 'Clarification Request 5," the licensee requested that the NRC document as "prior approval" with respect to Licensing Actions 11.10 and 11.18 for the increased combustible loading in Fire Area 1-CR-4 from an equivalent fire severity of 45 minutes to 1.38 hours. The licensee stated that the existing condition is acceptable since the increased combustible loading is still within the 1.5 hour fire barriers rating, a limit of less than 1.5 hours fire loading was established for the Process Instrumentation Room (1-CR-4), and the room will be provided with an

incipient detection system as part of the NFPA 805 modifications. It appears that the bases for and continuing validity of the exemption, and the NRC staff's original evaluation or basis for approval of the exemption, has not been maintained. Therefore, this condition is not considered a "clarification" to the approved exemption. Provide the following:

a. **The citation from the NRC SER dated August 30, 1984 (ADAMS Accession No. 8502220043), concludes that the 1.5 hour rated doors and ceiling exceed the combustible loading with a "considerable margin." Discuss how any administrative limit on combustible loading, the incipient detection system, and/or any other fire protection features are credited for offsetting the decrease in the safety margin.**

b. **Update LAR Attachment S, Table S-3, to include an administrative procedure update if a limit on combustible loading is credited for Fire Area 1-CR-4.**

c. **Discuss the impact on the Nuclear Safety Capability Assessment in meeting the nuclear safety performance criteria requirements of NFPA 805, Section 1.5, in the event that the 1.5 hour rated doors and ceiling were breached due to the increased combustible loading (e.g., risk, defense in depth, and safety margin).**

d. **Provide the appropriate updates to the LAR attachments.**

<u>Response:</u>

a. An engineering evaluation has been performed for the barriers separating fire compartment 1-CR-4 from adjacent fire compartments. This evaluation applied the performance-based approach for fire compartment 1-CR-4 that credited the following defense-in-depth enhancements:

    - The floor tiles that provide a barrier that encloses the underfloor cable combustible loading will minimize the likelihood of a fire propagating to the rest of 1-CR-4.
    - The underfloor Halon gaseous suppression systems will minimize the likelihood of a fire propagating to the rest of 1-CR-4.
    - The smoke detection system that is installed in 1-CR-4 will provide an early warning of a fire in 1-CR-4.
    - The very early warning fire detection system (the incipient fire detection) that is installed in electrical cabinets located in 1-CR-4 will provide an early warning of a fire in 1-CR-4.
    - The incorporation of Transient Combustible Exclusion Area (TCEA) requirements for 1-CR-4 will limit fire severity to within the evaluated conditions.

b. Attachment S, Table S-3 includes action item BV1-2907 to revise the site combustible control procedures to include additional TCEAs for various fire compartments, including 1-CR-4. These TCEAs are credited to maintain the fire loading below the fire barrier rating of less than 1.5-hours. The portion of this implementation item that relates to 1-CR-4 has been completed; therefore, no update is needed to LAR Attachment S, Table S-3 for this response.

c. The results of the engineering evaluation determined that the 1.5-hour fire rating of the ceiling and the fire doors associated with compartment 1-CR-4 are sufficient to meet the fire barrier performance criteria of NFPA 805 section 4.2.4 for the adjacent fire compartments. This analysis determined that, based on the performance-based approach, there is an acceptable safety margin between the fire hazards in the fire compartments and the associated fire barrier ratings. Since the barrier is adequate, there is no impact to the NSCA.

d. Because the performance-based approach was used for the barriers separating 1-CR-4 from adjacent compartments and for the fire doors associated with this compartment, 1-CR-4 complies with NFPA 805 sections 3.11.1, 3.11.2 and 3.11.3. Accordingly, the following LAR updates will be made and provided in a future submittal:

- LAR Attachment T, Clarification Requests 5 and 6 will be withdrawn.
- LAR Attachment K, Licensing Actions 11.09, 11.10 and 11.17 will not be transitioned.
- LAR Section 4.2.3 will be updated to reflect changes in licensing actions being transitioned.
- Attachment A, Table B-1, 3.11.2 and 3.11.3 records for 1-CS-1, 1-CR-2, 1-CR-3, 1-CR-4, 1-ES-1, 1-ES-2 and 1-MG-1 will be revised to change from “Complies by Previous NRC Approval” to “Complies.”

SSD RAI 11

NFPA 805, Section 1.3.1, “Nuclear Safety Goal,” states that “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, 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.

Provide additional descriptions pertaining to the non-power operations (NPO) discussions in LAR Section 4.3 and LAR Attachment D:

a) During NPO modes, spurious actuation of valves can have a significant impact on the ability to maintain decay heat removal and inventory control. Describe any actions being credited to minimize the impact of fire-induced spurious actuations of power operated valves (e.g., AOVs and MOVs) during NPO (e.g., pre-fire rack-out, actuation of pinning valves, and isolation of air supplies).

b) Describe the recovery actions and instrumentation that are credited to achieve key safety functions (KSFs) during NPO and describe how these recovery actions will be evaluated for feasibility and factored into operating procedures.

Response:

a) The NPO modes transition reports do not credit any specific actions to prevent spurious actuations during NPO. However, pre-positioning has not been excluded as a method of mitigating fire impact to KSFs. These reports identify plant configuration changes (such as removing power from valves) as an option to reduce fire risk and will be used as reference documents in support of site procedure updates as discussed in LAR Attachment S, Table S-3.

b) There are no recovery actions or related instrumentation credited to achieve KSFs during NPO.

SSD RAI 13

In LAR Attachment T, the licensee requested the NRC staff to document as a "prior approval" several clarifications of prior NRC approvals. RG 1.205, Section 2.2.1, states that a submittal addressing uncertain elements of the current fire protection program should include sufficient detail to allow the NRC to assess whether the licensee's treatment of these elements meets 10 CFR 50.48(c) requirements. The following summarizes the guidance in NEI 04-02, Section 2.3.1, for demonstrating that the NRC has been aware of the specific attribute being clarified and that plant conditions have not changed:

- **Determine whether the NRC has explicitly accepted or approved the program attribute. If so, retain documentation.**
- **If final correspondence, such as an SER [safety evaluation report] from the NRC, contains only general statements of acceptance or approval, it is necessary to find the related chain of supporting correspondence between the NRC and licensee and other related documentation. Where the available documentation indicates that the NRC has been aware of and accepted a specific attribute of the fire protection program, but does not include an explicit NRC approval to that effect, the licensee should document its basis for that conclusion in the Transition documentation for explicit approval in the new licensing basis.**
- **If during a review to determine previously approved documents by the NRC, the licensee finds that a fundamental design requirement or a program element does not meet Chapter 3 and there is not "prior approval," a licensee shall 1) conform to specific requirements of Chapter 3, or 2) obtain a license amendment.**

Response Summary:

A review of LAR Attachment T has determined that the majority of clarification requests are no longer necessary and will be withdrawn. The disposition of each LAR Attachment T clarification request is identified in Table SSD-13.

Table SSD-13: Summary of LAR Attachment T Clarification Requests	
Clarification Requests	**Disposition**
Clarification Request No. 1	Withdrawn - Reference FPE RAI 04(a)(b)(c)
Clarification Request No.2	Reference SSD RAI 13(a)
Clarification Request No.3	Withdrawn - Reference SSD RAI 13(b)
Clarification Request No.4	Withdrawn - Reference SSD RAI 13(b)
Clarification Request No.5	Withdrawn - Reference SSD RAI 06(a)(b)(c)(d)
Clarification Request No.6	Withdrawn - Reference SSD RAI 06(a)(b)(c)(d)
Clarification Request No.7	Withdrawn - Reference SSD RAI 13(c)
Clarification Request No. 8	Withdrawn - Reference SSD RAI 13(c)
Clarification Request No. 9	Withdrawn - Reference SSD RAI 13(c)
Clarification Request No. 10	Withdrawn - Reference SSD RAI 13(c)

Table SSD-13: Summary of LAR Attachment T Clarification Requests	
Clarification Requests	**Disposition**
Clarification Request No. 11	See below
Clarification Request No. 12	Withdrawn - Reference SSD RAI 13(b)
Clarification Request No. 13	Withdrawn - Reference SSD RAI 13(b)
Clarification Request No. 14	Withdrawn - Reference FPE RAI 16
Clarification Request No. 15	Withdrawn - Reference FPE RAI 05(a)(viii) and SSD RAI 13(d)
Clarification Request No. 16	Withdrawn - Reference SSD RAI 13(e)
Clarification Request No. 17	Reference SSD RAI 13(f)

Clarification Request No. 11

The RAI requested specific excerpts from the original exemption request to demonstrate that the NRC was made aware of and accepted the specific attribute being clarified. There is a detection and water-based suppression system for the charcoal filters inside containment (fire compartment 2-RC-1). The excerpt below summarizes the guidance in NEI 04-02, Section 2.3.1, for demonstrating that the NRC has been aware of the specific attribute being clarified and that plant conditions have changed due to an engineering change package to remove the combustible charcoal from the containment iodine filtration system. This engineering change requires a clarification to the extent that the approved detection and water-based suppression systems are no longer necessary and deletion of these systems from the licensing basis is required.

The following specific excerpt from the BVPS-2 NUREG-1057, “Safety Evaluation Report related to the operation of Beaver Valley Power Station,” Unit No. 2, Docket No. 50-412, Supplement 5, dated May 1987, in Section 9.5.1.4, “General Plant Guidelines,” addressed the detection and water-based suppression systems for the charcoal filter inside containment.

> Reactor Containment
>
> Equipment inside containment is not in compliance with Section C.5.b of BTP [branch technical position] CMEB 9.5-1 because redundant trains of safe shutdown components and circuitry are not separated by 3-hour walls or are not separated by 20 feet with no intervening combustibles. Generally, redundant cables inside the containment are run on opposite sides of the interior wall. Although this does not provide 3-hour separation, the wall is a significant barrier to fire and heat. Cables inside the containment are either qualified to IEEE Standard 383 or are run

> inside conduit. The only significant combustible loading other than cable is the oil inside the reactor coolant pumps, RHR [residual heat removal] pumps, and the charcoal filters. The reactor coolant pumps are provided with an oil collection system in compliance with the SRP [standard review plan], which reduces the potential for spread of combustible oil. Both the RHR pumps and the charcoal filters are provided with detection and suppression systems. The penetration area, where redundant divisions are separated by at least 18 feet, is provided with detection and automatic suppression. Because of the low in situ combustibles and the containment's large volume, it is expected that any fire would develop slowly with the heat dissipated to the large air space. In addition, because access to the area is tightly controlled, it is not expected that transient combustibles would contribute to the fire loading.
>
> Therefore, there is reasonable assurance that a fire inside the containment would not jeopardize both trains of redundant safe shutdown equipment, and lack of complete separation of redundant trains of safe shutdown components inside containment is an acceptable deviation from Section C.5.b of BTP CMEB 9.5-1.

This excerpt demonstrates that the NRC was made aware of and accepted the specific attribute for the detection and water-based suppression system for the charcoal filters inside containment. Since the combustible material has been removed from the iodine filters in containment, LAR Attachment T request No. 11 clarifies that the detection and water-based suppression system for the charcoal filters inside containment are no longer necessary and are removed from the basis for approval of licensing action 08.

In summary, three of the Attachment T clarification requests will remain in the LAR and are addressed as part of the specific responses to RAI SSD 13, items a through f.

SSD RAI 13

Accordingly, provide additional information to support the following clarification requests, and other similar conditions, that are included in LAR Attachment T:

a) **Prior Approval Clarification Request 2: The licensee requested clarification of Licensing Action 11.02 for which the associated NRC SER dated March 14, 1983 (ADAMS Accession No. 8303290263) stated that all cables in containment are routed in conduit when in fact some cables are routed in covered cable trays. Provide specific excerpts from the original exemption request to demonstrate that the NRC was made aware of and accepted this specific attribute.**

<u>Response:</u>

The question requested specific excerpts from the original exemption request to demonstrate that the NRC was made aware of and accepted that some cables are routed in covered cable trays in the containment building (fire area RC-1). The following specific excerpt (items 1-5) from the October 22, 1982, “Supplemental Information to Fire Protection – Appendix R Review Report,” addressed the routing of cables in trays.

1. PRESSURIZER POWER OPERATED RELIEF VALVES
   PCV-RC-455C D and 456

NOTE: SOV-RC-544 is included due to its associated circuit status

The routings for [PCV-RC-455C, D and 456] and [SOV-RC-544] are shown on drawing 11700-RE-34AK, 46A, 46E and 46F which are labeled [PCV-RC-455C, D, and 456], sheets 1 through 4. The Train A and Train B control cables for [PCV-RC-455C, D and 456] are run from the valves (located above the pressurizer cubicle) in conduit, to points just outside the crane wall.

Outside the crane wall, the control cables enter trays which run to the penetration area on either side of column 10¼. The control cables then drop down at the penetration area and are separated by approximately 25 feet. The cables are also separated by a fire barrier and a fire detection and suppression system.

The associated circuit, [SOV-RC-544] Train A control cable, runs in conduit from the solenoid to trays in the penetration area. The control cable does not run close to the above PCV [pressure control valve] control cable until the penetration area, and at that time, only in the vicinity of Train A.

These valves have been considered in the analysis because of inclusion in the High/Low Pressure Interface discussion (Chapter 8) of our initial submittal. See the following section covering the blocking valves for additional justification of the existing layout.

2. PRESSURIZER RELIEF BLOCKING VALVES

The routings of the power and control cables for [MOV-RC-535, 536 and 537] are depicted on (2) two drawings RE-34AK and RE-46A, labeled as (MOV-RC-535, 536 and 537) sheets 1 and 2 respectively.

The power cables for both Train A & B are run in conduit, from the motor operated valves located in the pressurizer cubicles to the penetration area at column 10¼. In this area the cable enters [the] tray which is separated by a fire barrier and are [sic] protected by a fire suppression and detection system.

These blocking valves [MOV-RC-535, 536 and 537] would be used to isolate a leaking or stuck open Power Operated Relief Valve [PCV-RC-455C, D and 456]. Each PCV is blocked by an MOV of the opposite train. As can be seen by the referenced drawings whenever these trains are routed in accessible areas they are separated by approximately 25 ft. [feet] and protected by a suppression system, or they are enclosed in conduit (PZR cubicle). In the one area where they run together in close proximity, they are routed at least 20 ft. off the floor in covered tray.

Based on the above layout and previously provided justification, we contend that this layout affords an equivalent level of protection to that required by III G-2 of Appendix R.

3. PRESSURIZER HEATERS A, B, D, AND E

The routing for pressurizer heater power cables for heaters A and C (Train A) and B and D (Train B) are depicted on the following three drawings: 11700-RE-34AK, 11700-RE-34AS and 11700-RE-34AG (labeled Pressurizer Heaters, sheets 1 through 3).

The power cables of those Train A and Train B heaters run entirely in tray from the pressurizer cubicle to either side of column 10¼, as shown on the drawings. The trays run parallel to each other at a height of 20 feet, in close proximity until they reach either side of column 10¼. At this point, the cables turn down in to four trays which run vertically, and are separated by 18 feet. The traverse runs of tray above the operating floor are covered trays.

Based upon the routing demonstrated by the referenced drawings and the previous justification presented in paragraph 11.2.3, this function is covered by an equivalent level of protection to that required by Appendix R to 10 CFR 50.

4. STEAM GENERATOR LEVEL

The routing of the Steam Generator Level transmitter cables are depicted on drawings RE-57U, Q, R, S and T labeled as sheets 1 through 5, respectively.

> The instrument cables for channels I, II and III are run in separate conduits from the penetration area where the trays are protected by suppression and detection. The conduit runs around the containment and returns to the penetration area from opposite directions; Channels I and III from the north, and Channel II from the south.
>
> We consider this layout acceptable because the routing provides the minimum separation and shielding requirements of paragraph III.G(2) of Appendix R to 10 CFR 50. Regardless of the area chosen at least one channel of Steam Generator Level indication will be available based on the criteria of III.G(2).
>
> 5. PRESSURIZER LEVEL TRANSMITTERS LT-RC-459 and 460
>
> The routings for level transmitters [LT -RC-459 and 460] are depicted on drawings 11700-RE-57Q, S, and 57U, which are labeled [LT -RC-459 and 460], sheets 1 through 3.
>
> As shown on sheets 1 and 2, the instrument cables for the two transmitters are in close proximity. The valves are enclosed in conduit at these critical points and continue in conduit with increasing separation. The cables eventually enter trays in the penetration area which are separated by a fire barrier at column 10¼, and are protected by a fire detection and suppression system. We consider this routing acceptable based on our prior justification and our above review, which shows that when the two functions are in close proximity, each is enclosed in a separate conduit.

Additionally, an internal NRC memorandum dated November 22, 1982, from William V. Johnston to Thomas Novak states in part, ... *"Based on our evaluation, we find the level of fire protection provided for the Reactor Containment (RC-1) …provides a level of protection equivalent to the technical requirements of Section III.G of Appendix R and should be granted*."

Further justification for NRC approval is located in section 3.2, "Evaluation," of the above memorandum and in exemption request 3 from enclosure 2 of "Beaver Valley Power Station, Unit 1 – Request for Exemption From Some Requirements of Appendix R to 10 CFR Part 50" dated March 14, 1983, that states,

> The protection for redundant trains of safe shutdown equipment inside containment does not meet the technical requirements of Section III.G.2.b because there is not twenty feet of separation between redundant power cables free of intervening combustibles. Due to their configuration and location within the containment and to the restricted access of these sub-areas during plant operations, an exposure fire involving the accumulation of significant quantities of

> transient combustible materials is unlikely. Because there are only a few cables in these sub-areas and all cables inside containment are qualified to a test comparable to that of IEEE Standard 383 and routed in conduit, a fire of sufficient magnitude to damage redundant cables or components is also unlikely.

The conclusion statement in section 3.3 of the internal NRC memorandum dated November 22, 1982, states,

> Based on the above evaluation, the existing protection for the containment area provides a level of fire protection equivalent to the technical requirements of Section III.G of Appendix R. Therefore, the exemption should be granted.

The above excerpts from the FENOC exemption requests and subsequent internal NRC memorandum demonstrates that the NRC was made aware of and accepted partial cable routing in trays. Two of the above cable routing excerpts, (Pressurizer Relief Blocking Valves and Pressurizer Heaters A, B, D, and E) contain specific references to cable routing in covered trays. Additionally, the LAR Attachment T, “Prior Approval Clarification Request 2 for BVPS-1” stated that:

> The licensee submittals associated with this exemption request did not state that ‘all’ cables are routed in conduit but stated that redundant trains of safe shutdown cables are routed in conduit or routed in trays that are of a covered design in 1-RC-1. The intent of this exemption request was met because tray covers are installed when required to separate redundant trains and channels inside containment. The actual plant installation specifications only required tray covers on horizontal trays. Vertical tray covers are installed when required for train separation. The SER did not take credit for this statement regarding all trays being covered. The covered trays offer equivalent protection for redundant trains of safe shutdown cables routed inside the reactor containment building.

SSD RAI 13

Accordingly, provide additional information to support the following clarification requests, and other similar conditions, that are included in LAR Attachment T:

b) Prior Approval Clarification Requests 3, 4, 12 and 13: The licensee requested clarification of Licensing Actions 11.02 (Unit 1) and 08 (Unit 2), respectively, for approval of the deluge systems in the Unit 1 and Unit 2 Containments. However, Licensing Actions 11.02 and 08, as described in LAR Attachment K, did not include citations from licensee submittals regarding the configuration of the deluge systems. Clearly describe the scope of the clarification relative to the previously approved configuration, and provide the specific excerpts from applicable licensing basis

documents to demonstrate that the NRC has been aware and accepted the specific attributes of the deluge systems.

Response:

Prior approval clarification request 3 and 12 are related to manual actuation of the BVPS-1 and BVPS-2 containment fire protection water spray systems. An engineering evaluation of the manual actuation of containment water suppression systems for BVPS-1 and BVPS-2 concluded that the containment penetration area water suppression systems are acceptable. Therefore, "Prior Approval Clarification Request 3 for BVPS-1" and "Prior Approval Clarification Request 12 for BVPS-2" will be withdrawn from LAR Attachment T, and section 4.1.2.2 will be revised to remove reference to NFPA 805 section 3.9.1.

Prior approval clarification request 4 and 13 described the actual water coverage for the containment cable penetration area fire protection water spray systems. An engineering evaluation of the ability of the cable penetration area water suppression systems for BVPS-1 and BVPS-2 to provide adequate separation of redundant safety-related equipment concluded that the containment penetration area water suppression systems are acceptable. Therefore, "Prior Approval Clarification Request 4 for BVPS-1" and "Prior Approval Clarification Request 13 for BVPS-2" will be withdrawn from LAR Attachment T, and section 4.1.2.2 will be revised to remove reference to NFPA 805 section 3.9.1.

A revision to LAR Attachment T, prior approval clarification requests 3, 4, 12, and 13 to address this item will be provided in a future submittal.

SSD RAI 13

Accordingly, provide additional information to support the following clarification requests, and other similar conditions, that are included in LAR Attachment T:

c) **Prior Approval Clarification Requests 8, 9, and 10: The licensee requested clarification of Licensing Actions 04 and 05 and stated that the original deviation requests were approved for specific fire areas, and that the licensee is requesting that this approval be applied to additional fire areas that were not part of the original deviation. The NRC staff does not consider the additional fire areas that were not part of the scope of the original deviation as a "Prior Approval Clarification". In accordance with 10 CFR 50.48(c)(2)(vii), RG 1.205, and the guidance of NEI 04-02, where prior NRC approval is not provided or adequately documented, the licensee may choose to comply with the deterministic requirement of NFPA 805, Chapter 3, comply with use of engineering evaluation or include a performance-based method in accordance with 10 CFR 50.48(c)(2)(vii).**

Provide the appropriate compliance basis for the additional fire areas in accordance with the requirements of 10 CFR 50.48(c) and the guidance of RG 1.205 and NEI 04-02.

Response:

LAR Attachment T, prior approval clarification requests 8, 9, and 10, requested that "Prior Approval Clarification" be granted for additional fire compartments that have two 1.5-hour fire dampers in series with a 1-hour fire wrap instead of one 3-hour fire damper. Further reviews determined that the correct method for obtaining NRC approval was the development of LAR Attachment L, approval request 5. Approval request 5 will provide the technical justification required for NRC approval; therefore, Attachment T, prior approval clarification requests 8, 9 and 10 will be withdrawn. Furthermore, prior approval clarification request 7 was judged to be similar to these requests and will be withdrawn as well.

Corresponding LAR changes will include:

- LAR Section 4.1.2.2: Delete clarification request for 3.11.4;
- LAR Section 4.1.2.3: Add approval request for 3.11.3;
- LAR Attachment A, Table B-1 BVPS-2 A2 records: Revise compartment records to align with the Attachment L request;
- LAR Attachment C: Delete compartment associations from compartments listed in the Attachment L request;
- LAR Attachment K BVPS-2 licensing actions 04 and 05: Delete compartment associations from compartments listed in the Attachment L request; and
- LAR Attachment L will be revised to include the request for the configuration of two fire dampers in series.

A revision to the LAR that addresses these items will be provided in a future submittal.

SSD RAI 13

Accordingly, provide additional information to support the following clarification requests, and other similar conditions, that are included in LAR Attachment T:

d) **Prior Approval Clarification Request 15: The licensee requested clarification of Licensing Action 30 because the previously approved exemption for the Intake Structure did not specifically mention the non-safety related fire pump area or the sections of the regulations applicable to fire pump sprinkler protection. Provide the specific excerpts from licensing basis documents to demonstrate that the NRC has been aware and accepted the diesel fire pump room without sprinkler protection.**

<u>Response:</u>

The following excerpts are provided to demonstrate that the NRC has been aware of and accepted the diesel fire pump room without sprinkler protection.

Section 5.13, "Intake Structure," of the appendix to the "Safety Evaluation By The Office Of Nuclear Reactor Regulation Related to Amendment No. 18 To Facility Operating License No. DPR-66 Duquesne Light Company" dated June 6, 1979, states:

> An unmitigated fire in the intake structure would not result in compromising safe shutdown capability because of the separation and barriers between redundant safety-related equipment. The river water pumps are located in separate compartments and cabling is in conduit. A separate alternate water intake structure with redundant river water pumps is provided 1800 feet away.
>
> Because of the curbing at the diesel day tank and the trench to the diesel engine, a leak from the tank or supply lines would not spread to other areas.

Section 5.13, "Intake Structure," of the appendix to the "Safety Evaluation By The Office Of Nuclear Reactor Regulation Related to Amendment No. 18 To Facility Operating License No. DPR-66 Duquesne Light Company" dated June 6, 1979, also states:

> The licensee will remove all unnecessary combustibles from the intake structure and will allow only fire retardant treated lumber to be used within the building. The licensee will also provide automatic fire detectors in the safety-related pump compartments IS-1, IS-2 and IS-3 arranged to alarm in the control room.
>
> We find that, upon implementation of the above described modifications, the Intake Structure fire protection satisfies the objectives identified in Section 2.2 of this report and is, therefore, acceptable.

In a letter from Duquesne Light and Power to the NRC dated October 27, 1976, a response to BTP 9.5.1 position IV C.2.c states:

> The source of water for fire protection is the Ohio River. Heated fire pump rooms are located in the Intake Structure… The pumps are located in separate seismic Class I cubicles with walls in excess of three hour fire rating.

The presence of the fire pumps located in the Intake structure was reiterated in the BVPS-2 NUREG-1057 titled "Safety Evaluation Report related to the operation of Beaver Valley Power Station, Unit 2," Section 9.5.1.5 which states in part….

> The fire pumps are located in the intake structure and are separated by 3-hour fire-rated barriers.

Since the above excerpts demonstrate that the NRC was aware that the diesel fire pump was located in the Intake Structure, which does not have sprinkler protection, the LAR prior approval clarification request 15 will be withdrawn. Additionally, in LAR section 4.1.2.2, NFPA 805 Chapter 3 requirements requiring clarification of prior NRC approvals, paragraph 3.9.4 concerning the LAR prior approval request clarification 15 will be deleted and Attachment K, BVPS-2, licensing action 30 will be revised to delete the reference to the LAR prior approval clarification request 15. A revision to the LAR for items changed in this response will be provided in a future submittal.

SSD RAI 13

Accordingly, provide additional information to support the following clarification requests, and other similar conditions, that are included in LAR Attachment T:

e) Prior Approval Clarification Request 16: The licensee requests that the NRC document as a "prior approval" the modified fire doors separating Fire Areas 2-WH-1 and 2-CP-1 from other compartments and recognize that these doors are still adequate with the removal of the requirement for automatic sprinklers from the original licensing basis. The NRC staff does not consider the removal of commitments from licensing basis documents as a "Prior Approval Clarification". In accordance with 10 CFR 50.48(c)(2)(vii), RG 1.205, and the guidance of NEI 04-02, where prior NRC approval is not provided or adequately documented, the licensee may choose to comply with the deterministic requirement of NFPA 805, Chapter 3, comply with use of engineering evaluation, or include a performance-based method in accordance with 10 CFR 50.48(c)(2)(vii). Provide the appropriate compliance basis for the removal of the automatic sprinklers in accordance with the requirements of 10 CFR 50.48(c) and the guidance of RG 1.205 and NEI 04-02.

Response:

The compliance basis for the removal of the automatic sprinklers for fire compartments 2-WH-1 and 2-CP-1 will be changed to NFPA 805 section 4.2.4.2, “Use of Fire Risk Evaluation,” which requires a performance-based approach consisting of an integrated assessment of the acceptability of risk, defense-in-depth, and safety margin. Fire compartments 2-WH-1 and 2-CP-1 are non-risk significant and a fire in either of these areas will not damage any risk significant equipment. VFDRs written for the evaluation of these fire doors will be included in LAR Attachment A (Table B-1) and LAR Attachment C. LAR Attachment T prior approval request 16 will be withdrawn. Changes to the LAR will be provided in a future submittal.

SSD RAI 13

Accordingly, provide additional information to support the following clarification requests, and other similar conditions, that are included in LAR Attachment T:

f) **Prior Approval Clarification Request 17: The licensee requests that the NRC document as a "prior approval" and recognize although the licensee discovered non-safety-related cables in Fire Area 1-CV-3 that are not fire retardant in contrary to the statements in the exemption request (Licensing Action 05), the existing condition is still acceptable based on the modification to install steel tray covers and to wrap exposed portions of cables to maintain the condition of low in-situ combustibles. The licensee also stated that cable tray enclosures prevent the 'nonfire-retardant' cables from being considered as an intervening combustible material. Clarify whether or not all 'nonfire-retardant' cables in Fire Area 1-CV-3 are placed in enclosed tray or wrapped. If not, provide a justification for the acceptability of exposed 'nonfire-retardant' cables with respect to flame spread, intervening combustible, and added combustible loading in Fire Area 1-CV-3. Also, provide a comparison between the amount of in-situ combustibles in the current configuration and in the original licensing basis, and if increased provide a technical basis for acceptability.**

<u>Response:</u>

The “nonfire-retardant” cables in 1-CV-3 are configured in enclosed trays or wrapped with fire-retardant Siltemp material. In addition, an engineering evaluation determined that “nonfire-retardant” electric cable with respect to qualification, intervening combustibles, and combustible loading in fire area 1-CV-3 is acceptable.

Also, the comparison between the original in-situ combustibles licensing basis and the current configuration depicts a decrease in combustible loading. In a letter from the NRC to Duquesne Light Co. dated March 14, 1983, “low in-situ combustibles” were identified among the exemption bases for 1-CV-3. An excerpt from this letter stated:

> The significant combustibles in this area consist of electrical cable insulation in the three horizontal cable trays and conduits. The fire loading from the 1311 pounds of insulation is 24,000 BTU/ft^2 [British thermal units per square foot].

The engineering evaluation reflects the current in-situ combustible loading is less than 10,000 BTU/ft^2 which results in a lower fire severity (greater safety margin) than the NRC previously approved.

LAR Attachment K, licensing action 11.05 will be revised to include a reference to the engineering evaluation of the 1-CV-3 electrical cable configuration.

LAR Attachment T, request 17 will be revised to describe the enclosed cable tray and electrical cable wrap modification, and the engineering evaluation which form the bases of the clarification request.

A revision to LAR Attachments K and T for these changed items will be provided in a future submittal.

Radioactive Release (RR) RAI 01

NFPA 805, Section 1.5.2, states that "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."

LAR Section 4.4, "Radioactive Release Performance Criteria," and LAR Attachment E - "Radioactive Release Transition," indicate in the radioactive release analysis for the yard area (3-YARD-1) around the BVPS-1 and BVPS-2 complex that pre-fire plan guidance was developed to address radiological storage and sea-land type containers. Since this area is open to the atmosphere, provide an analysis for a fire occurring in the yard area to demonstrate that gaseous and liquid effluent releases will result in doses that are as low as is reasonable achievable (ALARA) and would not exceed applicable 10 CFR Part 20 limits. Describe the administrative controls (e.g., procedures and training) that will limit the amount of activity which may be present in these containers.

Response:

An analysis was performed that calculated the radioactive material airborne release rate and organ dose rates at the unrestricted site area boundary from a fire in a sea-land type container with radioactive material and located in the protected yard area (3-YARD-1). FAQ 09-0056, "Radioactive Release Transition" states that compliance with the radioactive release goals, objectives, and performance criteria can be demonstrated by ensuring the instantaneous release of gaseous radioactive effluents specified in the unit's Technical Specifications are met as opposed to exceeding 10 CFR Part 20 limits.

LAR Attachment S, Table S-3 items BV1-2371 will update the yard pre-fire plan to specify use of non-water extinguishing agents while fighting fires in yard radiological controlled areas to minimize creation of contaminated water, and to consider the use of temporary damming to contain potentially-contaminated fire suppression water runoff if water is needed for fire suppression. Therefore, the bounding analysis is considered to be from gaseous radioactive effluents from a potential sea-land type container fire.

The Technical Specifications identify the limitations on the dose rate (instead of the requested dose and activity) resulting from radioactive material released in gaseous effluents from the site to areas beyond the site boundary. Technical Specification section 5.5.2.g.2 specifies, in part, "For iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days: a dose rate ≤ [less than or equal to] 1500 mrem/yr [millirem per year] to any organ." The analysis performed demonstrates that a yard sea-land type container fire and associated radioactive material airborne release, would not cause organ dose rates at or beyond the site boundary to exceed 1500 mrem/yr.

A review of shipping data between 2010 through February 2015 identified a maximum measured weight of 18,160 pounds (lbs) for sea-land type containers filled with combustible materials. Therefore, the analysis performed conservatively assumed a sea-land type container filled with 20,000 lbs of 100 percent combustible material. The nuclide quantities were estimated by use of the RADMAN software program.

The RADMAN analysis used 20 milliroentgens per hour (mR/hr) at 1 meter as the bounding dose rate for radioactive materials stored within a sea-land type container to determine the dose rate at the unrestricted site area boundary due to a potential fire. LAR Attachment S, Table S-3 will be revised in a future submittal to add implementation item BV1-3122 that will update site procedures specifying the 20 mR/hr dose rate at 1 meter administrative limit.

At the unrestricted site area boundary, the atmospheric dispersion factors (seconds per cubic meter, or s/m^3) were calculated using offsite dose calculation manual (ODCM) methodology. The calculated atmospheric dispersion factors were then used to determine the concentration (microcurie per cubic meter, or uCi/m^3) and dose rate for each of the organs that are used in the ODCM calculations by use of the ODCM child organ dose rate conversion factors (mrem/yr per uCi/m^3).

The analysis calculated an atmospheric dispersion factor of 3.00E-5 s/m^3, which was the most bounding value among the various calculated values at the most restrictive ODCM gaseous effluents unrestricted site area boundary location. Furthermore, in accordance with ODCM methodology, respirable release fractions from Table 13 of NUREG-1140 for packaged waste were used in the dose rate analysis.

The results of the analysis determined the organ dose rate at or beyond the unrestricted site area boundary is 37 mrem/yr. Additionally, to account for a peak burn/release rate, a factor of three was applied and resulted in a calculated maximum instantaneous organ dose rate of 111 mrem/yr, which does not exceed the annual dose limit of 1500 mrem/yr specified in the Technical Specifications. The substantial margin between the conservatively-calculated maximum instantaneous dose rate and the allowable dose rate limit in the Technical Specifications demonstrates that the radiation exposure is as low as is reasonably achievable (ALARA).

Administrative controls limit activity in sea-land type container containers by requiring site personnel performing actions associated with shipment of radioactive materials to be trained to the requirements of 49 CFR 172 Subpart H, 10 CFR 20, 10 CFR 71, and NRC Bulletin No. 79-19 dated August 10, 1979. Also, as discussed above, LAR Attachment S, Table S-3 will be revised in a future submittal to add implementation item BV1-3122 that will update site procedures specifying the 20 mR/hr dose rate at 1 meter administrative limit for radioactive materials stored within a sea-land type container.

Fire Modeling (FM) RAI 01

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

- **The algebraic equations implemented in NUREG-1805, "Fire Dynamics Tools (FDTs): Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program," December 2004 (ADAMS Accession No. ML043290075), were used to characterize flame height, plume centerline temperature, flame radiation (heat flux), plume radius, hot gas layer (HGL) temperature, ceiling jet temperature, smoke and heat detector actuation, and sprinkler activation.**

- **The FLASH-CAT model was used to calculate the fire propagation in a vertical stack of horizontal cable trays.**

- **The Consolidated Model of Fire and Smoke Transport (CFAST) was used in HGL and multi-compartment analysis (MCA) calculations for various compartments, the Main Control Room (MCR) abandonment calculations, and the temperature sensitive equipment HGL study.**

- **Fire Dynamics Simulator (FDS) was used in the temperature sensitive equipment zone of influence (ZOI) and plume/HGL interaction studies.**

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

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

a) **Identify any applications of fire modeling tools or methods used in the development of the LAR that are not discussed in LAR Attachment J.**

Response:

There are no applications of fire modeling tools or methods used in the development of the LAR that are not discussed in LAR Attachment J.

FM RAI 01

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

b) There appears to be some differences between BVPS Units 1 and 2 in the detailed fire modeling methodology applied in each fire area. For example, in BVPS Unit 1, targets were damaged up to the ceiling to bound plume/HGL interaction while in Unit 2 the results of the FDS plume/HGL interaction study were used to justify the application of Heskestad's plume temperature correlation to determine the vertical ZOI. Describe the differences between the fire modeling methodologies applied in the two units, and explain why different approaches were used.

Response:

The same general fire modeling methodologies were consistently applied to the fire modeling analyses of compartments within BVPS-1 and BVPS-2. BVPS-1 and BVPS-2 have very different plant layouts and as such, the compartments may have significant geometrical and ventilation configuration differences. Due to these differences, the specific details of the fire modeling analyses (such as decision to damage targets to the ceiling) between the units may differ; however, the overall fire modeling methodology is consistent.

Regarding the specific example cited in the RAI, the FDS plume/HGL interaction study analyzes compartments in both units based on the same criteria. In the plume HGL study, compartments are characterized based on their total volume and ceiling height. Based on the geometrical characteristics, each compartment is assigned to a category, which dictates how it should be treated.

Based on the study, compartments identified as category I and III do not need to consider plume/HGL interaction while compartments classified as category II require further analysis. The compartments in BVPS-1 classified as category II have low ceiling heights (12.5 feet or less), while the compartments in BVPS-2 classified as category II have higher ceilings (greater than 15 feet). Due to the geometrical dissimilarities between these compartments, different fire modeling strategies were applied. For example, a fire scenario in a category II compartment with a predicted plume zone of influence (ZOI) that could reach the ceiling (for example, compartment 1-CR-3), was already assumed to damage targets to the ceiling, and therefore, did not require further analysis. Conversely, if a category II compartment had a higher ceiling than the predicted plume ZOI (for example, compartment 2-CB-6), this compartment was further analyzed using the plume/HGL interaction study.

FM RAI 01

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

c) **The NRC staff notes that typically, during maintenance or measurement activities in the plant, electrical cabinet doors remain open for a certain period of time. Describe whether there are any administrative controls in place to minimize the likelihood of fires involving such a cabinet, and describe how cabinets with temporarily open doors were treated in the fire modeling analysis.**

Response:

Administrative controls are in place to minimize the likelihood of fires involving cabinets with doors that may remain open during maintenance or measurement activities in the plant. These administrative controls include compliance with applicable industrial/electrical safety requirements, prevention of foreign material from entering the maintenance area, and proper housekeeping practices related to fire prevention and protection of the equipment.

Procedurally, if maintenance or measurement activities can be performed while the cabinet is not energized, efforts are made to ensure that electrical equipment is de-energized prior to performing these activities, rendering the cabinet as a non-credible ignition source. Plant administrative procedures require that periodic inspections be performed to ensure electrical component doors and hardware are intact and that enclosure covers are not open, missing, or not secure. Maintenance logs are kept to ensure equipment is returned to the “As-Found” configuration at the completion of maintenance.

Based on plant procedures, electrical cabinet doors are unlikely to be left open when maintenance or measurement activities are not in progress. For the brief periods cabinet doors may be temporarily open, however, administrative procedures provide reasonable assurance that the likelihood of a fire in these cabinets is minimal. Therefore, the fire modeling analysis assumes that electrical cabinets with normally closed doors are maintained closed.

Implementation item BV1-3123 has been created to review, and update as necessary, operations and maintenance procedures to minimize the duration of open electrical cabinets. A revision to LAR Attachment S, Table S-3 for implementation item BV1-3123 will be provided in a future submittal.

FM RAI 01

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

e) **Describe how non-cable secondary combustibles were identified and accounted for in the fire modeling analyses. Also, specifically explain if and how the combustible loading of the array of batteries was accounted for in the fire modeling analyses in Fire Compartment 1-CR-4.**

Response:

Non-Cable Secondary Combustibles:

The identification of non-cable secondary combustibles is required as part of the detailed fire modeling procedure utilized at BVPS. Plant walkdowns were conducted in fire compartments where detailed fire modeling was performed to identify combustibles. This includes the identification of non-cable secondary combustibles. Small combustible items, such as small plastic signs, fiberglass ladders, plastic telephones, etc., were typically screened as negligible in terms of the fire growth analysis for fire scenarios, as the size or location of the combustibles were judged to not significantly increase the zone of influence (ZOI) of the fire scenarios.

In response to a verbal NRC request during the LAR audit (ADAMS Accession No. ML15027A235), confirmatory plant walkdowns were performed for areas containing previously screened, non-cable secondary combustibles. Evaluations were performed to determine if the screened combustibles are bounded by the existing fixed initiator fire scenarios or if any allocated heat release rate (HRR) for transient zones require refinement. Factors that determine whether the combustible loading of the non-cable secondary combustibles should be added to the applicable scenarios include the proximity of the non-cable secondary combustibles to nearby PRA targets, the level of conservatism used in the cable tray fire growth model, and whether whole room damage was already postulated. Any non-cable secondary combustibles that are not bounded were added as appropriate to the associated fire growth analysis and the new zone of influence reviewed to account for any new target impacts. Based on the small quantities of non-cable secondary combustibles currently identified, the extent of the changes did not significantly change the fire scenarios and are not expected to significantly change the fire PRA results.

The updates will be reflected in the revision to the fire modeling workbooks currently in progress, and the results will be used in the updated integrated analysis to be provided with the response to PRA RAI 03.

Array of Batteries in Fire Compartment 1-CR-4:

Ignition of battery arrays in fire compartment 1-CR-4 (BAT1-5 and BAT1-6) was evaluated using the damage criterion of thermoset cables (11 kilowatts per square meter, or kW/m^2), which is considered to be bounding for battery ignition.

To model the combustible loading of battery banks BAT1-5 and BAT1-6, a peak heat release rate of 200 kilowatts (kW) has been added to the fire growth analysis (based on the guidance of the NRC Inspection Manual, Chapter 0609 Appendix F) for scenarios capable of igniting these arrays. These results will be used in the updated integrated analysis to be provided with the response to PRA RAI 03.

FM RAI 01

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

j) **Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:**

   i. **Provide technical justification for not excluding the volumes of the main-control boards (MCBs), electrical panels, raised platforms, ductwork in the interstitial space above the egg-crate ceiling, and other obstructions from the effective control room volume used in the CFAST calculations.**

Response:

The effective MCR volume is being updated to account for physical obstructions, including MCBs, electrical panels, raised platforms, and heating, ventilation, and air-conditioning (HVAC) ductwork in the interstitial space above the egg-crate ceiling. No other obstructions with significant volume were noted. The occupied volume of these obstructions is being calculated based on walkdown information and drawings. The occupied volume is to be subtracted from the gross MCR volume to estimate the effective MCR free volume to be used in the revised CFAST abandonment analysis. The results of the revised BVPS-1 and BVPS-2 MCR abandonment analysis addressing this update will be used in the integrated analysis to be provided with the response to PRA RAI 03.

FM RAI 01

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

j) **Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:**

   iii. **Explain why transient fires against a wall or in a corner were not considered in the Unit 1 and Unit 2 MCR abandonment calculations.**

Response:

The MCR abandonment calculation estimates the time to abandonment based on the characteristics of the hot gas layer (HGL). The development of the HGL is largely dictated by the total heat release rate (HRR) of the fire. While wall and corner effects influence fire plume and ceiling jet development, they have no direct impact on the total HRR of the fire. Further, CFAST sensitivity runs have shown the position of the fire in relation to walls and corners has negligible impact on the HGL properties used to define MCR abandonment (NUREG/CR-6850 describes abandonment conditions in terms of HGL temperature, HGL height, and HGL smoke optical density). Consequently, considering transient fires against a wall or in a corner were not necessary in the BVPS-1 and BVPS-2 MCR abandonment analysis.

FM RAI 01

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

j) **Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:**

   iv. **The MCR abandonment calculations are based on the assumption that all doors would normally remain closed. In this case, explain what natural leakage vents were assumed in the analysis.**

Response:

Contrary to the statement made in the BVPS-1 and BVPS-2 MCR abandonment analysis, the calculations were performed assuming two open doors for cases with no forced ventilation (both HVAC units failed), and cases where the purge mode is in operation. As the doors are fully open and there are no other external permanent openings, no other natural leakage vents were considered.

In response to FM RAI 01(j)(v), the MCR abandonment analysis is being re-evaluated with the MCR door being initially closed and subsequently opened at a time based on the arrival of the fire brigade. The brigade arrival time will be based on review of fire drill records. During the time the MCR doors remain closed, the only significant natural leakage will be assumed to be the leakage around the external doors. Following the guidance in NUREG/CR-6850, Appendix F, this will be represented by a 0.5 inch high leakage path below the width of the door. This is considered conservative, since other leakage paths may exist, but are not credited for hot gases flowing out of the zone. If this natural leakage vent opening is not sufficient to sustain the assumed fire HRR, the size of the opening will be increased to the minimum size that allows the fire to be sustained at the assumed HRR. The results of the revised BVPS-1 and BVPS-2 MCR abandonment analysis addressing this update will be used in the integrated analysis to be provided with the response to PRA RAI 03.

FM RAI 01

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

j) **Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:**

   v. **In the event of loss of both MCR Units and two HVAC systems, doors are assumed to be open. In this case, identify the MCR doors that are assumed to be open, explain whether they are assumed to open at a specific time, and, if so, provide the basis for this time (e.g., estimated fire brigade arrival time based on drill data).**

Response:

The MCR has two entrances that lead outside, the north entrance and the south entrance. In the MCR abandonment analysis, the double leaf doors of the south entrance are assumed to be open.

These doors are assumed to be open at the start of the fire and remain open throughout the fire duration. This approach ensured there was sufficient natural leakage to sustain the fire and captured the opening of the MCR doors by the fire brigade. In order to refine the time at which the MCR doors open on brigade arrival, the door opening time used in the analysis is being updated to reflect the estimated fire brigade arrival time based on review of fire drill records. The results of the revised BVPS-1 and BVPS-2 MCR abandonment analysis addressing this update will be used in the integrated analysis to be provided with the response to PRA RAI 03.

FM RAI 01

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

j) Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:

vii. Provide technical justification for not considering cabinet fires that spread to adjacent cabinets.

<u>Response:</u>

The MCR abandonment analysis is being updated to include fire spread to adjacent cabinets.

To evaluate the impact of propagating fires, the methodology in NUREG/CR-6850, Appendix S is applied, with fire propagation limited to the adjacent cabinet (directly next to the initiating section) only. Therefore, the maximum number of cabinets to be affected is three (the source plus one cabinet on either side). The time to fire propagation from one cabinet section to the adjacent cabinet section has been taken to be 10 minutes based on NUREG/CR-6850, Appendix S. This propagation time is based on cabinets being separated by a single metal wall, and cables in the adjacent cabinet in direct contact with the separating wall.

Large open cabinets such as the MCB vertical boards are also assumed capable of fire propagation equivalent to three cabinets with multiple cable bundles.

In addition, when the conditions below are satisfied, the NUREG/CR-6850, Volume 2, Appendix S, “Appendix for Chapter 11, Fire Propagation to Adjacent Cabinets,” recommended approach assuming no fire spread to adjacent cabinets is credited:

1. Cabinets are separated by a double wall with an air gap, or
2. Either the exposed or exposing cabinet has an open top, and there is an internal wall, possibly with some openings, without diagonal cable running between the exposing and exposed cabinet.

A review of the walkdown notes is being conducted to determine those cabinets that would be limited to a single cabinet fire and those that could propagate to an adjacent cabinet or cabinets. Once the fire propagates to one or both of the adjacent cabinets, the adjacent cabinet fire(s) will follow the same cabinet fire HRR growth profile as the ignition source cabinet.

The CFAST MCR abandonment modeling will be updated to incorporate the additional cabinet fire propagation cases involving two and three-cabinet fires. The results of the revised BVPS-1 and BVPS-2 MCR abandonment analysis addressing this update will be used in the integrated analysis to be provided with the response to PRA RAI 03.

FM RAI 01

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

j) **Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:**

  ix. **Explain whether there are (or will be) any administrative controls in place to support the assumption that transient fires grow to peak HRR in 8 minutes (e.g., administrative controls that prohibit the accumulation of loose trash in the MCR area).**

Response:

Supplement 1 to NUREG/CR-6850, Chapter 17 defines the 8 minute growth to peak HRR for transient fires to represent common trash can fires. BVPS has general administrative procedures in place to prevent accumulation of loose trash. As would be expected, good housekeeping practice is exercised in the MCR which keeps the accumulation of loose transient combustibles to a minimum. Since the MCR is continually manned, and the presence of transient combustibles is therefore continuously being monitored, the accumulation of loose trash in the MCR is therefore considered highly unlikely despite the lack of a specific transient control procedure for the MCR. A contained trash fire with a time to peak HRR in 8 minutes as used in the BVPS-1 and BVPS-2 MCR abandonment analysis is therefore considered representative of transient fires in the MCR.

FM RAI 01

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

j) **Specifically regarding the use of CFAST in the MCR abandonment calculations for Units 1 and 2:**

  xi. **Provide the results of the calculations that support the licensee's assertion that MCR abandonment will not be required if at least one of the HVAC systems is changed to smoke purge mode within 705 seconds (~12 minutes).**

Response:

The assertion that MCR abandonment will not be required if at least one of the HVAC systems is changed to smoke purge mode within 705 seconds is based on CFAST analysis. A fire with the highest credible HRR of 1462 kW, representing a multi-bundle, qualified cable cabinet fire was selected. Two doors are assumed to be open throughout the fire duration, with no forced ventilation at the start of the fire. CFAST runs were performed varying the activation time of purge mode from a single HVAC unit. The results of the analysis are shown below. Based on the criteria proposed in NUREG/CR-6850, it is assumed that abandonment would become necessary if:

- The heat flux at a height of 1.83 meters (6 feet) above the floor exceeds 1 kW/m^2, consistent with the industry approach taken to be equivalent to a smoke layer at a temperature of about 93 degrees Celsius (°C) (200 degrees Fahrenheit, or °F) or
- The hot gas layer descends to below 1.83 meters (6 feet) above floor level and the optical density (OD) of the smoke is greater than 3.0 per meter, or 3.0 m^{-1}. Note that the NUREG/CR-6850 criteria is incorrect in that it specifies abandonment is necessary when the OD of the smoke is less than 3.0 m^{-1}.

With these abandonment criteria, abandonment conditions are not achieved for the case when purge mode is activated at 705 seconds. When the activation of purge mode is delayed beyond 705 seconds (to 710 seconds), it was shown the hot gas layer height and optical density satisfy the abandonment criteria. Table 01(j)(xi) summarizes the results, and Figures 01(j)(xi)-1 through Figure 01(j)(xi)-3 present the CFAST hot gas layer profiles when purge mode is activated at 705 seconds.

This analysis will be revised in response to other MCR abandonment analysis RAIs (FM RAI 01(j)(i), (iv), (v), and (vii)), and the results of the revised BVPS-1 and BVPS-2 MCR abandonment analysis addressing these updates will be used in the integrated analysis to be provided with the response to PRA RAI 03.

Table 01(j)(xi) – MCR abandonment times with one HVAC unit purge mode activated

Description	HRR (kW)	Time HGL Exceeds 93°C (seconds)	Time HGL Descends to 1.83 m Above Floor (seconds)	Time HGL OD Exceeds 3 m^{-1} (seconds)	Evacuation Time (minutes)
One HVAC Unit Purge Mode on at 705 seconds	1462	Not reached	705	Not reached	Not reached
One HVAC Unit Purge Mode on at 710 seconds	1462	Not reached	705	710	11.8

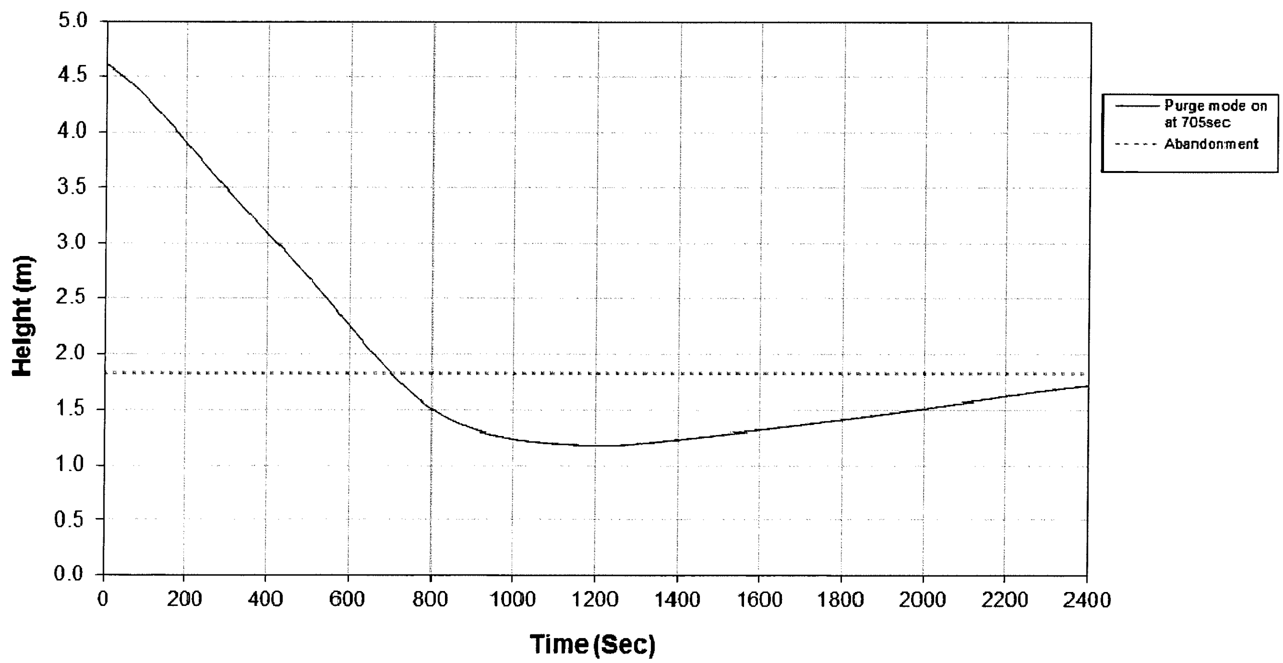


Figure 01(j)(xi)-1. HGL height with purge mode activated at 705 seconds.

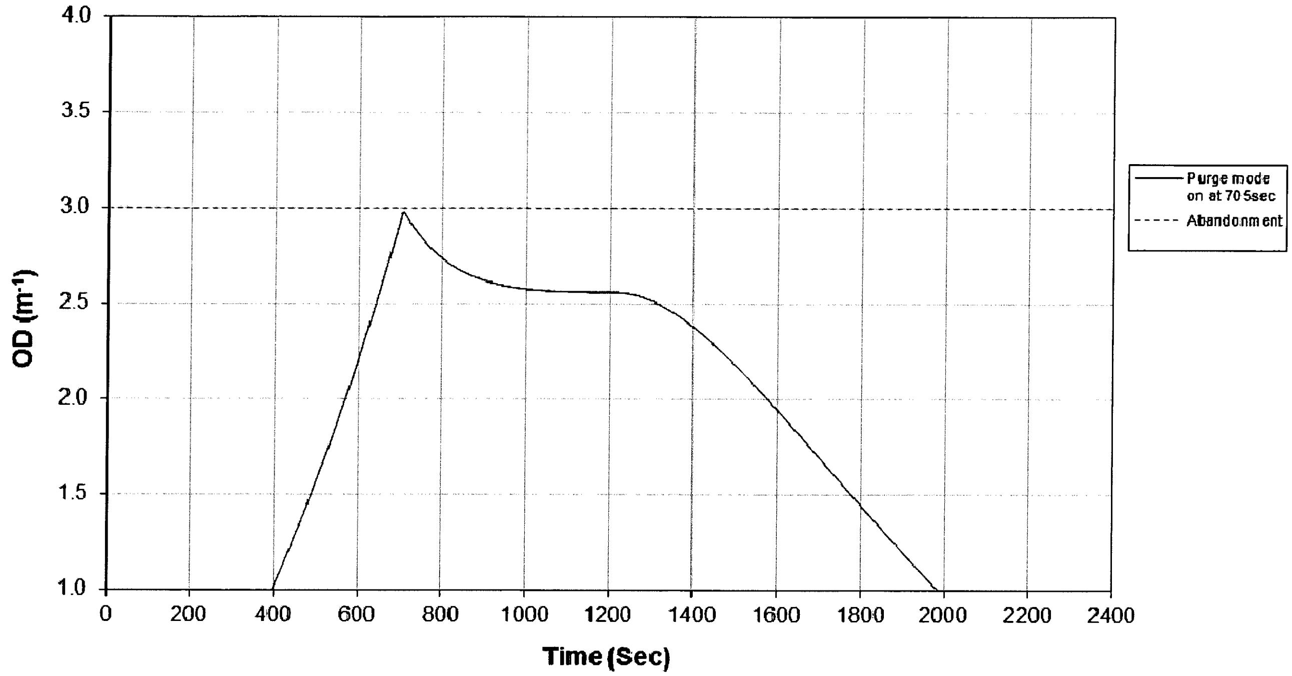


Figure 01(j)(xi)-2. HGL optical density with purge mode activated at 705 seconds.

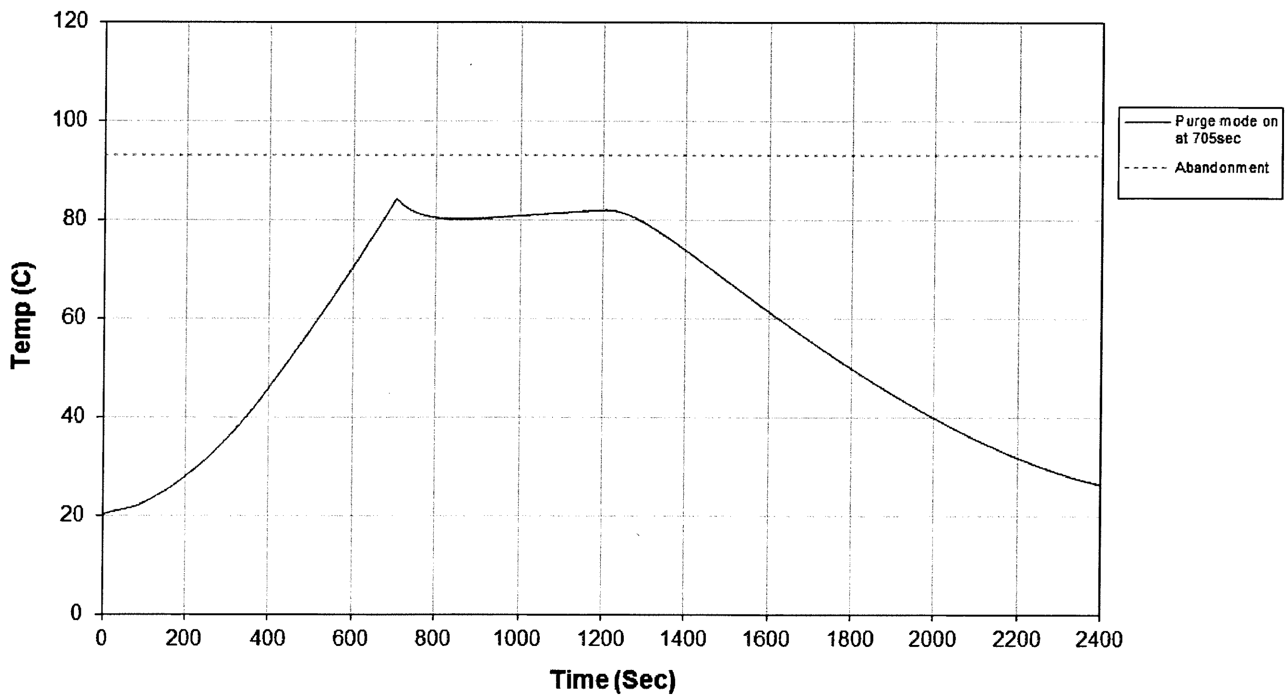


Figure 01(j)(xi)-3. HGL temperature with purge mode activated at 705 seconds.

FM RAI 02

LAR Section 4.5.1 states, in part, that "In accordance with the guidance in RG 1.205, Fire PRA (FPRA) models were developed for BVPS-1 and BVPS-2 in compliance with the requirements of Part 4 "Requirements for Fires at-Power PRA," of the ASME and ANS combined PRA Standard, ASME/ANS RA-Sa-2009, "Standard for Level1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Application…"

The American Society of Mechanical Engineers (ASME) and American Nuclear Society (ANS) standard ASME/ANS RA-Sa-2009, Part 4, requires damage thresholds be established to support the FPRA. Thermal impact(s) must be considered in determining the potential for thermal damage of SSCs and appropriate temperature and critical heat flux criteria must be used in the analysis.

b) Explain if and how solid cable tray covers and fire wraps or electrical raceway fire barrier systems were credited in any areas in terms of delaying or preventing damage, ignition and subsequent flame spread of cables. In addition, explain how perforated and corrugated cable tray covers were treated in this respect with regard to damage criteria, fire propagation, etc., in the fire modeling analyses.

Response:

The damage threshold for FPRA target cables in conduit and cable trays was based on the damage thresholds identified in NUREG/CR-6850, Table H-1. For additional information, see the FENOC response to FM RAI 02(a) that was previously submitted with the 90-day responses.

Cable Tray Covers:

Some cable trays are provided with top covers, bottom covers, or are fully enclosed, which allows for fire PRA risk reduction credit. Cable tray covers do not impact the cable damage thresholds, but are credited with delaying damage and ignition to thermoplastic and thermoset cables in accordance with NUREG/CR-0381 and NUREG/CR-6850, Appendix Q.2.2, respectively. Fire growth and propagation was not postulated for fully enclosed cable trays.

The acceptability of these covers/enclosures was determined by visual inspection during walkdowns. These cable tray covers have been evaluated and confirmed to be outside the ZOI of any high hazard event (high energy arching fault (HEAF), hydrogen or transformer explosion) which may cause mechanical damage to the cover. If within the ZOI of a high hazard event, cable tray covers are not credited to prevent damage in those scenarios.

In response to this RAI, tray covers were visually inspected for holes or gaps. Any top or bottom covers or enclosures with holes or gaps will not be credited to delay damage; however, credit may be given to delay ignition, as long as the holes or gaps are very small (1 inch or less) and infrequent (spaced three or more feet apart). Postulating full ignition of the trays with these covers would be overly conservative due to the small size of the gaps. In addition, the small number of gaps ensures that there is a very low probability of a fire being precisely located such that it is capable of igniting the cables within the tray covers.

Tray covers were also visually inspected for whether they were raised or corrugated. Any trays found to have raised or corrugated covers will not be credited to delay damage or ignition in fire modeling analyses.

Credit for cable tray covers will be updated to reflect the above treatment as applicable. These updates will be reflected in the updated fire risk results that will be provided to the NRC as part of the integrated analysis to be performed in response to PRA RAI 3.

Fire Wraps or Electrical Raceway Fire Barrier Systems (ERFBS):

Some fire PRA cable trays, conduit, and cables are provided with fire wrap or ERFBS, with a fire-resistance rating specified by the manufacturer. Existing fire wraps were visually inspected and have been evaluated and confirmed to be outside the ZOI of any high hazard event (such as, HEAF, hydrogen or transformer explosion) which may cause mechanical damage to the wraps. If within the ZOI of a high hazard event, wraps are not credited to prevent damage in those scenarios. Fire wraps confirmed to be currently intact, undamaged, and outside the ZOI of high hazard events, were credited in the BVPS fire PRA analysis to prevent fire damage to the wrapped targets for the duration of the manufacturer’s rating.

Walkdowns indicated that some cables that are air dropped (not in a conduit or tray) are wrapped in a silica-based fabric (welding cloth). In other instances, some raceways are protected by fire wrap that has been abandoned in place and marked as such in the field. In situations such as these, a delay to damage is not credited for the wrap, but these cables were not considered secondary combustibles.

FM RAI 02

c) **Explain how exposed temperature-sensitive equipment was treated, and provide a technical justification for the damage criteria that were used.**

<u>Response:</u>

NUREG/CR-6850, Volume 2, Section H.2 recommends the use of 65 °C and 3 kW/m^2 as the critical damage temperature and heat flux for solid state components (such as temperature-sensitive electronic equipment).

Analyses that consider damage to sensitive electronics by hot gas layer immersion (gas layers above 65 °C engulfing the cabinet) are consistent with the critical temperature threshold established in the NUREG/CR-6850 guidance.

Analyses considering damage by radiant heat are consistent with the guidance provided in fire PRA FAQ 13-0004, which relies on the shielding characteristics of cabinet walls to allow the radiant damage to the ZOI for thermoset cables (11 kW/m^2) to be used. The FAQ can be applied to cabinets as long as the component is not mounted on the surface of the cabinet (front or back wall/door) where it would be directly exposed to the convective and/or radiant energy of an exposure fire, and where the presence of louvers or other ventilation means could expose the cabinet to damaging heat fluxes, invalidating the FAQ results.

In response to this RAI, walkdowns were performed on cabinets in fire-modeled compartments to verify that the sensitive electronic limitations were not exceeded. Some cabinets were identified with exposed temperature-sensitive components. FENOC will update the BVPS modeling analyses by considering these cabinets damaged based on the temperature-sensitive component damage criteria (3 kW/m^2 and 65 °C) as provided in NUREG/CR-6850, Section H.2. Any necessary updates to fire modeling associated with temperature-sensitive components will be reflected in the updated fire risk results that will be provided to the NRC as part of the integrated analysis to be performed in response to PRA RAI 3.

Additional details regarding the treatment of sensitive electronics are provided in the response to PRA RAI 07.

FM RAI 03

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

LAR Section 4.5.1.2 states that fire modeling was performed as part of the FPRA development (NFPA 805, Section 4.2.4.2). Reference is made to LAR Attachment J, for a discussion of the verification and validation (V&V) of the fire models that were used. Furthermore, LAR Section 4.7.3 states that, "Calculational models and numerical methods used in support of compliance with 10 CFR 50.48(c) were verified and validated as required by Section 2.7.3.2 of NFPA 805."

Regarding the V&V of fire models:

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

<u>Response:</u>

Based on the response to FM RAI 01(a), the V&V bases for tools and methods used to support the LAR have already been provided in LAR Attachment J. There are no new V&V bases to provide.

FM RAI 04

NFPA 805, Section 2.7.3.3, states that acceptable engineering methods and numerical models shall only be used for applications to the extent these methods have been subject to V&V. These engineering methods shall only be applied within the scope, limitations, and assumptions prescribed for that method.

LAR Section 4.7.3 states that, "Engineering methods and numerical models used in support of compliance with 10 CFR 50.48(c) are used and were applied appropriately as required by Section 2.7.3.3 of NFPA 805."

Regarding the limitations of use:

a) Identify uses, if any, of algebraic models outside the limits of their applicability and for those cases explain how their use was justified.

<u>Response</u>

The limitations and assumptions associated with the algebraic models in the fire dynamics tools (FDTs) are documented in NUREG-1805, NUREG-1824, NUREG-1934, and the BVPS fire modeling verification and validation documentation. Using this guidance, the fire modeling analyst verifies that the fire modeling tools are used within the limits and ranges of applicability.

In most cases, the subject correlations have been applied within the validated ranges reported in NUREG-1934. In cases where the models have been applied outside the validated ranges reported in NUREG-1934, these have been justified as acceptable, either by qualitative analysis of the conservative assumptions in the model and the resulting safety margin (for example, the selected heat release rate provides a bounding zone of influence), or by quantitative sensitivity analysis. Technical details demonstrating the models are within range, as well as any justification of models outside the range or parameters that do not apply to a given scenario, are outlined in the BVPS fire modeling verification and validation documentation.

FM RAI 04

Regarding the limitations of use:

b) **Identify uses, if any, of fire scenarios outside the limits of applicability of the CFAST model and for those cases explain how the use of [sic] CFAST model was justified.**

Response:

CFAST was verified and validated by NUREG-1824, which provides the limitations of model applicability. BVPS utilized CFAST within the limitations discussed in NUREG-1824 by conservatively following the guidance provided in model preparation.

To demonstrate that the CFAST analyses were performed within the applicable guidelines, the model input parameters were analyzed to determine that they were within the normalized parameter ranges summarized in NUREG-1934. In most cases, the subject correlations have been applied within the normalized parameter ranges reported in NUREG-1934. In cases where the models have been applied outside the validated ranges, their use has been justified as acceptable, either by qualitative analysis of the conservative assumptions in the model and the resulting safety margin (for example, the selected heat release rate provides a bounding zone of influence), or by quantitative sensitivity analysis. Technical details demonstrating the models are within range, as well as any justification of models outside the range or parameters that do not apply to a given scenario, are outlined in the BVPS verification and validation documentation.

FM RAI 04

Regarding the limitations of use:

c) **Identify uses, if any, of fire scenarios outside the limits of applicability of the FDS model and for those cases explain how the use of the FDS model was justified.**

Response:

The FDS model was verified and validated by NUREG-1824, which provides the limitations of model applicability. BVPS utilized the FDS model within the limitations discussed in NUREG-1824 by conservatively following the guidance provided in model preparation.

To demonstrate that the FDS analyses were performed within the applicable guidelines, the model input parameters were analyzed to determine they were within the normalized parameter ranges summarized in NUREG-1934. In most cases, the subject correlations have been applied within the normalized parameter ranges reported in NUREG-1934. In cases where the models have been applied outside the validated ranges, their use has been justified as acceptable, either by qualitative analysis of the conservative assumptions in the model and the resulting safety margin (for example, the selected heat release rate provides a bounding zone of influence), or by quantitative sensitivity analysis. Technical details demonstrating the models are within range, as well as any justification of models outside the range or parameters that do not apply to a given scenario, are outlined in the BVPS fire modeling verification and validation documentation.

Probabilistic Risk Assessment (PRA) RAI 04

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff require additional justification to allow the NRC staff to complete its review of the proposed method.

The LAR does not appear to state whether the Fire PRA includes deviations from NRC Accepted Fire PRA Methods (e.g., NUREG/CR-6850, FAQs or interim guidance). For the Unit 1 and 2 Fire PRAs, identity deviations from NRC accepted guidance, and if deviations were used, then justify them or replace them with another method and submit that method to the NRC for review. Also, determine the impact on Fire CDF, LERF, Δ CDF, and Δ LERF by including any new approaches as part of the integrated analysis performed in response to PRA RAI 3.

<u>Response:</u>

The BVPS-1 and BVPS-2 fire PRA models include deviations from NRC-accepted fire PRA methods. Some of these deviations are discussed in the responses to PRA RAIs 01, 07, 09, 10, 25, 26, and FM RAIs 01 and 02. The following are additional deviations from accepted methods, not already the subject of other RAIs:

- Treatment of transient fire frequencies in BVPS-1 fire compartment 1-CV-3
- Treatment of junction boxes in fire modeling for BVPS-1 and BVPS-2
- Treatment of fire scenarios in the yard area (fire compartment 3-YARD-1)
- Transient fire ignition frequency in 1-TB-1 pipe tunnel

Details of these deviations are provided individually below.

Deviation 1 – Treatment of transient fire frequencies in BVPS-1 fire compartment 1-CV-3

Background

Fire compartment 1-CV-3 is the cable tunnel located on the 720 foot elevation at the eastern end of the service building in BVPS-1. The cable tunnel functions essentially as a transition area for cables routed from the service building to the electrical underground duct banks in the north and south yard.

The only potential ignition sources in 1-CV-3 are transient fires or cable fires that could arise from welding/cutting or other test, inspection, and maintenance activities. In accordance with the accepted fire modeling guidance, self-ignited cable fires are precluded since cables in 1-CV-3 are either thermoset or are low power thermoplastic cables associated with control or protection of normal power supplies. There are no other fixed ignition sources in 1-CV-3.

Access to the cable tunnel is normally prevented by a locked-closed hatch and thus the opportunity to introduce transient fires is limited to short periods when access is required for test, inspection and maintenance. At other times during plant operation the hatch is locked and access is controlled by control room operations personnel. Security records are maintained to monitor the length of time for which the hatch into 1-CV-3 is open for access. Over the 3 years previous to the analysis being performed (2008, 2009 and 2010), the hatch was open for at most 14 hours in any one year. It is estimated that the monthly surveillance to check the portable fire extinguisher accounts for 10 minutes per entry (120 minutes or 2 hours annually). During this time, the Halon system (auto detection and auto suppression) remains available. The remaining occupancy time of 12 hours per year is conservatively assumed to be for maintenance and/or testing of the Halon and smoke detection systems.

The cable tunnel contains cables associated with both trains of normal and emergency power in a relatively confined space. Fires are therefore potentially highly-risk significant. The standard method for addressing transient fires is overly-conservative and would lead to unduly high risk predictions.

Transient Frequency Analysis

The transient frequency is evaluated using the general approach described in NUREG/CR-6850 task 6, that is:

$$\lambda_{IS,J} = \lambda_{IS}\, W_L\, W_{IS,J,L}, \quad \text{,where}$$

λ_{IS} = Plant level fire frequency associated with ignition source IS
W_L = Location weighting factor associated with the ignition source
$W_{IS,J,L}$ = Ignition source weighting factor reflecting the quantity of the ignition source type present in compartment J of location L.

For general transient fires, the ignition source weighting factor is given by:

$$W_{GT,J,L} = (n_{m,J,L} + n_{o,J,L} + n_{s,J,L})/N_{GT,L} \quad \text{, where:}$$

$n_{m,J,L}$ = Maintenance influence factor rating of compartment J of location L,
$n_{o,J,L}$ = Occupancy influence factor rating of compartment J of location L,

$n_{s,J,L}$ = Storage influence factor rating of compartment J of location L and
$N_{GT,L}$ = Σ ($n_{m,i,L}$ + $n_{o,i,L}$ + $n_{s,i,L}$) (summed over i, compartments of location L).

The weighting factor for transient fires caused by welding or cutting is given by:

$W_{WC,J,L} = n_{m,J}/N_{WC}$
$N_{WC} = \Sigma\, n_{m,i,L}$ (summed over i, compartments of location L)

The weighting factor for cable fires caused by welding or cutting is thus given by:

$W_{CF,J} = n_{m,J}\, W_{Cable,J} / N_{CF}$, where

$N_{CF} = \Sigma\, n_{m,i,L}\, W_{Cable,I}$ (summed over i, compartments of location L)

$W_{Cable,i}$ = Cable load of compartment i, based on the ratio of the quantity of cables in compartment i over the total quantity of cables in the location.

For 1-CV-3 the maintenance influence factor n_m used for each of the above expressions was adjusted to account for the extremely low occupancy of this compartment while allowing for the fact that, when this compartment is occupied, the level of maintenance activities (including test and inspection), is very high. The highest value (50) is therefore used as the influence factor for the time that 1-CV-3 is occupied, but this is only applicable for a fraction of the time equivalent to 14 hours (0.58 days) per year (see above). The time-averaged maintenance influence factor is then calculated to be 50 x 0.58/365 = 0.08. While this approach is considered to be reasonable and the frequency adjustment was made at the influencing factor level, thereby preserving the plant-wide frequency, it is still a deviation from accepted methods.

Other than for maintenance, the occupancy influence factor is set to 0, since entrance to the compartment during plant operation is prevented by a locked hatch.

For the same reason, the storage influence factor is set to 0, noting that transient fires caused by temporary storage of materials required for inspection/maintenance are covered by the weighting factor for maintenance.

Resolution Using Approved Method

Subsequent to the 1-CV-3 analysis being performed, FAQ 12-0064 provides additional guidance on calculating transient combustible and activity fire weighting factors. A modified set of rating levels to be applied to the influencing factors are provided and includes a very low (0.3) ranking value for general electro-mechanical maintenance. The guidance describes locations where this ranking level is applicable as follows:

A "0.3" rating may be applied only to locations meeting the strictest of access controls, that are largely devoid of equipment, and that contain no equipment subject to frequent maintenance. This rating may be applied provided that (1) access to the location is strictly controlled ………., and (2) the location contains no plant equipment or components other than cables, fire detectors, junction boxes and other minor plant support equipment such as normal and emergency lighting, access control panels, plant paging or communications equipment, alarms or alarm panels, and security monitoring or support equipment.

In general, the presence of any piece of equipment that was counted as a fire ignition source during Step 6 would preclude assignment of "very low" for this factor. Conversely, it cannot be assumed that the lack of countable fire ignition sources implies that the very low ranking factor applies. If equipment items are present that may require maintenance but do not meet the counting criteria (e.g., smaller pumps, motors or ventilation subsystems) then the very low ranking factor would not apply.

Application of this ranking value requires verification that no violations of the controls associated with transient combustibles and activities have occurred over a reasonable prior time period (i.e., five years).

This rating may not be applied to the MCR but may be applied to a cable spreading room (CSR) devoid of other equipment, and cable vault and tunnel areas meeting the criteria. Other plant locations may also be assigned the "very low" (0.3) ranking factor provided all of the defined criteria are met.

As described above, access to 1-CV-3 is strictly controlled and the fire ignition frequency calculation confirms that apart from minor plant support equipment, there are no countable, fixed ignition sources in this compartment. A review of records associated with violations in transient combustible and activity controls over the last 5 years has revealed that there have been no violations in these control measures for 1-CV-3. Given the lack of ignition sources and the successful adherence to combustion and activity controls, 1-CV-3 satisfies the conditions set out above for use of the 0.3 ranking, and the 0.3 ranking is considered to most accurately describe the level of maintenance activity in this compartment. Therefore, it is proposed the maintenance influencing factor ranking for 1-CV-3 be changed to 0.3.

Impact on Core Damage Frequency (CDF) and Large Early Release Frequency (LERF)

The impact on CDF and LERF of using a ranking of 0.3 for the 1-CV-3 maintenance influencing factor has been calculated by performing a sensitivity analysis. The 1-CV-3 scenario frequencies were updated and adjusted to account for the 0.3 factor and using the conditional core damage probability (CCDP) and conditional large early release probability (CLERP) from the Task 7 screening analysis, the CDF and LERF were re-evaluated. It was shown that the CDF and LERF values still remain below the scenario screening criteria of CDF < 1.0E-08 and LERF < 1.0E-09, and consequently, 1-CV-3 will not be subject to further analysis. The analysis for 1-CV-3 will be updated to reflect the new approach in accordance with FAQ 12-0064 as part of the integrated analysis to be performed in response to PRA RAI 03; however, since the compartment will continue to quantitatively screen out, the results of the analysis will not be affected.

Deviation 2 - Treatment of junction boxes in fire modeling for BVPS-1 and BVPS-2

Background

In the BVPS detailed fire modeling, junction boxes were considered to be well-sealed and robustly secured, and were therefore screened from consideration as ignition sources on that basis. This is not in alignment with FAQ 13-0006 regarding the treatment of junction boxes in the fire modeling analysis.

Resolution Using Approved Method

Subsequent to performance of the detailed fire modeling for BVPS-1 and BVPS-2, FAQ 13-0006 was issued to provide guidance on how junction boxes should be treated in the analysis for the fire PRA. In recognition of this, the BVPS fire model will be updated to properly account for junction box fires in accordance with the guidance in FAQ 13-0006. The results of this update will be incorporated in the integrated analysis to be performed in response to PRA RAI 03.

Deviation 3 - Treatment of fire scenarios in the yard area (fire compartment 3-YARD-1)

Background

In the absence of NRC-accepted guidance for performing detailed fire modeling in a yard area, the common BVPS yard area (fire compartment 3-YARD-1) was modeled using a method judged to be reasonable and sufficiently conservative.

BVPS plant boundary definition and partitioning for the fire PRA defines fire compartment 3-YARD-1 as containing electrical manholes and associated underground duct lines in the yard area. For the purpose of detailed fire modeling analysis, the exterior power block area was considered including areas outside of the protected area fence such as manholes and underground duct lines containing fire PRA-credited cables that lead to the intake and alternate intake structures. Although the exterior transformers are defined as separate fire compartments, they were also evaluated as part of this analysis with regard to potential damage due to a fire in the yard area.

Underground duct lines located in the yard area are not exposed to fire sources except where they enter a manhole or building. Duct lines entering a building are treated as a raceway and included in the scope of the building fire model as required. Electrical manholes in the yard area are located below ground level and are stand-alone concrete enclosures configured such that it is not credible for a fire within one manhole to spread to another manhole. Buildings are separated from the yard by walls that are judged to be adequate to withstand damage from a transient fire in the yard without loss of function.

There will be no hot gas layer in the yard, so the only concern is radiant heat. Since the construction of the building exterior walls is typically concrete or metal, with solid metal doors, radiant heat will be substantially mitigated and is therefore not a concern.

There are no fixed ignition sources in 3-YARD-1. Bulk hydrogen storage and station transformers are contained in separate fire compartments and are analyzed separately from the yard area.

Transient fires have been considered for 3-YARD-1. Three different transient fire types have been analyzed for the yard: general transients, cable fires caused by hot work, and transient fires caused by hot work. For the general transient fires, the concern is spread of flammable liquids such as fuel to more than 1 manhole from a spill in the yard. The type and nature of transient combustible materials in this compartment is expected to be a flammable liquid fuel spill. The bounding transient fire has been considered to be a large (greater than 100 gallon) spill of diesel fuel from a fuel delivery truck. Separation of FPRA manholes and exterior transformers has been considered to determine the extent of damage. The criteria for spatial separation are:

- Sufficiently raised above-grade to preclude fuel spill that may overcome and breach manhole cover (to be judged, but height should at least be a few inches);
- Off road/transit path such that fuel spill is not likely to occur in the area;
- 50 feet apart (similar to NFPA separation criteria for transformers, and building separation);
- Slope of road, such that fuel will be directed away from a common collection area and will not affect multiple manholes simultaneously;
- Unpaved surface (will not permit fuel to spill evenly).

For bin 25 transients:

There are 32 risk-significant locations where a fuel spill could affect at least 1 manhole (and sometimes more than 1), and 4 scenarios involving transformers and associated cables. Each of these locations is weighted according to the type of the location of the manhole, with respect to likelihood of a vehicle fuel spill fire. Common vehicle paths, parking lots, roads, and so on have been assigned a weighting factor of 5. Off road, dirt roads, walkways, and so on have been assigned a weighting factor of 1. For manholes without PRA cables, or where a fuel spill cannot affect a manhole (due to criteria above) no weighting factor was given. This is considered a conservative weighting approach, since no fire-ignition frequency was apportioned to areas with negligible fire risk.

For bin 11 cable fires caused by welding and cutting, and bin 24 transient fires caused by welding and cutting:

There are 57 manholes that contain PRA targets, and 4 scenarios involving transformers and associated cables. Therefore, a weighting factor of 1/61 is used to apportion the frequency equally across these scenarios.

Resolution

Specific guidance for performing detailed fire modeling of an exterior yard area does not exist; however, this fire modeling methodology for the yard area employs standard fire modeling parameters while accounting for the unique features of the yard as a nonstandard compartment, and is believed to be sufficiently conservative and adequately justified for use in the BVPS-1 and BVPS-2 fire PRA models.

Deviation 4 - Transient fire ignition frequency in 1-TB-1 pipe tunnel

Background

In the detailed fire modeling performed for BVPS-1 fire compartment 1-TB-1 (turbine building), the transient fire scenario ignition frequency in one specific, isolated corner tunnel of the compartment connecting 1-TB-1 to compartment 1-PT-1 (pipe tunnel) was reduced by a factor of 10. Since this tunnel is not a normal transit path and contains no fixed plant equipment requiring regular maintenance and is not used for storage of combustible or flammable materials, this was believed to be reasonable at the time of the original analysis. Subsequent to performance of the initial fire modeling analysis, FAQ 12-0064 provided additional guidance on calculating transient combustible and activity fire weighting factors. Per the FAQ, transient fire frequency reductions are allowable per certain specific criteria, including strict access controls, and although this particular tunnel is not a normal transit path, access is not strictly controlled. Therefore, the use of the frequency reduction in this particular scenario deviates from the approved methods.

Resolution Using Approved Method

The 1-TB-1 fire model will be updated to properly account for the transient fire scenario frequency in the corner pipe tunnel in accordance with the guidance in FAQ 12-0064. The results of this update will be incorporated in the integrated analysis to be performed in response to PRA RAI 03.

Impact on CDF / LERF

The impact on the BVPS-1 fire CDF and LERF due to this change is expected to be negligible. This change affects only a single transient fire scenario, which was initially quantified with a CDF of 2.03E-09 and LERF of 1.46E-11 and was screened out.

Increasing the scenario frequency to remove the factor of 10 reduction, in accordance with the guidance in FAQ 12-0064, would yield CDF and LERF values of 2.03E-08 and 1.46E-10 respectively, which would be an insignificant increase in the total fire PRA CDF and LERF for BVPS-1. This analysis for 1-TB-1 will be updated to reflect the new approach as part of the integrated analysis to be performed in response to PRA RAI 03.

PRA RAI 06

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff require additional justification to allow the NRC staff to complete its review of the proposed method.

The licensee's analysis indicates that although a bounding 98% heat release rate (HRR) of 317 kW from NUREG/CR-6850 was typically used, reduced transient fire HRRs were applied as part of detailed fire modeling for some fire areas. Discuss the key factors used in Unit 1 and 2 Fire PRAs to justify the reduced rate below 317 kW per the guidance endorsed by the June 21, 2012, memo from Joseph Giitter to Biff Bradley, "Recent Fire PRA Methods review Panel Decisions and EPRI 1022993, 'Evaluation of Peak Heat Release Rates in Electrical Cabinets Fires'" (ADAMS Accession No. ML120172A406) and associated documentation (ADAMS Accession No. ML113130446). Include in this discussion:

b) **For each location where a reduced HRR is credited, a description of the administrative controls that justify the reduced HRR including how location-specific attributes and considerations are addressed. Provide a discussion of required maintenance for ignition sources in each location, and types/quantities of combustibles needed to perform that maintenance. Also, discuss the personnel traffic that would be expected through each location.**

Response:

Transient fires were evaluated based on the 98th percentile heat release rate (HRR) (317 kilowatts, or kW) specified in NUREG/CR-6850, “EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities,” Table G-1, except in fire compartments

1-CR-4, 1-CS-1, 2-CB-1, 2-CB-6, 2-CV-1, 2-CV-3, and 2-SB-3 which utilized reduced transient HRRs.

The guidance provided in the June 21, 2012 memo from Joseph Giitter to Biff Bradley allows the user to choose a lower screening heat release rate for transient fires in a fire compartment based on "the specific attributes and considerations applicable to that location." The guidance indicates that "plant administrative controls should be considered in the appropriate HRR for a postulated transient fire" and that "a lower screening HRR can be used for individual plant specific locations if the 317 kW value is judged to be unrealistic given the specific attributes and considerations applicable to that location."

Walkdowns were performed and the room usage/contents were considered when prescribing the transient HRR. This provided assurance that the HRRs used for the transient scenarios, modeled in the fire PRA, would be appropriate representations of any potential transient fire in the fire compartment. Fire compartments where a reduced transient HRR is modeled are safety related areas and are therefore required to meet the requirements of the BVPS transient combustible control program procedure. The combination of transient combustible controls and expected room usage/contents allow for an appropriate reduced transient HRR to be selected as follows.

In fire compartments 1-CR-4, 2-CB-1, 2-CV-1, and 2-CV-3, the 75th percentile transient HRR (142 kW) was used for the majority of transient fire scenarios. The HRR is reduced in these fire compartments for transient fire scenarios based on the following criteria:

- Large combustible liquid fires are not expected in the locations where the reduced HRR is applied, since activities in these locations do not include maintenance of oil-containing equipment. Any portion of a fire compartment where oil-containing equipment is present (for example, the area surrounding an air conditioning unit in 2-CV-3) will utilize a minimum transient HRR of 317 kW.

- The 98th percentile HRR (317 kW) for transient fires is based on tested fuel package configurations identified in NUREG/CR-6850, Table G-7 that are not representative of the typical materials expected to be located in these fire compartments. Untreated wood (typically prohibited at BVPS), airline trash bags with over 2 kg of paper products or over 4 kg of straw/grass/eucalyptus duff are unlikely to be present in fire compartments 1-CR-4, 2-CB-1, 2-CV-1, or 2-CV-3. Therefore, since the fuel packages are not expected to contain many of the tested configurations and materials, BVPS utilized the 75th percentile HRR in these fire compartments, where necessary.

In fire compartments 1-CS-1, 2-CB-6, and 2-SB-3, a 69 kW transient HRR was used for transient fires. In addition to the justification provided above, the reduced transient HRR was based on the following criteria:

- These fire compartments have strict combustible controls, where only small amounts of contained trash are considered possible. A fire this size is judged to be no larger than the 75th percentile fire in an electrical cabinet with one bundle of qualified cable.

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

Additionally, administrative controls have been enhanced in fire compartments 1-CR-4, 1-CS-1, 2-CB-1, 2-CV-1, and 2-SB-3 that limit combustible transient material within the fire compartment by designating these compartments as “Transient Combustible Exclusion Areas.” Exclusion areas have localized visual warnings such as red painted floor areas or other signage such as marked floor mats at the entrances/exits of the room indicating transient combustibles are not permitted.

Fire compartments 2-CB-6 and 2-CV-3 will be designated as “Transient Combustible Exclusion Areas” as part of LAR Attachment S, Table S-3, implementation item BV1-2907. A revision to the LAR Attachment S, Table S-3 for implementation item BV1-2907 will be provided in a future submittal.

BVPS plant procedures require that transient combustible materials shall not be allowed to accumulate in any critical building or location except in metal containers with approved fire suppressive lids or designated in-plant storage areas. Allowances are made for on-going work activities and transient combustible permits. However, BVPS plant procedures require that transient combustibles introduced as part of work activities or permits shall be protected from ignition sources including hotwork, steam lines, hot components or other hot piping. No unattended transient combustible materials shall be left in transient combustible exclusion areas without initiating appropriate compensatory measures (typically an hourly fire watch patrol), as determined by the site fire marshal.

Transient combustible permits (TCPs) shall be obtained prior to taking transient combustible or flammable materials into any of the identified fire compartments, which allows for any necessary maintenance activities to be conducted with appropriate compensatory measures in place, as determined by the site fire marshal. This ensures proper notification to the site fire marshal and maintenance supervisor by maintenance personnel and work planners of additional hazards, and the duration for which this hazard exists to enable a prompt response in the event of an incident during maintenance.

Typical ignition source maintenance activities include, but are not limited to, cleaning and inspecting battery chargers, load tests on battery chargers, cleaning and inspecting exhaust fans, instrumentation and control testing, and electrical cabinet troubleshooting and repair. The types and quantities of combustibles that may be temporarily introduced to perform these maintenance activities consist of limited amounts of testing wires, cable insulation, various test meters, plastic service carts, mixed plastic/rubber and metal tools, small tables, chairs, and fiberglass ladders. Hot work permit records from the past year indicate that no welding, cutting, or grinding was performed in any of these compartments, indicating that hot work is not a typical maintenance activity therein.

Access to fire compartments 1-CR-4, 1-CS-1, 2-CB-1, 2-CB-6, 2-CV-1, 2-CV-3, and 2-SB-3 is strictly controlled. These fire compartments are within the power block, and thus access is restricted to those with unescorted access authorization. While there is regular access to these compartments, they are not in a normal travel path, so personnel traffic is limited. The exclusion area visual warnings also provide notification to these authorized personnel that transient combustibles are not permitted.

Therefore, based on administrative controls, location-specific attributes and considerations, required maintenance activities and materials, and expected personnel traffic, the reduced HRRs utilized in fire compartments 1-CR-4, 1-CS-1, 2-CB-1, 2-CB-6, 2-CV-1, 2-CV-3, and 2-SB-3 are justified.

PRA RAI 06

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff require additional justification to allow the NRC staff to complete its review of the proposed method.

The licensee's analysis indicates that although a bounding 98% heat release rate (HRR) of 317 kW from NUREG/CR-6850 was typically used, reduced transient fire HRRs were applied as part of detailed fire modeling for some fire areas. Discuss the key factors used in Unit 1 and 2 Fire PRAs to justify the reduced rate below 317 kW per the guidance endorsed by the June 21, 2012, memo from Joseph Giitter to Biff Bradley, "Recent Fire PRA Methods review Panel Decisions and EPRI 1022993, 'Evaluation of Peak Heat Release Rates in Electrical Cabinets Fires'" (ADAMS Accession No. ML120172A406) and associated documentation (ADAMS Accession No. ML113130446). Include in this discussion:

c) **The results of a review of records related to violations of the transient combustible and hot work controls.**

Response:

Condition reports dated between June 1, 2010 and June 1, 2015 identifying violations of transient combustible and flammable materials controls were reviewed. During this period, a number of violations of the transient combustible control program were noted. The condition reports for the individual incidents initiated corrective actions for these violations, which have been completed. Furthermore, FENOC has escalated the oversight level of concern with the control of transient combustibles at BVPS, including a focus on the recently-implemented transient combustible exclusion areas due to the requirements of the site transition to NFPA 805. This is intended to increase management attention and to drive performance for control of transient combustibles at BVPS. In addition to focusing management attention on the importance and risk-significance of maintaining appropriate control of transient combustibles, this escalation also includes the addition of training material that discusses transient combustibles, transient combustible exclusion areas, NFPA 805, and the importance of fire protection for site personnel into general plant access training. Finally, FENOC has recently implemented new processes and programs at BVPS to manage and control transient combustibles and fire risk under the maintenance rule, which will maintain appropriate controls of transient combustibles and hot work.

PRA RAI 07

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

Neither the procedure for performing assessment of sensitive electronics nor Appendix H of the LAR refers to use of FAQ 13-0004, "Clarifications on Treatment of Sensitive Electronics", dated December 3, 2013 (ADAMS Accession No. ML13322A085). Describe the treatment of sensitive electronics for the Unit 1 and 2 Fire PRAs and explain whether it is consistent with the guidance in FAQ 13-0004, including the caveats about configurations that can invalidate the

approach (i.e., sensitive electronic mounted on the surface of cabinets and the presence of louver or vents). If the approach is not consistent with FAQ 13-0004, justify the approach or replace the current approach with an acceptable approach into the integrated analysis performed in response to PRA RAI 3.

Response:

PRA-credited components in compartments where detailed fire modeling has been performed have been examined to determine if they meet the definition of temperature sensitive equipment as defined in fire PRA frequently asked question (FAQ) 13-0004. The components that meet this definition were analyzed to determine whether they may be exposed to fire conditions exceeding the damage threshold recommended by NUREG/CR-6850.

Regarding hot gas layer exposure, a temperature sensitive equipment hot gas layer study using the Consolidated model of Fire and Smoke Transport (CFAST) has been performed with varying representative geometries and a range of fire sizes for both fixed and transient sources. The CFAST simulations were used to develop generic categories as documented in the BVPS fire modeling verification and validation documentation. For each category, the upper gas layer and the lower gas layer were analyzed to determine if the damaging hot gases could descend to equipment level, resulting in equipment failure.

The conclusions from the temperature sensitive equipment hot gas layer study were applied in the fire modeling analysis by correlating each modeled fire compartment to a generic category. The correlation was made by examining the fire compartment parameters (for example, compartment volume and ceiling height), with consideration of fire scenario characteristics (for example, heat release rate and fire growth profile). Fire compartments with parameters within the limits of a generic category were judged to perform similarly with respect to gas layer formation. Details regarding the application of this study can be found on a compartment basis in each detailed fire modeling report.

Damage to temperature sensitive plant equipment caused by radiant heat makes use of a study using the Fire Dynamics Simulator (FDS) referenced in fire PRA FAQ 13-0004. The FDS study concludes that the metal housing of temperature sensitive equipment is effective in reducing damaging heat fluxes so that the damage threshold for thermoset cable can be used. This treatment is consistent with the guidance in fire PRA FAQ 13-0004.

Fire PRA FAQ 13-0004 includes caveats that can invalidate the use of the thermoset heat flux damage threshold. These caveats include the presence of louvers or vents on the face of a panel, and sensitive electronics that are mounted to the surface of the cabinet.

In developing this response, field inspections were conducted on cabinets in physical analysis units (PAUs) where detailed fire modeling was performed to determine if the cabinets should make use of the heat flux damage threshold of fire PRA FAQ 13-0004. During the field inspections, some cabinets were identified that violate the caveats above with exposed temperature sensitive components. FENOC will update the BVPS modeling analyses by considering these cabinets damaged based on the temperature sensitive component damage criteria (for example, 3 kilowatts per square meter [kW/m^2] and 65 degrees Celsius [°C]) as provided in NUREG/CR-6850, Section H.2. Cabinets that have exposed electronics on the cabinet face that are either test devices, electronic readouts of meters, or monitoring devices that are not critical to cabinet functionality will not be considered to violate these caveats. In addition, some cabinets contain vents on the face of the cabinet. However, these caveats will not be considered violated if the vents are positioned such that there is no gap in shielding that would allow radiant heat to damage the sensitive components (for example, down-pointed louvers).

Any necessary updates to fire modeling associated with temperature sensitive components will be reflected in the updated fire risk results that will be provided to the NRC as part of the integrated analysis performed in response to PRA RAI 3.

PRA RAI 08

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

The NRC staff could not find any description of how "pinch points" were modeled for transient fires. The fire modeling analysis indicates that fire compartment floor space is allocated into defined "transient areas" where transient fire scenarios appear to be postulated and into other areas where transient fire appears not to be postulated. Per the guidance provided in NUREG/CR-6850, Section 11.5.1.6, transient fires should at a minimum be placed in locations within the plant physical analysis units (PAUs) where CCDPs are highest for that PAU (i.e., at "pinch points"). The NRC staff notes that pinch points include locations of redundant trains or the vicinity of other potentially risk-relevant equipment. The NRC staff notes that hot work should be assumed to occur in locations where

hot work is a possibility, even if improbable. For Unit 1 and 2 Fire PRAs, provide the following:

a) **Explain how "pinch points" were identified and modeled for transient fires. Also, justify exclusion of any PAU locations from transient fire impact.**

Response:

Transient fires have been postulated in each fire compartment in the fire PRA. Accessible floor area is postulated as a possible transient ignition source location. Each fire compartment has been subdivided into one or more transient fire zones (weighted by floor area), to refine the frequency of damage to risk significant targets. The total transient and hot work ignition frequency for each compartment is apportioned throughout the accessible floor area. A "pinch point" focused approach is not utilized at BVPS. By analyzing transient fires for accessible floor areas within fire compartments, potential pinch point locations were considered for damage.

Transient and hot work fires were not postulated in locations within fire compartments that were considered inaccessible. Inaccessible areas are defined as follows:

- An area that is impossible to access because it is occupied by permanent fixtures such as plant equipment, structural features, piping, and cable trays. These permanent fixtures either occupy the floor space entirely or are sufficiently low to the floor (2 feet or less), so as to obstruct the placement of transient material.

- An area where access is prohibited or extremely difficult due to the presence of a permanent fixture (as defined above) and there is no credible reason to expect transient material to accumulate (for example, areas on top of half-height rooms, confined areas behind a floor-to-ceiling stack of cable trays in the cable spreading room with no expected reason for access).

PRA RAI 08

b) **Include description of how transient and hot work fires are distributed within the PAUs, and the criteria used to determine where such ignition sources are placed within the PAUs.**

Response:

Transient and hot work fires (NUREG/CR-6850, fire ignition frequency bins 3, 6, 7, 24, 25, 36, and 37) are distributed within the fire compartments in accordance with the process described below:

In compartments where detailed fire modeling has been performed, transient and hot work fires are postulated in accessible floor areas. The accessible floor area of each fire compartment is subdivided into one or more transient fire zones. The boundaries of each transient fire zone are chosen such that the associated fire growth and resulting damage to PRA targets (for example, cables and equipment) can be represented by a common bounding fire scenario (including or excluding secondary combustibles).

In order to keep the number of locations (and therefore the number of transient scenarios) requiring separate analysis to a minimum, locations with similar fire PRA targets may be grouped into larger transient scenarios. The remainder of the floor space of the fire compartment is subdivided as necessary to distinguish between different fire growth potential (that is, locations where secondary combustibles are at a low enough elevation to be ignited by the transient fire) and fire PRA targets. In some cases this leaves a section of the floor area with no fire growth potential beyond the initial transient source and no targets within the zone of influence (ZOI), creating a transient scenario with no target damage. This process ensures that accessible floor area is accounted for in the transient analysis.

Target damage sets for a transient fire zone are not limited to the targets within the designated floor area boundary, but are based on the ZOI of the transient when placed anywhere within the transient floor area, including the border. The result is that multiple transient fire scenarios may damage common targets, since they may have overlapping zones of influence.

PRA RAI 08

c) **Include explanation of how ignition frequency for transient fires is allocated to specific fire scenarios.**

Response:

Ignition frequency for transient and hot work fires (NUREG/CR-6850 fire ignition frequency bins 3, 6, 7, 24, 25, 36, and 37) are allocated to specific fire scenarios in accordance with the process described below:

To refine the scenario-specific frequency of damage to risk-significant targets, each compartment was subdivided into one or more transient zones. The compartment frequency is apportioned to each transient fire zone using a geometric factor (floor area ratio). The floor area of each transient fire scenario is determined and then divided by the total floor area of transient fire zones in the fire compartment.

PRA RAI 09

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In a letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff require additional justification to allow the NRC staff to complete its review of the proposed method.

The fire modeling procedure states "[w]ell sealed cabinets with voltages >440 V should be counted but fire propagation excluded." For cabinets with circuits that are 440 V and higher, Section 6.5.6 of NUREG/CR-6850 states, in part, that "panels that house circuit voltages of 440 V or greater are counted because an arcing fault could compromise panel integrity (an arcing fault could burn through the panel sides, but this should not be confused with the high energy arcing fault type fires)." Accordingly, propagation of fire outside the ignition source panel must be evaluated for Bin 15 electrical cabinets that contain circuits of 440 volts or greater. Describe for the Unit 1 and 2 Fire PRAs how fire propagation from well-sealed electrical cabinets greater than 440 V is evaluated. For Motor Control Centers (MCCs) include description of which cubicles are assumed to fail in a given fire. If your approach to evaluating fire propagation is not consistent with NUREG/CR-6850 guidance, then replace the current method with an acceptable method or address the impact of your proposed method as part of the integrated analysis performed in response to PRA RAI 3.

<u>Response:</u>

As a result of new industry guidance (fire PRA FAQ 14-0009), FENOC is reviewing the approach for fire propagation from cabinets that house circuits of 440 volts alternating current (VAC) or greater and that were determined to be "well-sealed." For such cabinets, other than MCCs, propagation of fire beyond the ignition source will be reviewed and updated as necessary to ensure that it has been evaluated consistent with the guidance of NUREG/CR-6850.

For MCCs that house circuits of 440 VAC or greater and that are considered to be "well-sealed," propagation of fire beyond the ignition source will be evaluated using the guidance in fire PRA FAQ 14-0009, "Treatment of Well-Sealed MCC Electrical Panels Greater than 440V," revision I. The present fire modeling analysis considers an individual MCC as a fire source, and any fire starting from an MCC affects the other cubicles in the MCC.

Any necessary updates to fire modeling associated with cabinets that house circuits of 440 VAC or greater will be reflected in the updated fire risk results that will be provided to the NRC as part of the integrated analysis performed in response to PRA RAI 3.

PRA RAI 10

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

The Main Control Room (MCR) analysis and the response to F&O FSS-B2-01 for Unit 2 presented in Attachment V of the LAR appear to indicate that MCR abandonment scenarios due to loss of habitability (LOH) were "insignificant risk contributors" and were, therefore, quantitatively screened from the fire risk contribution. Two issues are relevant to this determination. First, the staff notes from the audit that MCR abandonment due to loss of habitability is caused by abandonment conditions produced for the combined Unit 1 and 2 MCR. However, MCR abandonment is only evaluated for a single unit at a time. Secondly, this screening analysis performed for both Units 1 and 2 appears to indicate that fire damage to the Main Control Board (MCB) is assumed to be non-recoverable, and therefore set to 1.0, and that the CCDP for non-MCB fires damage was set to 0.1. While setting the CCDP of MCB fires to a value of 1.0 is clearly a conservative, it is not clear that setting the CCDP associated with non MCB fires to 0.1 is bounding. In light of these observations:

a) **Clarify how MCR abandonment due to LOH was modeled in the Unit 1 and 2 Fire PRAs, and indicate how the range of fire-induced failures including spurious operations is accounted for.**

<u>Response:</u>

General Approach

The analysis performed using the Consolidated Model of Fire and Smoke Transport (CFAST) shows that if both units' smoke purge systems are unavailable and the fire is not suppressed quickly enough, conditions within the MCR would become untenable and force abandonment of the MCR.

In this case, no control is claimed from the MCR, and recovery is from actions taken outside the MCR following the alternate safe shutdown procedures. For scenarios causing damage to the MCB bench board or vertical board associated with the unit being evaluated, it is conservatively assumed that damage states are non-recoverable from outside the MCR. This is based on the conservative assumption that the damage to the MCB may be extensive and, together with coincident random failures, may result in fault conditions for which safe shutdown may be complex or compromised from outside the MCR. This is a bounding assumption made in the present analysis for the purposes of screening abandonment scenarios due to loss of habitability.

Recovery from outside the MCR is assumed to be possible for the other scenarios including fire scenarios which impact the opposite unit controls. These other fire scenarios are limited to damaging, at worst, one or two electrical cabinets associated with the unit being evaluated and are thus far more benign in their impact related to the unit under evaluation. There are no fires which impact controls for both units and there are no credited systems shared by both units. For non-MCB cabinets, a conservative overall CCDP value of 0.1, as suggested in NUREG/CR 6850 (section 11.5.2.10) is used. This value accounts for both operator errors and random equipment failures and is applied to those scenarios that do not compromise the ability to shut down from outside the MCR.

This analysis resulted in an overall contribution to core damage frequency (CDF) due to LOH abandonment as follows:

BVPS-1: 1.48E-08 per year
BVPS-2: 1.07E-08 per year

Spurious Actuations

For the BVPS-1 abandonment analysis, in addition to the Unit 1 MCB, those abandonment scenarios in which BVPS-1 equipment is damaged and may potentially result in spurious actuations are associated with fires originating in:

PNL-DC2
PNL-DC3
PNL-VITBUS-1
PNL-VITBUS-2
PNL-VITBUS-3
PNL-VITBUS-4
LP-S12

In the current MCR analysis, fire scenarios impacting these cabinets are assigned a CCDP of 0.1 following abandonment due to LOH since the number of spurious actuations is limited and alternate safe shutdown procedures direct actions to mitigate such events. However, if the abandonment CCDP for fire scenarios impacting BVPS-1 equipment, excluding the BVPS-1 building service panel (which impacts only the BVPS-1 area ventilation and fire protection pumps), is set to 1.0, the overall contribution to CDF due to LOH abandonment increases marginally to 1.56E-08 per year.

For the BVPS-2 abandonment analysis, in addition to the unit 2 MCB, those abandonment scenarios in which BVPS-2 equipment is damaged and may potentially result in spurious actuations are associated with fire originating in:

RMS-BAY 3
RK-2RAD-MON

However, in this case spurious actuation is limited to one of the recirculation spray system heat exchanger isolation valves which does not impact the credited path for alternate safe shutdown capability. Thus, spurious actuations will not occur for those abandonment fire scenarios which credit a CCDP of 0.1.

Conclusion

In summary, the current BVPS-1 and BVPS-2 MCR analysis of abandonment due to loss of habitability assigns a CCDP of 0.1 for scenarios for which mitigation is not complex or compromised. Where there is potential for complexity or compromise of accident mitigation, a value of 1.0 is used. This conservative approach has resulted in a CDF for both BVPS-1 and BVPS-2 which marginally exceeds 1.0E-08.

This screening approach and results will be revisited following a re-evaluation of the MCR abandonment frequency in the integrated analysis to be performed in response to PRA RAI 03.

PRA RAI 10

b) Justify the reason for evaluating MCR abandonment for each unit separately.

<u>Response:</u>

Fire compartment 3-CR-1 houses the common BVPS-1 and BVPS-2 MCR. A fire in one unit MCR, however, could lead to the abandonment of both the affected MCR and the non-affected MCR due to a loss of habitability. Such scenarios are evaluated; however, the impact of abandoning the non-affected unit MCR on the affected MCR unit's accident mitigation is expected to be insignificant for the following reasons:

a. Even though 3-CR-1 is common to both MCRs, the equipment and associated raceways are spatially separated from each other. There are no fire scenarios which impact controls for both units, and there are no credited systems shared by both units.
b. It is likely that the non-affected unit can be shutdown or controlled in a more timely manner before abandoning the non-affected unit MCR. Therefore, the conditional core damage probability should be small as well.
c. BVPS-1 and BVPS-2 control room and plant operators have sufficient resources to shutdown their respective units simultaneously due to a fire at one unit which renders the MCRs at both units uninhabitable.
d. The frequency of non-habitability fire scenarios is lower than 1E-07 in all cases. Therefore the CDF for MCR abandonment at the unaffected unit is expected to be very small, even if the CCDP for such a shutdown is assumed to be 0.1.

PRA RAI 10

c) If MCR abandonment scenarios due to LOH were screened, then describe and justify the process used to screen these scenarios. If MCR abandonment scenarios due to LOH were not screened, then discuss their risk contribution.

<u>Response:</u>

MCR abandonment scenarios due to loss of habitability were screened on the basis that the overall CDF contribution, when conservatively evaluated, only marginally exceeded 1E-08 per year.

The abandonment analysis was performed using CFAST and shows that, if both units' smoke purge systems are unavailable and the fire is not suppressed quickly enough, conditions within the MCR would become untenable, forcing abandonment of the MCR. The frequencies of fire scenarios for which MCR abandonment is required are conservatively calculated with no credit claimed for the availability of the opposite unit's HVAC system to purge smoke from the MCR. This analysis is addressed further in responses to the various parts of FM RAI 01(j).

For scenarios causing damage to the affected unit's MCB bench board or vertical board, it is conservatively assumed that damage states are non-recoverable from outside the MCR, in which case the conditional probability of failure to recover from outside the MCR is 1.0. Recovery from outside the MCR is assumed possible for other scenarios, for which a failure probability of 0.1 is applied. Justification of this approach is discussed further in the response to PRA RAI 10(a).

This analysis resulted in an overall contribution to CDF due to LOH abandonment as follows:

BVPS-1: 1.48E-08 per year
BVPS-2: 1.07E-08 per year

As stated in the response to PRA RAI 10(a), this screening approach and results will be revisited following a re-evaluation of the MCR abandonment frequency in the integrated analysis to be performed under PRA RAI 03.

PRA RAI 10

d) If modeling the MCR abandonment due to loss of habitability does not adequately address abandonment or if the CCDP is not realistic to conservative, adjust the integrated analysis provided in response to PRA RAI 3.

Response:

With regards to the two issues in this question:

1) The evaluation of the loss of MCR habitability for a single unit at a time is considered to be justifiable on the basis described in the response to PRA RAI 10(b).

2) The use of a CCDP of 0.1 for scenarios (except those involving the affected unit's MCB) is considered to be justifiable on the basis described in the response to PRA RAI 10(a).

The approach and results used for screening the scenarios resulting in MCR abandonment due to loss of habitability will be revisited following a re-evaluation of the MCR abandonment frequency in the integrated analysis to be performed in response to PRA RAI 03.

PRA RAI 11

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official

agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

The MCR analysis appears to indicate that MCR abandonment was credited for loss of control (LOC) for certain scenarios. For LOC scenarios, the MCR analysis states, in part, that "[s]cenarios for which recovery actions from outside the MCR can be credited are modeled explicitly within the Fire PRA model ... and corresponding CDF and LEF values are calculated in Task 14 Fire Quantification)." Based on this statement, it appears that HRA was performed to credit "outside the MCR actions" for certain scenarios. It is not clear from the analyses how MCR abandonment was credited for LOC scenarios or why MCR abandonment was credited for certain scenarios and not others. Also, it is not clear how the CCDP for these scenarios was determined. The NRC staff notes that it can be difficult to establish the time associated with the decision to abandon the MCR and the time available for operators to perform required actions given that cues to abandon and available time is dependent on scenario-specific fire-induced impacts. In light of these observations, address for Units 1 and 2 the following:

a) **Explain which LOC scenarios credit MCR abandonment and how those scenarios were modeled including the HRA that was performed for those scenarios.**

Response:

MCR abandonment for LOC is only credited for BVPS-2, and not for BVPS-1. BVPS-2 has a full Alternate Shutdown Panel (ASP) containing indications and controls for one train (Train A) of required safe shutdown equipment, which presents a viable option to the operators in the event a fire significantly compromises main control room functionality. At BVPS-1, however, the Appendix R alternate shutdown strategy relies on the Backup Indicating Panel (BIP) containing only a very limited set of indicators and control switches for a few valves, which is used in conjunction with a myriad of well-coordinated local actions performed by a number of operators in the field. When asked for their opinion, numerous BVPS-1 senior reactor operators (SROs) stated that they would prefer to remain in the control room for any state of equipment failure, since they know the abandonment option using the BIP would be complex and exacting. Remaining in the control room, if possible, would invariably offer a better chance of success than transferring command and control to the BIP, since once the BIP is activated plant parameters will need to be controlled by local operator actions. When BVPS-2 SROs were asked a similar question, however, they expressed much more comfort with the prospect of leaving the control room in the face of significant loss of control and safely shutting down the plant from the ASP. Therefore, the decision was made to credit abandonment on LOC for BVPS-2, but not for BVPS-1.

The screening performed to determine which BVPS-2 scenarios would require MCR abandonment on LOC is described in the response to PRA RAI 11(c), but the result is that scenarios retained in the fire PRA model for fire compartments 2-CB-1, 2-CB-6, and 3-CR-1 (MCR) postulate MCR abandonment on LOC. These scenarios are modeled much like any other scenario in the BVPS-2 fire PRA model, in that certain targets are affected based on the source of the fire and how it spreads for the scenario, and those targets map to basic event impacts whose values are either 1.0 (for demand failures) or between 0.0 and 1.0 (for spurious failures, per the appropriate guidance). With one exception, there are no special abandonment recovery actions credited in abandonment scenarios; rather, these scenarios credit the same local actions, in response to fire-induced equipment failures, as would be credited for non-abandonment scenarios. Detailed human reliability analysis (HRA) is used to quantify these actions, as documented in the fire HRA notebook, and the timing used for the detailed HRA evaluation of these actions is described in the responses to PRA RAIs 11(d) and 11(e). The additional action for abandonment is modeled by basic event ASPGEN in top event ASP, and represents both the action to successfully transfer command and control to the ASP and the primary control station (PCS) actions subsequently performed at the ASP. For abandonment scenarios, if this action fails the sequence it is mapped directly to core damage. If this action is successful the sequence progresses through the model as normal, considering fire damage states and recovery actions as it would for any other scenario. For components available on the ASP, the effects of fire damage are removed in abandonment scenarios. Random failures of the components are still postulated, but the fire damage is removed since the ASP uses separate circuits for the available components which remain free of fire damage for fires in compartments crediting MCR abandonment. The components and instruments available on the ASP are listed below in Table PRA 11(a)-1. Sequences involving failures which cannot be mitigated from the ASP, such as unisolated loss of coolant accidents (LOCAs) greater than reactor coolant pump (RCP) seal leakage or failures of auxiliary feedwater (AFW), are mapped directly to core damage.

The abandonment action ASPGEN uses a probability of 0.1, as supported by the guidance in FAQ 13-0002. While this FAQ is written specifically for abandonment on loss of habitability (LOH), and there is no explicit guidance on modeling abandonment due to LOC, most of the concepts involved in using a value of 0.1 for the action remain relevant in this case. The primary difference between LOH scenarios and LOC scenarios is simply the reason the operators are abandoning the control room. While the decision to abandon the control room on LOC will be more difficult than for LOH, the 0.1 value is believed to be applicable because it is not claimed to represent all recovery actions for the abandonment scenario; instead the 0.1 value is used to represent only the abandonment and activation of the ASP and subsequent PCS actions performed at the ASP. Local recovery actions performed following MCR abandonment are not assumed to be included in this 0.1 human error probability (HEP) and are quantified separately.

When considering that the HEP of 0.1 is applied only to the abandonment and activation of the ASP and subsequent PCS actions performed at the ASP, it can be seen that the relevant conditions conform to the criteria defined in FAQ 13-0002 to allow use of the 0.1 HEP for abandonment. Specifically:

- Required actions are feasible, independently or taken together. Feasibility was confirmed for recovery actions when preparing LAR Attachment G;
- There is no cognitive complexity, per the definition in NUREG-1921 and the description in FAQ 13-0002;
- There is no execution complexity, per the definition in NUREG-1921 and the description in FAQ 13-0002;
- Actions covered by this HEP are taken from the dedicated, remote shutdown panel (the ASP). As described above, this HEP is used for only those actions involved in activating the ASP, and the actions designated as PCS and performed at the ASP;
- Controls, cues/indications, and other needs for cognition and execution are provided by the remote shutdown panel (without need for another location). The PCS actions credited for abandonment in the FPRA, as listed in the response to PRA RAI 11(b), require only controls, cues, and indications available at the ASP;
- Procedures provide support for performance of required actions for the associated scenario. Current SSD procedures are explicit and detailed. The procedures are currently being updated and will continue to meet this requirement;
- Required actions are trained upon (including appropriately designed "simulations," walkthroughs, and so on). Operators will be thoroughly trained on the new abandonment procedures as part of the NFPA 805 implementation activities, and the new fire procedures will become part of the regular operations training program;
- Each operator action (with appropriate treatment of any dependencies) has a time margin of two, using the definition of time margin provided in NUREG-1921. Note that a multiplicative time margin criterion may not be appropriate for very short action times (less than 2 minutes), where some minimum additional, additive margin greater than a factor of two may be appropriate (that is, at least 2 minutes). The PCS operator actions listed in the response to PRA RAI 11(b) and credited in the FPRA model were reviewed and verified to have adequate time margin per this requirement.

Based on the above, the use of this ASPGEN HEP of 0.1 is appropriately justified in the BVPS-2 FPRA model. Furthermore, its use, as described above, also ensures that LOC MCR abandonment scenarios should result in a conditional core damage probability (CCDP) between 0.1 and 1.0, which is discussed further in the response to PRA RAI 11(g).

Table PRA 11(a)-1: Controls and Instruments Available on the ASP

Equipment	Mark No.
Residual heat removal pump	2RHS*P21A(AO)
Residual heat removal supply isolation valve	2RHS*MOV701A(AO)
Residual heat removal supply isolation valve	2RHS*MOV702A(AO)
Residual heat removal outlet isolation valve	2RHS*MOV720A(AO)
Primary component cooling	2CCP*P21A(AO)
Residual heat removal heat exchanger 21A supply	2CCP*MOV112A(AO)
Service water pump	2SWS*P21A(AO)
Steam generator auxiliary feed pump	2FWE*P23A(AO)
Auxiliary feed pump header to steam generator	2FWE*HCV100C(AO)
Auxiliary feed pump header to steam generator	2FWE*HCV100E(AO)
Pressurizer heater	2RCP-H2A(ZO)
Atmosphere steam dump valve to steam generator A	2SVS*PCV101A(AO)
Atmosphere steam dump valve to steam generator B	2SVS*PCV101B(AO)
Charging pump	2CHS*P21A(AO)
Charging pump discharge flow line	2CHS*FCV122(Z-)
Pressurizer power relief	2RCS*PCV456(BO)
Nitrogen supply valve to safety injection	2GNS*SOV853A(AO)
Nitrogen supply valve to safety injection	2GNS*SOV853B(BO)
Nitrogen supply valve to safety injection	2GNS*SOV853C(CO)
Safety injection accumulator nitrogen vents	2GNS*SOV854A(AO)
Letdown isolation valve supply	2CHS*LCV460A(ZO)
Letdown isolation valve	2CHS*LCV460B(ZO)
Letdown valve - coolant recovery	2CHS*MOV100A(-O)
Letdown valve - coolant recovery	2CHS*MOV100B(-O)
Letdown orifice isolation valve	2CHS*AOV200A(AO)
Nonregenerative heat exchanger discharge	2CHS*PCV145
Boric acid transfer pump	2CHS*P22A(AO)
Redundant to emergency boration	2CHS*SOV206(ZO)
Emergency diesel generator set	2EGS*EG2-1(-O)
Steam generator level (Loop 21)	2FWS-LI477F
Steam generator level (Loop 22)	2FWS-LI487F
Steam generator discharge pressure (Loop 21)	2MSS-PI475F
Steam generator discharge pressure (Loop 22)	2MSS-PI485F
Pressurizer level protection (Loop 21)	2RCS-LI459AF

Table PRA 11(a)-1: Controls and Instruments Available on the ASP	
Equipment	**Mark No.**
Reactor coolant pressure (Loop 21)	2RCS-PI403F
Pressurizer pressure protection (Loop 21)	2RCS-PI455F
Reactor coolant hot leg temperature (Loop 21)	2RCS-TI413F
Reactor coolant hot leg temperature (Loop 22)	2RCS-TI423F
Reactor coolant cold leg temperature (Loop 21)	2RCS-TI410F
Reactor coolant cold leg temperature (Loop 22)	2RCS-TI420F
Steam generator auxiliary feed line	2FWE-FI100AF
Steam generator auxiliary feed line	2FWE-FI100BF
Source range count rate	2NMS-NI31BF
Source range start-up rate	2NMS-NI31DF
Bus 2A supply breaker	ACB-42A
Bus 2AE supply breaker	ACB-2A10
Bus 2AE emergency supply breaker	ACB*2E7
Emergency diesel generator supply breaker	ACB*2E10
Diesel generator heat exchanger service water header valve	2SWS*MOV113A(AO)
Service water pump discharge valve	2SWS*MOV102A(AO)
Charging pump suction valve from refueling water storage tank	2CHS*LCV115B(AO)

PRA RAI 11

b) **Identify in Table G-1 of Appendix G recovery and primary control station (PCS) actions required for MCR abandonment due to loss of control (i.e., alternate shutdown actions), including those actions that must be performed before and after leaving the MCR. Note that operator actions taken at a PCS should be identified as PCS actions.**

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. An update of LAR Attachment G Tables G-1 and G-2 (as they should have been numbered; both BVPS-1 and BVPS-2 tables in Attachment G of the LAR were inadvertently labeled G-1, but the BVPS-2 table should have been labeled G-2) was previously provided in the 90-day RAI response to PRA RAI 18(b). For the sake of clarity, the PCS and recovery actions for BVPS-2 from the updated tables in the response to PRA RAI 18(b) are reproduced below in Table PRA 11(b)-1 for the abandonment compartments 2-CB-1, 2-CB-6, and 3-CR-1. Information specifying the basic event of the operator actions credited in the FPRA model for the risk reduction

(RR) actions is added to this table. The PCS actions are addressed by the basic event ASPGEN, as detailed in the response to PRA RAI 11(a).

The actions labeled as PCS in this table are credited to be performed from the ASP following abandonment; however, some of them will initially be attempted in the MCR prior to leaving. FPRA-credited actions performed in the MCR prior to leaving in abandonment scenarios are as follows:

- Manually trip the reactor
- Stop main feedwater pumps
- Stop reactor coolant pumps
- Align charging pump suction to refueling water storage tank (RWST)
- Isolate letdown

In accordance with the guidance in NUREG/CR-6850 and the analysis in the BVPS-2 FPRA component selection notebook, the reactor trip is assumed to be successful. The remaining four actions are simple, well-practiced actions which can be accomplished in moments prior to evacuating the MCR. Furthermore, there is a local recovery action available for each of these actions in case they fail to be performed in the MCR prior to evacuation, or in case fire impacts to control circuits prevent success of the actions from the MCR.

Local actions performed after abandoning the MCR are dependent on the specific fire that occurs and the way the scenario develops – in other words, a given action will only be required if a particular failure or set of failures occurs. Table PRA 11(b)-1 contains the list of actions from Attachment G which could be required for abandonment fire scenarios. Some scenarios may not fail every target, therefore every fire may not require each of the listed actions. Therefore this is a list of actions which may be performed following MCR abandonment. The FPRA model is built such that these actions mitigate specific fire-induced equipment failures as necessary, based on the working assumption that the fire procedures under NFPA 805 will be symptom-based. The procedures are currently being developed in this manner to validate this assumption. Furthermore, the HRA will be updated using the final procedures once they are issued, per LAR Table S-3 implementation item BV1-3060, prior to using the FPRA to self-approve changes to the fire protection program.

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
2-CB-1	OPFCI1	Close 2CHS-214 to isolate seal water return heat exchanger flow.	BV2-0801	RR
2-CB-1	(None)	De-energize 2BDG-AOV101A2, B2 and C2 at PNL-DC2-10 to isolate SG A, B and C blowdown flow.	BV2-0797	DID
2-CB-1	(None)	De-energize 2SDS-AOV112A, B and C at PNL-AC2-03 to stop steam flow from SG A, B and C.	BV2-0815	DID
2-CB-1	ASPGEN	Throttle 2SVS-PCV101A from the ASP to control SG C pressure and throttle 2SVS-PCV101B from the ASP to control SG B pressure.	BV2-1397	PCS
2-CB-1	(None)	De-energize 2SVS-HCV104 at MCC2-E14 to stop SG A, B and C steam flow. De-energize 2SVS-PCV101A at MCC2-E05 to stop SG A steam flow. De-energize 2SVS-PCV101B at MCC2-E13 to stop SG B steam flow. De-energize 2SVS-PCV101C at 480VUS-2-8 to stop SG C steam flow. THEN Manually throttle 2SVS-HCV104 to control SG A, B and C pressure. Manually throttle 2SVS-PCV101A to control SG A pressure. Manually throttle 2SVS-PCV101B to control SG B pressure. Manually throttle 2SVS-PCV101C to control SG C pressure.	BV2-1397	DID

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
2-CB-1	OPRS03	If 2SWS-P21A and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close it. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and open it to align the A SWS flow path. De-energize 2SWS-MOV170A at MCC2-E01 and open it to align seal water to 2SWS-P21C. De-energize 2SWS-MOV102C1 at MCC2-E01, restart the diesel, manually start 2SWS-P21C while manually opening 2SWS-MOV102C1 to provide A SWS flow. Start other AE bus loads as required. OR If 2SWS-P21C and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close it. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and open it to align the A SWS flow path. De-energize 2SWS-MOV102A at MCC2-E01, restart the diesel, manually start 2SWS-P21A while manually opening 2SWS-MOV102A to provide A SWS flow. Start other AE bus loads as required.	BV2-0818	RR

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
2-CB-1	OPRS16	If 2SWS-P21A and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close it. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and open it to align the A SWS flow path. De-energize 2SWS-MOV170A at MCC2-E01 and open it to align seal water to 2SWS-P21C. De-energize 2SWS-MOV102C1 at MCC2-E01, restart the diesel, manually start 2SWS-P21C while manually opening 2SWS-MOV102C1 to provide A SWS flow. Start other AE bus loads as required. OR If 2SWS-P21C and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close it. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and open it to align the A SWS flow path. De-energize 2SWS-MOV102A at MCC2-E01, restart the diesel, manually start 2SWS-P21A while manually opening 2SWS-MOV102A to provide A SWS flow. Start other AE bus loads as required.	BV2-0851	RR
2-CB-1	OPRD05	De-energize 2MSS-AOV101A, B and C at PNL-DC2-10 to stop steam flow from SG A, B and C.	BV2-0809	RR
2-CB-1	OPRAF4F1/F2	De-energize 2FWE-P23B at 4KVS-2DF to stop train B AFW flow. Manually throttle 2FWE-HCV100E to control A train SG A flow. Manually throttle 2FWE-HCV100C to control A train SG B flow. Manually throttle 2FWE-HCV100A to control A train SG C flow.	BV2-0808	RR

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
2-CB-1	ASPGEN	Throttle 2FWE-HCV100E at the ASP to control SG A level. Throttle 2FWE-HCV100C at the ASP to control SG B level.	BV2-0808	PCS
2-CB-1	(None)	De-energize 2FWS-P21A at 4KVS-2A & 4KVS-2B and de-energize 2FWS-P21B at 4KVS-2C & 4KVS-2D to stop main feedwater pump flow to the steam generators.	BV2-0821	DID
2-CB-1	(None)	De-energize the C control group heater at 480VUS-2-2, de-energize the A and D backup group heaters at 480VUS-2-8 and de-energize the B and E backup group heaters at 480VUS-2-9 to prevent RCS overpressure.	BV2-0820	DID
2-CB-1	ASPGEN / (None)	Operate the A backup group heater at the ASP to control RCS pressure.	BV2-0820	PCS (DID)
2-CB-1	Pf_{MCR-TV}	Install a 5000 CFM portable fan in the Control Room doorway to supply temporary ventilation.	BV2-1329	RR
2-CB-1	(None)	De-energize 2CHS-LCV115C at MCC2-E03 and manually close the valve OR De-energize 2CHS-LCV115E at MCC2-E04 and manually close the valve to prevent hydrogen intrusion into the charging pump suction.	BV2-0806	DID
2-CB-1	OPRC11	Manually open 2CHS-477 to bypass the charging flow control valve. Manually close 2CHS-30 to isolate the charging flow control valve. Manually throttle 2CHS-477 to control charging flow.	BV2-0807	RR
2-CB-1	(None)	De-energize the C control group heater at 480VUS-2-2, de-energize the A and D backup group heaters at 480VUS-2-8 and de-energize the B and E backup group heaters at 480VUS-2-9 to prevent RCS overpressure.	BV2-1413	DID
2-CB-1	ASPGEN	Attempt to control 2RCS-PCV456 at the ASP.	BV2-1413	PCS

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
2-CB-1	(None)	Perform repair procedure to provide power to the reactor vessel head vent valves.	BV2-1418	DID
2-CB-1	OPRD10	De-energize 2RCS-P21A at 4KVS-2A, de-energize 2RCS-P21B at 4KVS-2B and de-energize 2RCS-P21C at 4KVS-2C to prevent an RCP seal LOCA.	BV2-0812	RR
2-CB-1	(None)	De-energize 2CHS-P21A(C) at 4KVS-2AE AND De-energize 2CHS-P21B(C) at 4KVS-2DF to control charging/HHSI flow.	BV2-0825	DID
2-CB-1	(None)	De-energize 2CNM-P21A at 4KVS-2B, de-energize 2CNM-P21B at 4KVS-2C and de-energize 2CNM-P21C at 4KVS-2D to stop condensate flow to the steam generators.	BV2-1349	DID
2-CB-1	OPRQS1	Trip 2QSS-P21A at 4KVS-2AE to stop A train quench spray flow and trip 2QSS-P21B at 4KVS-2DF to stop B train quench spray flow.	BV2-0824	RR
2-CB-1	OPRAO1	Align AE and DF bus loads as required.	BV2-0823	RR
2-CB-1	(None)	De-energize 2CHS-P21A and 2CHS-P21C at 4KVS-2AE and de-energize 2CHS-P21B and 2CHS-P21C at 4KVS-2DF to prevent pump damage on loss of suction. De-energize 2CHS-LCV115B at MCC2-E03 and manually open it or open 2CHS-LCV115B from the ASP to align suction to the charging pumps. Manually start 2CHS-P21A or 2CHS-P21C at 4KVS-2AE to provide RCS makeup flow.	BV2-0796 BV2-0805	DID

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
2-CB-1	ASPGEN	Open 2CHS-LCV115B from the ASP to provide suction to Charging/HHSI pump 2CHS-P21A and start 2CHS-P21A from the ASP to provide RCS makeup.	BV2-0796 BV2-0805 BV2-0816 BV2-1390	PCS
2-CB-1	(None)	De-energize 2CHS-P21A(C) at 4KVS-2AE AND De-energize 2CHS-P21B(C) at 4KVS-2DF to stop excessive RCS makeup flow. De-energize 2SIS-MOV836, 2SIS-MOV840, 2SIS-MOV867C and 2SIS-MOV869A at MCC2-E05 and manually close the valves and de-energize 2SIS-MOV867D and 2SIS-MOV869B at MCC2-E06 and close them to isolate spuriously opened SI flow paths. Manually start 2CHS-P21A or 2CHS-P21C at 4KVS-2AE to provide RCS makeup flow.	BV2-0816 BV2-1390	DID

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
2-CB-1	OPRD16	Close 2RCS-PCV455C and 2RCS-PCV455D at the keylock isolation switches. OR Perform repair procedure to allow the closing of 2RCS-MOV535 and 2RCS-MOV537 to isolate the PORVs. OR To provide a flow path from the containment sump to Charging/HHSI pump 2CHS-P21A de-energize 2SIS-MOV8809A, 2SIS-MOV8887A, 2SIS-MOV8811A, 2RSS-MOV156C, 2SIS-MOV863A, 2RSS-MOV155C and 2SIS-MOV8890A at MCC2-E11, de-energize 2CHS-LCV115B at MCC2-E03 and then manually close 2SIS-MOV8809A, 2SIS-MOV8887A, 2RSS-MOV156C and 2SIS-MOV8890A, manually open 2SIS-MOV8811A, 2SIS-MOV863A and 2RSS-MOV155C and then manually close 2CHS-LCV115B.	BV2-0813	RR and DID
2-CB-1	OPRMA2F1/F2	Provide an alternate suction to the A AFW pump.	BV2-0798	RR
2-CB-1	(None)	De-energize 2SWS-AOV130A at 480VUS-2-8 to restore the service water pump seal water supply.	BV2-0850	DID
2-CB-1	(None)	Take the plant to "Safe and Stable" utilizing selected instruments and controls at the auxiliary shutdown panel, as directed.	BV2-0855	DID
2-CB-6	(None)	De-energize 2SDS-AOV112A, B and C at PNL-AC2-03 to stop steam flow from SG A, B and C.	BV2-1031	DID

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
2-CB-6	OPRD06 OPRD07	De-energize 2SVS-HCV104 at MCC2-E14 to stop SG A, B and C steam flow and manually throttle it to control SG A, B and C pressure. De-energize 2SVS-PCV101A at MCC2-E05 to stop SG A steam flow and manually throttle it to control SG A pressure. De-energize 2SVS-PCV101B at MCC2-E13 to stop SG B steam flow and manually throttle it to control SG B pressure. De-energize 2SVS-PCV101C at MCC2-E13 to stop SG C steam flow and manually throttle it to control SG C pressure.	BV2-1398	RR
2-CB-6	ASPGEN	Throttle 2SVS-PCV101A from the ASP to control SG C pressure and throttle 2SVS-PCV101B from the ASP to control SG B pressure.	BV2-1398	PCS
2-CB-6	OPRAF4F1/F2	De-energize 2FWE-P23B at 4KVS-2DF to stop train B AFW flow. Manually throttle 2FWE-HCV100E to control A train SG A flow. Manually throttle 2FWE-HCV100C to control A train SG B flow. Manually throttle 2FWE-HCV100A to control A train SG C flow.	BV2-1028	RR
2-CB-6	ASPGEN	Throttle 2FWE-HCV100E at the ASP to control SG A level. Throttle 2FWE-HCV100C at the ASP to control SG B level.	BV2-1028	PCS
2-CB-6	(None)	De-energize the C control group heater at 480VUS-2-2, de-energize the A backup group heater at 480VUS-2-8 and de-energize the B and E backup group heaters at 480VUS-2-9 to prevent RCS overpressure.	BV2-1034	DID
2-CB-6	Pf_{MCR-TV}	Install a 5000 CFM portable fan in the Control Room doorway to supply temporary ventilation.	BV2-1334	RR
2-CB-6	OPRMA2F1/F2	Provide an alternate suction to the AFW pumps.	BV2-1356	RR

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
2-CB-6	OPRC17	De-energize 2CHS-LCV115C at MCC2-E03 and manually close the valve OR De-energize 2CHS-LCV115E at MCC2-E04 and manually close the valve to prevent hydrogen intrusion into the charging pump suction.	BV2-1026	RR
2-CB-6	OPRD10	De-energize 2RCS-P21A at 4KVS-2A and de-energize 2RCS-P21B at 4KVS-2B to prevent an RCP seal LOCA.	BV2-1029	RR
2-CB-6	(None)	De-energize 2CHS-P21A(C) at 4KVS-2AE AND De-energize 2CHS-P21B(C) at 4KVS-2DF to control charging/HHSI flow.	BV2-1037	DID
2-CB-6	(None)	De-energize 2CHS-P21A(C) at 4KVS-2AE AND De-energize 2CHS-P21B(C) at 4KVS-2DF to stop excessive RCS makeup flow. De-energize 2SIS-MOV867D and 2SIS-MOV869B at MCC2-E06 and close them to isolate spuriously opened SI flow paths. Manually start 2CHS-P21A or 2CHS-P21C at 4KVS-2AE and manually throttle 2SIS-MOV867D to control RCS makeup flow.	BV2-1032 BV2-1391	DID
2-CB-6	OPRC16	De-energize 2CHS-P21A and 2CHS-P21C at 4KVS-2AE and de-energize 2CHS-P21B and 2CHS-P21C at 4KVS-2DF to prevent pump damage on loss of suction. De-energize 2CHS-LCV115B at MCC2-E03 and manually open it or open 2CHS-LCV115B from the ASP to align suction to the charging pumps. Manually start 2CHS-P21A or 2CHS-P21C at 4KVS-2AE to provide RCS makeup flow.	BV2-1024	RR

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
2-CB-6	OPRD16	Close 2RCS-PCV455C at the keylock isolation switch. OR Perform repair procedure to allow the closing of 2RCS-MOV535 to isolate the PORV. OR To provide a flow path from the containment sump to Charging/HHSI pump 2CHS-P21A de-energize 2SIS-MOV8809A, 2SIS-MOV8887A, 2SIS-MOV8811A, 2RSS-MOV156C, 2SIS-MOV863A, 2RSS-MOV155C and 2SIS-MOV8890A at MCC2-E11, de-energize 2CHS-LCV115B at MCC2-E03 and then manually close 2SIS-MOV8809A, 2SIS-MOV8887A, 2RSS-MOV156C and 2SIS-MOV8890A, manually open 2SIS-MOV8811A, 2SIS-MOV863A and 2RSS-MOV155C and then manually close 2CHS-LCV115B.	BV2-1030	RR and DID
2-CB-6	OPRQS1	Trip 2QSS-P21B at 4KVS-2DF to stop quench spray flow.	BV2-1038	RR
2-CB-6	OPRAO1	Align AE and DF bus loads as required.	BV2-1353	RR
2-CB-6	(None)	Take the plant to "Safe and Stable" utilizing selected instruments and controls at the auxiliary shutdown panel, as directed.	BV2-1354	DID
3-CR-1	OPFCI1	Close 2CHS-214 to isolate seal water return heat exchanger flow.	BV2-0866	RR
3-CR-1	(None)	De-energize 2BDG-AOV101A2, B2 and C2 at PNL-DC2-10 to isolate SG A, B and C blowdown flow.	BV2-0865	DID

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
3-CR-1	OPRC16	De-energize 2CHS-P21A and 2CHS-P21C at 4KVS-2AE and de-energize 2CHS-P21B and 2CHS-P21C at 4KVS-2DF to prevent pump damage on loss of suction. De-energize 2CHS-LCV115B at MCC2-E03 and manually open it or open 2CHS-LCV115B from the ASP to align suction to the charging pumps. Manually start 2CHS-P21A or 2CHS-P21C at 4KVS-2AE to provide RCS makeup flow.	BV2-0873	RR

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
3-CR-1	(None)	If 2SWS-P21A and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close if spuriously opened. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and verify that it is open to align the A SWS flow path. De-energize 2SWS-MOV170A at MCC2-E01 and open it to align seal water to 2SWS-P21C. De-energize 2SWS-MOV102C1 at MCC2-E01, restart the diesel, manually start 2SWS-P21C while manually opening 2SWS-MOV102C1 to provide A SWS flow. Start other AE bus loads as required. OR If 2SWS-P21C and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close if spuriously opened. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and verify that it is open to align the A SWS flow path. De-energize 2SWS-MOV102A at MCC2-E01, restart the diesel, manually start 2SWS-P21A while manually opening 2SWS-MOV102A to provide A SWS flow. Start other AE bus loads as required.	BV2-0883	DID

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
3-CR-1	(None)	If 2SWS-P21A and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close if spuriously opened. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and open it to align the A SWS flow path. De-energize 2SWS-MOV170A at MCC2-E01 and open it to align seal water to 2SWS-P21C. De-energize 2SWS-MOV102C1 at MCC2-E01, restart the diesel, manually start 2SWS-P21C while manually opening 2SWS-MOV102C1 to provide A SWS flow. Start other AE bus loads as required. OR IF 2SWS-P21C and 2SWE-P21A are damaged, stop the 2-1 diesel to prevent overheating. De-energize 2SWS-MOV103A at MCC2-E03 and close if spuriously opened. De-energize 2SWE-MOV116A at MCC2-E03 and close if spuriously opened. De-energize 2SWS-MOV106A at MCC2-E03 and open it to align the A SWS flow path. De-energize 2SWS-MOV102A at MCC2-E01, restart the diesel, manually start 2SWS-P21A while manually opening 2SWS-MOV102A to provide A SWS flow. Start other AE bus loads as required.	BV2-0894	DID
3-CR-1	OPRD05	De-energize 2MSS-AOV101A, B and C at PNL-DC2-10 to stop steam flow from SG A, B and C.	BV2-0875	RR
3-CR-1	(None)	De-energize 2SDS-AOV112A, B and C at PNL-AC2-03 to stop steam flow from SG A, B and C.	BV2-0880	DID

Table PRA 11(b)-1

Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
3-CR-1	(None)	De-energize 2SVS-HCV104 at MCC2-E14 to stop SG A, B and C steam flow and manually throttle it to control SG A, B and C pressure. De-energize 2SVS-PCV101A at MCC2-E05 to stop SG A steam flow and manually throttle it to control SG A pressure. De-energize 2SVS-PCV101B at MCC2-E13 to stop SG B steam flow and manually throttle it to control SG B pressure. De-energize 2SVS-PCV101C at MCC2-E13 to stop SG C steam flow and manually throttle it to control SG C pressure.	BV2-0882	DID
3-CR-1	ASPGEN	Throttle 2SVS-PCV101A from the ASP to control SG C pressure and throttle 2SVS-PCV101B from the ASP to control SG B pressure.	BV2-0882	PCS
3-CR-1	(None)	De-energize 2FWE-P23B at 4KVS-2DF to stop train B AFW flow. Manually throttle 2FWE-HCV100E to control A train SG A flow. Manually throttle 2FWE-HCV100C to control A train SG B flow. Manually throttle 2FWE-HCV100A to control A train SG C flow.	BV2-0874	DID
3-CR-1	(None)	De-energize 2FWS-P21A at 4KVS-2A & 4KVS-2B and de-energize 2FWS-P21B at 4KVS-2C & 4KVS-2D to stop main feedwater pump flow to the steam generators.	BV2-0888	DID
3-CR-1	(None)	De-energize the C control group heater at 480VUS-2-2, de-energize the A and D backup group heaters at 480VUS-2-8 and de-energize the B and E backup group heaters at 480VUS-2-9 to prevent RCS overpressure.	BV2-0884	DID
3-CR-1	Pf_{MCR-TV}	Install a 5000 CFM portable fan in the Control Room doorway to supply temporary ventilation.	BV2-1328	RR

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
3-CR-1	OPRMA1F1/F2	Perform actions of procedure 2OM-53A.1.A-1.8 to provide an alternate suction to the AFW pumps.	BV2-0891	RR
3-CR-1	(None)	De-energize 2CHS-LCV115C at MCC2-E03 and manually close the valve OR De-energize 2CHS-LCV115E at MCC2-E04 and manually close the valve to prevent hydrogen intrusion into the charging pump suction.	BV2-0871	DID
3-CR-1	OPRC11	Manually open 2CHS-477 to bypass the charging flow control valve. Manually close 2CHS-30 to isolate the charging flow control valve. Manually throttle 2CHS-477 to control charging flow.	BV2-0887	RR
3-CR-1	(None)	Perform repair procedure 2OM-56C.4.F-8 to allow the opening of 2RCS-MOV536.	BV2-1416	DID
3-CR-1	ASPGEN	Attempt to control 2RCS-PCV456 at the ASP.	BV2-1416	PCS
3-CR-1	(None)	Perform repair procedure 2OM-56C.4.F-19 to provide power to the reactor vessel head vent valves.	BV2-1422	DID
3-CR-1	OPRD10	De-energize 2RCS-P21A at 4KVS-2A, de-energize 2RCS-P21B at 4KVS-2B and de-energize 2RCS-P21C at 4KVS-2C to prevent an RCP seal LOCA.	BV2-0877	RR
3-CR-1	(None)	De-energize 2CHS-P21A(C) at 4KVS-2AE AND De-energize 2CHS-P21B(C) at 4KVS-2DF to control charging/HHSI flow.	BV2-0886	DID
3-CR-1	(None)	De-energize 2CNM-P21A at 4KVS-2B, de-energize 2CNM-P21B at 4KVS-2C and de-energize 2CNM-P21C at 4KVS-2D to stop condensate flow to the steam generators.	BV2-1350	DID

Table PRA 11(b)-1				
Fire Compartment	Basic Event	Recovery Actions	VFDR	PCS/RR/DID
3-CR-1	(None)	De-energize 2CHS-P21A(C) at 4KVS-2AE AND De-energize 2CHS-P21B(C) at 4KVS-2DF to stop excessive RCS makeup flow. De-energize 2SIS-MOV836, 2SIS-MOV840, 2SIS-MOV867C and 2SIS-MOV869A at MCC2-E05 and manually close the valves and de-energize 2SIS-MOV867D and 2SIS-MOV869B at MCC2-E06 and close them to isolate spuriously opened SI flow paths. Manually start 2CHS-P21A or 2CHS-P21C at 4KVS-2AE and manually throttle 2SIS-MOV836 to control RCS makeup flow.	BV2-0881 BV2-1395	DID
3-CR-1	OPRD16	Close 2RCS-PCV455C and 2RCS-PCV455D at the keylock isolation switches. OR Perform repair procedure to allow the closing of 2RCS-MOV535 and 2RCS-MOV537 to isolate the PORVs. OR To provide a flow path from the containment sump to Charging/HHSI pump 2CHS-P21A de-energize 2SIS-MOV8809A, 2SIS-MOV8887A, 2SIS-MOV8811A, 2RSS-MOV156C, 2SIS-MOV863A, 2RSS-MOV155C and 2SIS-MOV8890A at MCC2-E11, de-energize 2CHS-LCV115B at MCC2-E03 and then manually close 2SIS-MOV8809A, 2SIS-MOV8887A, 2RSS-MOV156C and 2SIS-MOV8890A, manually open 2SIS-MOV8811A, 2SIS-MOV863A and 2RSS-MOV155C and then manually close 2CHS-LCV115B.	BV2-0878	RR and DID

Table PRA 11(b)-1				
Fire Compartment	**Basic Event**	**Recovery Actions**	**VFDR**	**PCS/RR/DID**
3-CR-1	(None)	De-energize 2SWS-AOV130A at 480VUS-2-8 to restore the service water pump seal water supply.	BV2-0893	DID
3-CR-1	OPRQS1	Trip 2QSS-P21A at 4KVS-2AE to stop A train quench spray flow and trip 2QSS-P21B at 4KVS-2DF to stop B train quench spray flow.	BV2-0890	RR
3-CR-1	OPRAO1	Align AE and DF bus loads as required.	BV2-1327	RR
3-CR-1	(None)	Take the plant to "Safe and Stable" utilizing selected instruments and controls at the auxiliary shutdown panel, as directed.	BV2-0892	DID

PRA RAI 11

c) **Indicate your criteria for abandoning the MCR due to LOC and how this is implemented in your fire PRA[.]**

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. While the final fire procedures for NFPA 805 are currently under development, it has been determined that the criteria for abandoning the MCR due to LOC should be generally described as follows:

Abandon if:

Fire in 2-CB-1 OR 2-CB-6 OR 3-CR-1 (MCR)
AND
Significant, irrecoverable loss of multiple safe shutdown (SSD) functions is observed in the control room
AND
The Shift Manager determines safe shutdown can no longer be adequately implemented from the control room due to the extent of fire effects

Scenarios in compartments 2-CB-1, 2-CB-6, and 3-CR-1 were evaluated to determine if each scenario would cause abandonment due to severe fire damage to instruments and controls, in accordance with the above criteria. This was done by calculating the CCDP of each scenario without crediting local operator actions. A CCDP value of 0.1 for these cases is used as a screening threshold that reflects severe fire damage to plant instruments and controls and serves as a quantitative representation of the point at which operators doubt their continued ability to effectively control and shut down the plant from the main control room. The need for main control room abandonment will be determined based on the extent of the equipment failures observed by control room operators, so local operator actions are excluded from the quantitative evaluation (set to guaranteed failure) in order to obtain an accurate measure of the CCDP due solely to equipment damage. Scenarios that quantify in this manner with a CCDP of 0.1 or higher are considered to represent a plant state trending toward core damage, and will be treated as main control room abandonment scenarios. Scenarios found to have a CCDP less than 0.1 are considered to represent a less severe set of plant damage and will be treated normally as non-abandonment scenarios. CLERP is not considered as part of the abandonment determination because the potential for large early release will be less of a concern for plant operators as the event develops. They will likely not consider the possibility of a release until the reactor core has already been damaged or is heading toward damage, so factors directly related only to CLERP will not likely factor into the operators' decision to abandon the MCR. Therefore CCDP was determined to be the appropriate metric by which to judge this approximation of the operators' decision threshold.

The results of this screening show that the CCDP value of 0.1 chosen as the threshold between abandonment and non-abandonment is not particularly sensitive, such that when operator actions are not credited the vast majority of scenarios in these compartments have a CCDP either significantly greater than 0.1, or significantly less than 0.1. Only 17 of the nearly 700 scenarios defined for these compartments were found to have equipment-only CCDPs between 9E-02 and 0.2. Furthermore, the scenarios determined to be non-abandonment in these compartments were also found to have CDF values low enough to screen them out of the final FPRA model.

PRA RAI 11

d) **Explain and justify how the times associated with cues in the HRA to abandon the MCR were established given the different combinations of component failures and spurious actions possible from fires that affect MCR function.**

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. The LOC abandonment modeling used for BVPS-2 did not explicitly treat the timing of cues to trigger abandonment within a specific time. Unlike current licensing basis abandonment procedures, the MCR abandonment procedures under NFPA 805 will be symptom based, only crediting actions to mitigate failures as they actually occur instead of requiring the actions to be performed within a certain time window following the onset of the fire. These procedures are currently being developed with operations department support, and are incorporating lessons learned through simulator validation as part of their development.

The new abandonment procedures under NFPA 805 are designed to mitigate fire failures as they occur, and will not rely upon short-time actions to prevent failures since the specific timing of fire failures will be unknown and actions therefore cannot be credited to prevent fire failures prior to their occurrence. Thus, the timing of when the MCR is abandoned is not so critical, as local actions will be cued from individual fire-induced failures and the credited instruments providing the cues will be available both in the MCR and at the ASP. Additionally, the previous fire protection licensing basis required the plant to achieve cold shutdown within 72 hours, so the timing for MCR abandonment was intended to support this goal. This is no longer a requirement under NFPA 805, so the timing of MCR abandonment becomes less critical. The only critical cue timings which may be affected by abandonment are for certain initial, short time-window actions which are discussed in the response to PRA RAI 11(e). Other action timings have sufficient margin that even if the cue comes in while command and control is being transferred to the ASP, the operators will still be able to recognize the appropriate cue(s), and subsequently take the appropriate action well within the allowable time window for the action.

PRA RAI 11

e) **Explain and justify how the times available for operator actions outside the MCR in the PRA were established given the different combinations of component failures and spurious actions possible from fires that affect MCR function.**

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. The times available for operator actions (Tsw) outside the MCR in the FPRA model were established using Modular Accident Analysis Program (MAAP) runs, hand calculations, or other documented, verifiable methods, based on conservative, limiting case assumptions considering the scope of possible failures. As described in the response to PRA RAI 11(a), the local operator actions in MCR abandonment scenarios are a subset of those credited for other non-abandonment fire scenarios, and the basis for operator action Tsw times for local actions are documented in the fire HRA notebook. With respect to the timing of failures, relevant failures were assumed to occur coincident with reactor trip (at time zero) unless a later failure time would be more limiting, such that the least amount of time was assumed to be available for operator actions following the fire. In many cases, actions which carry over from the internal events PRA model already used a limiting case Tsw which required no change due to fire effects, but in other cases changes needed to be made. Such actions were reviewed and appropriately dispositioned in the fire HRA notebook. For most actions, the delay time was extended to account for general effects of the fire and fire procedures, as compared to a normal transient initiating event. The standard extension was 35 minutes, although a number of actions include specific justification for a lesser extension of the delay time. In the case of actions OPRCC1 and OPRCC3 from the internal events model, the Tsw was actually extended for fire conditions. The nominal Tsw for these actions in the internal events model is 13 minutes, and is based on restoring thermal barrier cooling to the RCP seals. For fires, however, the instrument air system is deemed unreliable and is assumed to be lost; therefore thermal barrier cooling cannot be restored because it relies upon air-operated valves in the flowpath. The next relevant Tsw was determined by calculation to be 52 minutes, in order to cool RCP seal return and prevent charging pump suction from heating to the point of cavitation.

Fire-specific actions not adapted from the internal events PRA model were also evaluated for the limiting case Tsw based on possible fire effects. Many of these actions were developed from the current BVPS-2 SSD procedures, for which the current procedural time restrictions were reviewed and validated relevant to the future NFPA 805 licensing basis. For example, actions OPRD06 and OPRD07 model the operators to locally close a spuriously-open atmospheric steam dump valve or the residual heat release (RHR) valve and credit the same Tsw as was developed to support the current safe shutdown licensing basis. The calculation which established the available time window for those actions was reviewed and determined to remain applicable, so the same Tsw was used in the FPRA. Other actions were created to directly mitigate new failure scenarios observed in creation of the fire PRA model. Such new actions were assigned an appropriate Tsw based on specific thermal/hydraulic analysis for the scenario, or existing analyses for a similar scenario, where appropriate. Operator action OPRAO1, for instance, was created to mitigate spurious breaker operations on an emergency 4160 volt bus and the appropriate Tsw had to be selected. This action was determined to be limited by restoration of AFW, assuming failure of the turbine driven AFW pump, so the allowable time to restore 4160V power by manually aligning the breakers is based on preventing steam generator dryout following the reactor trip.

Thus, the abandonment actions in the BVPS-2 FPRA model use Tsw values which are designed to be conservative and bounding, in recognition of the fact that the actual scope of failures experienced in any given fire cannot be precisely known. Spurious failures, in particular, cannot be predicted to occur with absolute accuracy, and the timing of their occurrence is even less predictable, so the worst-case failure timing is assumed in order to prove the viability of an action under possible fire conditions.

With respect to the timing of MCR abandonment and its effect on the nominal available time for operator actions, abandonment is considered to have a negligible effect on operator action timing as it is modeled in the BVPS-2 FPRA. The majority of instruments credited as cues for operator actions in the MCR are also available at the ASP, so the delay time associated with cues and indications for actions remains unchanged. There may be a small additional delay if the cue for a particular action happens to come in as command and control is in the process of being transferred to the ASP, but the relevant cue would be available as soon as the ASP is fully activated such that the actual increase in delay time, should this improbable coincidence occur, would be less than 5 minutes. While this small increase could cause an observable difference in certain actions, the low probability of coincident occurrence with those more delay-sensitive actions is judged to have a negligible effect on the analysis. Furthermore, the actions in which an additional delay of 5 minutes could be significant are typically cued and demanded very early in the event, such as the actions to trip the RCPs and main feedwater pumps. In these cases the operators are tasked to perform the actions prior to leaving the MCR regardless of other cues, with subsequent backup local actions to be performed by a local operator (also regardless of cues) to verify the pumps remain successfully tripped. Another credited local action which may be significantly affected by the increased delay time is the action to locally trip the MSIVs, but this would likely be demanded immediately following reactor trip for a fire since the condenser is not a credited safe shutdown path to remove decay heat. This immediate demand means the action cue would be received prior to abandoning the MCR on LOC, which precludes abandonment from affecting the timing of this action. Thus the BVPS-2 fire PRA model treats the timing for abandonment scenarios in an appropriately conservative manner.

PRA RAI 11

f) **Explain how the CCDPs/CLERPs are estimated for fires that lead to MCR abandonment due to loss of control and how they address the range of possible fire-induced failures. Specifically include in this explanation, discussion of how the following scenarios are addressed:**

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

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

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

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. In the BVPS-2 FPRA model, the CCDPs and CLERPs for abandonment scenarios are determined in essentially the same manner as for other fire scenarios. The integrated FPRA model calculates CCDP and CLERP using basic event impacts based on the specific targets affected in a given fire scenario. The only real difference is that abandonment scenarios also query the ASP top event (described more fully in response to PRA RAI 11(a)), which applies a conservative probability of 0.1 to the likelihood of successfully transferring command and control to the ASP and performing the necessary PCS actions (ASPGEN). If this top event fails, the abandonment sequence maps directly to core damage. However, if the top event ASP is successful, the sequence will continue to progress normally through the remaining fault trees and event trees to calculate the conditional damage probability based on fire scenario impacts and credited local operator actions to mitigate those impacts. Additionally, the top event ASP is set to guaranteed failure for plant conditions which cannot be mitigated from the ASP, such as LOCAs greater than RCP seal leakage, or failures of AFW.

In this manner the BVPS-2 integrated FPRA model appropriately addresses potential abandonment scenarios, including i) scenarios where fire fails only a few functions aside from forcing MCR abandonment and successful alternate shutdown is straightforward; ii) scenarios where fire could cause some recoverable functional failures or spurious operations that complicate the shutdown, but successful alternate shutdown is likely; and, iii) scenarios where the fire-induced failures cause great difficulty for shutdown by failing multiple functions and/or causing complex spurious operations that make successful shutdown unlikely. Since the ASPGEN action represents only activation of the ASP and performance of associated PCS actions, with the remainder of the fire damage effects and required local operator actions being quantified as normal for each scenario, plant damage states due to fire effects are properly represented in the model for abandonment scenarios based on the actual failures which would occur.

PRA RAI 11

g) **Provide your range of CCDPs for abandonment due to LOC. If your maximum CCDP is not equal to 1.0, please provide a discussion as to why your CCDP maximum is less than 1.0.**

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. The CCDPs for the BVPS-2 LOC MCR abandonment scenarios range between a low value of 2.66E-03 up to 9.98E-01 (effectively 1.0). The maximum CCDP is slightly less than 1.0 because the failures which would cause guaranteed failure of safe shutdown outside the control room (that is, LOCAs greater than RCP seal leakage) are caused by spurious failure modes which have probabilities less than 1.0, given fire damage to the relevant circuits. The BVPS-2 FPRA model contains 278 LOC abandonment scenarios, 225 of which have CCDPs between 0.1 and 1.0. Of the remaining abandonment scenarios, 43 have CCDPs between 1E-02 and 0.1, and only 10 scenarios have CCDPs less than 1E-02. The mean CCDP for the abandonment scenarios is 3.39E-01, and the median CCDP value is 4.37E-01.

These values will be recalculated as part of the integrated analysis to be provided in response to PRA RAI 03.

PRA RAI 11

h) **For assessment of scenarios resulting in MCR abandonment due to loss of control, if the timing considerations associated with the cues to abandon the MCR or the times available to perform MCR abandonment actions cannot be justified or if the assessment does not address the range of possible fire-induced failures, then provide an alternate acceptable approach in the integrated analysis provided in response to PRA RAI 3.**

Response:

As described in the response to PRA RAI 11(a), MCR abandonment due to LOC is only credited for BVPS-2. For these LOC abandonment scenarios, the responses to PRA RAIs 11(a)-(g) have justified the timing considerations associated with the cues to abandon the MCR and the times available to perform MCR abandonment actions, and have addressed the range of possible fire-induced failures. As noted in the response to PRA RAI 11(g), MCR abandonment CCDP values will be recalculated in the integrated analysis to be provided in response to PRA RAI 03.

PRA RAI 12

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

Table S-2 of the LAR indicates that incipient detection will be installed in Unit 1 Process Rack cabinets in Fire Compartments 1-CR-4 and 2-CB-1 and in the Unit 2 Communications Room in Fire Compartment 2-CB-6. Table W-3 of the LAR indicates that these incipient detectors have an appreciable impact on reducing risk. Given the high risk significance of these incipient detection systems, explain the modeling performed in the Unit 1 and 2 Fire PRA to credit these detectors. Include discussion of whether these detectors were credited to reduce the risk of arcing fault fire scenarios. If incipient detection was used to reduce the risk of these scenarios, justify this treatment or remove this credit and evaluate its impact as part of the integrated analysis provided in response to PRA RAI 3. Explain how the approach to credit incipient detection system is consistent with existing guidance in FAQ 08-0046.

<u>Response:</u>

Background

The approach for crediting incipient detection as described in the BVPS-1 and BVPS-2 fire PRA quantification notebooks is consistent with FAQ 08-0046 and takes into account the associated NRC's resolution of comments dated November of 2009 and documented in ADAMS accession number ML093220197.

Incipient detection systems were only credited for reducing the probability of fires which propagate from cabinets in which they are installed and not for reducing the likelihood of damage within the source cabinets, or for area-wide detection. Furthermore, incipient detection was not credited for fires originating in cabinets containing equipment with an operating voltage greater than 250 volts, and consequently was not credited to reduce the risk of arcing fault fire scenarios.

Key assumptions regarding the applicability of this guidance to specific plant installations are summarized below.

Applicability Assumptions

1. The incipient detection system design, installation, testing, calibration and maintenance is consistent with the requirements of the FAQ 08-0046. This is justified in the previously-submitted FENOC response to the 60-day FPE RAI 15.

2. Effective methods are established for locating the alarm, and alarm responders are appropriately trained. This is also justified in the previously-submitted FENOC response to the 60-day FPE RAI 15.

3. Compensatory measures to address the unavailability or inoperability of the incipient detection system are included in the BVPS fire protection program.

Model

Two event tree models are provided in FAQ 08-0046. The simplified version is shown below in Figure PRA 12-1 and was used at BVPS to derive a failure probability of non-suppression before damage outside of the cabinet.

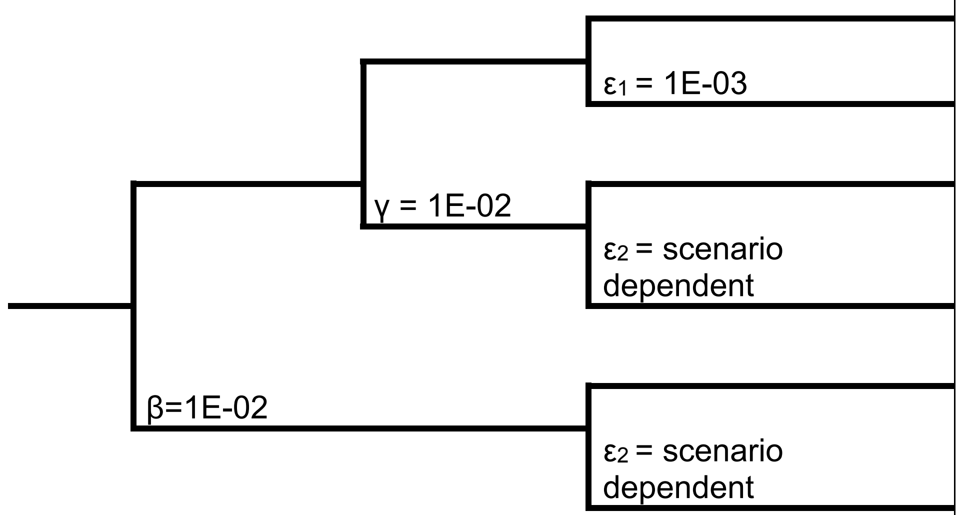
Fire Initiating Event	Detector System Available and Reliable	Successful Operator Response to Alert	Fire Suppressed	End State-Damage Outside of Cabinet
				1. No damage (damage to source only) 2. Damage 3 No damage 4. Damage 5. No Damage 6. Damage

Figure PRA 12-1: Simplified event tree.

The simplified event tree excludes two events contained in the detailed version; specifically “The fraction of components that exhibit an incipient phase” and “Technician successful in preventing fire in the incipient stage.” The NRC’s response to industry comment number 3 documented in ADAMS accession number ML093220197 indicates that this is acceptable on the grounds that the potential non-conservatism in the former is compensated for by the conservatism in the latter (that is, using this approach, there is no need to count fast acting sources in cabinets being protected in order to establish a probability of non-suppression).

Detector System Available and Reliable - Success of this branch implies that the incipient detection has issued an alert (of an incipient fire). β, the failure probability for this branch is set equal to 1E-02 in accordance with FAQ 08-0046 per applicability assumption 1 above.

Successful Operator Response to Alert - Success of this event implies that plant personnel have identified the cabinet which contains the source of the alert and have staged appropriately trained personnel (qualified fire watch similar to that used to monitor hot work). γ, the probability of the operator / fire brigade to respond to the alert and find the component, is set conservatively to 1E-02 if the incipient detection is assigned to multiple cabinets in accordance with FAQ 08-0046 per applicability assumption 2 above (which was previously discussed in FENOC's response to FPE RAI 15).

Fire Suppressed – Success of this event implies that the fire watch successfully controls the fire before it affects the target(s) (outside of the cabinet). There are two cases evaluated here:

- ε_1 represents the probability that given the success of operator response, personnel staged at the cabinet fail to suppress the fire quickly enough to prevent damage outside the cabinet. In this case, the probability of non-suppression ε_1 may be set to 1E-03 in accordance with FAQ 08-0046.

- ε_2 is the probability of normal suppression failure given the incipient detection system fails or operator response event fails. In this case, the value may be derived from the detection /suppression event tree described in NUREG/CR-6850 Appendix P using the electrical non-suppression curve for manual suppression.

Evaluation

The probability of damage outside of a cabinet protected by incipient detection will depend upon the reliability and response of normal area detection and suppression as well as incipient detection. However, since the normal area detection and suppression are evaluated independently of the incipient detection, no credit has been taken for these systems in this evaluation (that is, the probability of ε_2 is set to 1.0). In this case, quantification of the event tree in Figure PRA 12-1 above results in the probability of failing to detect and suppress the fire prior to damage outside of the cabinet equal to 2.1E-02, based solely on incipient detection (see Table PRA 12-1 below).

Table PRA 12-1: Evaluation of Event Tree in Figure PRA 12-1

End state	**1-β or β**	**1-γ or γ**	**ε or 1- ε**	**Probability of damage outside of cabinet (Pnid)**
1	0.99	0.99	0.999	n/a
2	0.99	0.99	0.001	0.00098
3	0.99	0.01	0	n/a
4	0.99	0.01	1	0.0099
5	0.01	1	0	n/a
6	0.01	1	1	0.01
			Total	0.02088

Application

Fire scenario frequencies (FSi) were initially evaluated in accordance with the accepted fire modeling guidance without credit for incipient detection but accounting only for fire severity factor and the probability of failure of the normal area detection systems, manual suppression by fire fighters and automatic suppression where applicable.

The incipient detection is a totally independent system, and the manual response to the incipient detection can be decoupled from the normal fire fighter response due to the diversity of signals, procedures, training and lack of any overlap in the time windows credited for actions. The probability of failing to prevent a fire resulting in damage outside of the source cabinet due to incipient detection alone (Pnid) can therefore be considered independent of the fire scenario frequency evaluated without incipient detection (FSi).

The overall frequency of any fire scenario which leads to damage outside the source cabinet is therefore evaluated as:

$$= (FSi) * (Pnid)$$

While the probability of the damage outside of the source cabinet will decrease due to the presence of incipient detection, the probability of fire scenarios where damage is sustained within the source cabinet only is correspondingly increased.

Based on the information provided in this response, the incipient detection approach has been applied in accordance with FAQ 08-0046 and would not be subject to change in the integrated analysis to be provided in response to PRA RAI 03.

PRA RAI 25

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

During the audit, BVPS indicated that cable fires due to welding and cutting were analyzed in two ways. For some PAUs, fire was assumed to damage the highest CCDP tray in the PAU and the entire PAU frequency for cable fires due to welding and cutting was applied to this CCDP. For other PAUs, the fire frequency and

location of hot work induced cable fires was applied according to a grid in the PAU. Given that the later approach deviates from accepted methods, please:

a) **Confirm the NRC staff's understanding of BVPS's approach to hot work fires summarized above is correct. Otherwise, provide additional detail as warranted.**

Response:

The NRC staff's understanding of FENOC's approach to hot work fires at BVPS (for example, cable fires due to welding and cutting) as summarized in PRA RAI 25 is correct. FENOC analyzed cable fires due to welding and cutting at BVPS in two ways.

For most PAUs, the fire was assumed to damage the tray with the highest CCDP in the PAU and the full PAU frequency for cable fires due to welding and cutting was applied to this CCDP. For some PAUs (that is, 1-CR-4, 1-CS-1, and 2-SB-3), the fire frequency and location of hot-work-induced cable fires was applied according to a grid in the PAU.

PRA RAI 25

b) **Justify the treatment of hot work induced cable fires**

Response:

FENOC analyzed hot-work-induced cable fires at BVPS (for example, cable fires due to welding and cutting) in two ways, as discussed in the response to PRA RAI 25(a). The first method applied the full PAU frequency for cable fires due to welding and cutting to the tray with the highest CCDP and this approach is consistent with fire PRA FAQ 13-0005.

The second method divided the PAU frequency and location of the cable fires due to welding and cutting according to a grid of the PAU. This method will no longer be applied to the BVPS fire modeling. Any PAUs that previously applied this second method (grid method) will be reviewed and revised to analyze cable fires due to welding and cutting in accordance with fire PRA FAQ 13-0005 as further discussed in the response to PRA RAI 25(c).

PRA RAI 25

c) **Absent an adequate justification for treatment of hot work fires, incorporate an acceptable approach (i.e., FAQ 13-0005) in the integrated analysis provided in response to PRA RAI 3.**

Response:

As discussed in the response to PRA RAI 25(b), FENOC will revise the BVPS analysis for any PAUs that were not consistent with fire PRA FAQ 13-0005 (where the grid method was used, as discussed in the response to PRA RAI 25(a)). The PAUs being revised will analyze cable fire scenarios due to welding and cutting in accordance with fire PRA FAQ 13-0005 utilizing an iterative process as defined below:

1. The total PAU frequency for cable fires due to welding and cutting may be mapped to a target set using the cable tray with the highest CCDP in the PAU. This is consistent with section 2, step 2 of fire PRA FAQ 13-0005.

2. For PAUs where further refinement is needed, the cable fires due to welding and cutting will be further refined to apportion the PAU frequency to more than one scenario in the PAU. The PAU frequency will be apportioned using a compartment area ratio based on the plan view area of the target tray to the total area of trays in the PAU, in accordance with section 2, step 3 of fire PRA FAQ 13-0005.

The updates to the fire modeling analysis associated with the treatment of cable fires due to welding and cutting will be reflected in the updated fire risk results that will be provided to the NRC as part of the integrated analysis to be provided in response to PRA RAI 03.

PRA RAI 26

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. In letter dated July 12, 2006, to NEI (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

The NRC staff learned at the audit that the Unit 1 MCB vertical boards were analyzed using the Appendix L methodology. Inherent to the analysis was an assumption that an additional 15 minutes due to separation was added to the time allowable for suppression prior to damage of the Appendix L target sets. In

absence of partitions in the MCB vertical boards, additional explanation is needed to support this credit. If this treatment cannot be justified, then replace this treatment with an acceptable method in the integrated analysis provided in response to PRA RAI 03.

Response:

The BVPS-1 and BVPS-2 individual main control board (MCB) vertical boards are fully open to one another without intervening partitions. It is therefore agreed that an additional 15 minute time delay for fire damage progression between sections in the vertical boards in accordance with NUREG/CR 6850 section 11.5.2.8, cannot be credited. The BVPS-1 and BVPS-2 MCB analysis is therefore being revised to eliminate such credit in the vertical boards and perform the analysis accounting only for spatial separation employing the fire growth suppression model as defined within NUREG/CR 6850 Appendix L. The results of this revised analysis will be incorporated in the integrated analysis to be provided in response to PRA RAI 03.

The Nuclear Regulatory Commission (NRC) staff provided a request for additional information (RAI) to FirstEnergy Nuclear Operating Company (FENOC) in a letter dated May 11, 2015 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML15125A416). The NRC requested information to complete its review of a FENOC license amendment request (LAR) for Beaver Valley Power Station (BVPS), Unit No. 1 (BVPS-1) and Unit No. 2 (BVPS-2). The LAR would change the fire protection program to one based on the National Fire Protection Association NFPA Standard 805 (NFPA 805), "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition. The NRC staff's RAI questions are provided below in bold text followed by the corresponding FENOC response.

Human Factors (HF) RAI 01

The regulations in 10 CFR Section 50.34(f) contain requirements related to Three Mile Island that address the human factors design considerations for Main Control Rooms (MCRs). Section 50.34(f)(2)(iii) of 10 CFR states:

> **Provide, for Commission review, a control room design that reflects state-of-the art human factor principles prior to committing to fabrication or revision of fabricated control room panels and layouts.**

Chapter 18.0, "Human Factors Engineering," of NUREG-0800, "Standard Review Plan," identifies guidance that may apply to the review of new/modified fire protection controls, alarms, displays and for the review of manual operator actions that may be altered by the use of new/modified hardware. The following questions are intended to support the NRC review related to human factors design as it is related to the NFPA 805 LAR.

LAR Attachment S, Table S-2, modifications BV1-1875 and BV2-0829 describe Very Early Warning Fire Detection Systems (VEWFDS) that will be installed in low voltage electrical cabinets located in fire compartments 1-CR-4, 2-CB-1, and 2-CB-6 as part of the NFPA 805 transition. The following questions are regarding these systems:

The in-cabinet and area wide VEWFDS are new installations, and the information collected by the systems must be communicated to operators. This will occur

through a new human-system interface (HSI) or through a modification to existing fire alarm control panels.

(a) Describe any new or modified HSI that will be used as a result of the VEWFDS systems.

(b) Describe visual displays, alarms/alerts, and controls.

(c) Identify the human factors standards used to create or modify the HSI (such as NUREG-0700, "Human-System Interface Design Review Guidelines").

(d) Include screen shots of any new computer screens being used and a description of any annunciator equipment being used to present alarms.

<u>Response:</u>

a) In the letter dated April 27, 2015 (ADAMS Accession No. ML15118A484), the response to FPE RAI 15(a) stated that the VEWFDS will be connected to interface with the control room annunciation system, and that LAR Attachment S, Table S-2 will be revised to add this modification for both BVPS-1 and BVPS-2. The modification is not complete at this time and is not required to be implemented until the second refueling outage after approval of the LAR. The requested information will be available for NRC inspection at that time.

   The VEWFDS systems will communicate system trouble/fault conditions and fire alarm conditions to operators in the main control room using the existing HSI provided by the plant annunciator system. The existing HSI characteristics of the MCR plant annunciator systems at BVPS-1 and BVPS-2 will not be modified. No new HSI will be required in the MCR to support functionality of the VEWFDS or associated alarm response.

b) The VEWFDS systems will communicate system trouble/fault conditions and fire alarm conditions to operators in the MCR using the existing HSI provided by the plant annunciator system. The existing HSI characteristics of the MCR plant annunciator systems at BVPS-1 and BVPS-2 will not be modified. The existing MCR plant annunciator systems at BVPS-1 and BVPS-2 consists of various alarm lights, windows, and horns located in the MCR. Upon actuation of the MCR annunciator system, the associated annunciator window lights up and flashes, and the horn sounds. The horn will continue to sound and lights will flash until the operator acknowledges the alarm by depressing a pushbutton located in the MCR.

c) The existing HSI characteristics of the MCR plant annunciator systems at BVPS-1 and BVPS-2 will not be modified. No new HSI will be required in the MCR to support functionality of the VEWFDS or associated alarm response.

d) No new computer screens or annunciator equipment will be relied upon to present VEWFDS alarms. The existing MCR plant annunciator systems at BVPS-1 and BVPS-2 consists of various alarm lights, windows, and horns located in the MCR. Upon actuation of the MCR annunciator system, the associated annunciator window lights up and flashes, and the horn sounds. The horn will continue to sound and lights will flash until the operator acknowledges the alarm by depressing a pushbutton located in the MCR.

HF RAI 02

The regulations in 10 CFR Section 50.34(f) contain requirements related to Three Mile Island that address the human factors design considerations for MCRs. Section 50.34(f)(2)(iii) of 10 CFR states:

> **Provide, for Commission review, a control room design that reflects state-of-the art human factor principles prior to committing to fabrication or revision of fabricated control room panels and layouts.**

Chapter 18.0, "Human Factors Engineering," of the NUREG-0800, "Standard Review Plan," identifies guidance that may apply to the review of new/modified fire protection controls, alarms, displays and for the review of manual operator actions that may be altered by the use of new/modified hardware. The following questions are intended to support the NRC review related to human factors design as it is related to the NFPA 805 LAR.

LAR Attachment S, Table S-2 modifications BV1-1875 and BV2-0829 describe VEWFDS that will be installed in low voltage electrical cabinets located in fire compartment 1-CR-4, 2-CB-1, and 2-CB-6 as part of the NFPA 805 transition. The following questions are regarding these systems.

(a) Describe the results of an operating experience review (including plant-specific condition reports, Licensee Event Reports, Institute of Nuclear Power Operations reports, and other relevant sources) regarding the use of similar VEWFDS systems.

(b) Describe any changes that were required of the MCR task analysis that was necessary to support installation of VEWFDS displays. If no changes were necessary for the task analysis, describe how the task requirements were developed.

(c) Describe any verification and validation that was done to ensure that any new or changed risk-important human actions can be completed within the time limits of the relevant scenarios. Include a description of the relevant conditions under which the validation was conducted (for example, did the

licensee use a representative sample of operators under Technical Specification minimum staffing?).

Response:

a) As noted in the response to HF RAI 01(a), the VEWFDS and associated plant annunciator modification is not complete at this time. However, an OE review was performed and identified in one VEWFDS installation, cabinets were unable to be sampled due to the sample ports not completely drilled out. Reconciliation of this OE at BVPS was to ensure during implementation of the modification that cabinets are drilled out accordingly. Additional informal input from other nuclear power plants regarding the installation, maintenance, operation, and alarm response for similar VEWFDS systems was solicited by FENOC and resulted in selection of the preferred VEWFDS equipment vendor for BVPS.

b) As noted in the response to HF RAI 01(a), the modification is not complete at this time and is not required to be implemented until the second refueling outage after approval of the LAR. The requested information will be available for NRC inspection at that time.

c) As noted in the response to HF RAI 01(a), the VEWFDS and associated plant annunciator modification is not complete at this time. However, the existing HSI characteristics of the MCR plant annunciator system will not be changed and a time factor is not credited in the performance-based analysis. The only credit taken is preventing a potential fire from spreading from the cabinet of origin, in accordance with FAQ 08-0046. Therefore, there are no new or changed risk-important human actions associated with the VEWFDS system.