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Fax: 724-643-8069May 12, 2016  
L-16-162ATTN: 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 Requests for Additional Information Regarding License Amendment  
Request to Adopt National Fire Protection Association Standard 805, and Request to  
Change Implementation Schedule (CAC Nos. MF3301 and MF3302)

By letter dated December 23, 2013 (Accession No. ML14002A086), as supplemented by letters dated February 14, 2014; April 27, 2015; May 27, 2015; June 26, 2015; November 6, 2015; December 21, 2015; and February 24, 2016 (Accession Nos. ML14051A499, ML15118A484, ML15147A372, ML15177A110, ML15313A306, ML15356A136, and ML16055A160 respectively), FirstEnergy Nuclear Operating Company (FENOC) submitted a license amendment request (LAR) to change the Beaver Valley Power Station, Unit Nos. 1 and 2, fire protection program to one based on the National Fire Protection Association (NFPA) Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition.

By letters dated March 30, 2016 and April 7, 2016 (Accession Nos. ML16084A844 and ML16071A122, respectively), the Nuclear Regulatory Commission (NRC) requested additional information to complete its review. The FENOC response to the requested information is attached. The enclosure to this letter contains the revised Approval Request 5 for LAR Attachment L – NFPA 805 Chapter 3 Requirements for Approval, which was submitted in the February 24, 2016 letter.

The information provided by this submittal does not invalidate the significant hazards consideration analysis provided in the December 23, 2013 letter.

FENOC also requests a change to the new NFPA 805 fire protection program implementation schedules from 180 days after issuance of the license amendments to 12 months after issuance of the license amendments. The requested program implementation extension is based on the limited site resources required to prepare for

and support the Beaver Valley Power Station Unit No. 2 outage in the spring of 2017. There are no requested changes to the modification implementation schedules.

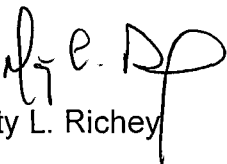
The NFPA 805 fire protection program implementation schedules are reflected in LAR Attachment M - License Condition Changes, and Attachment S, Table S-3, Implementation Items. A change to the LAR reflecting the 12-month implementation period will be provided in a future submittal.

By letter dated December 23, 2013, FENOC established two regulatory commitments. The first commitment was to implement the new NFPA 805 fire protection program, including procedure changes, process updates, and training affected plant personnel within 180 days after issuance of the license amendments. The second commitment was to complete listed plant modifications associated with the transition to NFPA 805 by the startup following the second refueling outage for each unit after issuance of the license amendments. These commitments are unnecessary and are withdrawn as they are addressed by the proposed transition license conditions that were submitted in Attachment M - License Condition Changes to the December 23, 2013 letter.

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 May 12, 2016.

Sincerely,



Marty L. Richey

Attachment:

Response to March 30, 2016 and April 7, 2016 Requests for Additional Information

Enclosure:

Revised LAR Attachment L Approval Request 5 – NFPA 805 Chapter 3 Requirements for Approval

cc: NRC Region I Administrator  
NRC Resident Inspector  
NRC Project Manager  
Director BRP/DEP  
Site BRP/DEP Representative

Attachment  
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Response to March 30, 2016 and April 7, 2016 Requests for Additional Information  
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The NRC staff's request for additional information (RAI) questions are provided in bold text followed by the corresponding FENOC response.

**Safe Shutdown RAI 13.01**

**In its letter dated February 24, 2016, the licensee submitted new Approval Request 5 for the use of two 1.5-hour rated fire dampers in series with 1-hour fire wrap on duct penetrations as an acceptable method to meet the requirements of NFPA 805, Section 3.11.3, for fire barrier penetrations. The licensee stated that the approval request applies to Unit No. 2 fire areas that received prior approval of 1-hour fire wrap extending from the fire barrier to, and including, the fire damper outside the plane of the fire barrier.**

**The licensee cited excerpts from NRC Safety Evaluation Report NUREG-1057, Supplement 5, Section 9.5.1.4, dated May 1987, which described the fire loading as less than .50 hour on either side of the subject dampers, with smoke detection provided in all areas where the 1-hour fire wrap is installed and hose racks available for fire brigade use. However, in the approval request, the licensee described significant differences in the configurations under consideration in that the fire areas evaluated in the approval request have fire loadings equivalent to a fire duration between 1-hour and 2.25 hours, and in some of the fire areas, there is no credited fire detection.**

**Provide the following information to support the conclusion that the configurations are acceptable:**

- a) In LAR Attachment C, the licensee stated that a performance-based analysis is credited to meet the nuclear safety performance criteria in accordance with NFPA 805, Section 4.2.4. Describe how it can be assured that the fire damper/wrap configurations described in the approval request are capable of withstanding the fire hazards associated with the fire areas. In particular, describe how the configurations are adequate for areas with fire loadings greater than 1 hour.**

**Response:**

The fire damper configurations within the areas described in Approval Request 5 have been determined to be adequate and capable of withstanding the fire hazards associated with those areas as concluded in FENOC evaluation 2701.620-000-169. Additional plant walkdowns and review of design drawings identified that the majority of

the two configurations of 1.5-hour rated fire dampers in series are located within the fire barrier of the areas listed in Approval Request 5. The identified fire damper configurations were different than those discussed in the previous Approval Request 5, which described the fire damper configurations as being "two 1.5-hour fire dampers in series with 1-hour fire wrap and the fire dampers being close to but outside the fire barrier." In most cases, the identified fire damper configurations are more robust than those previously described in that the fire dampers are located within the fire barrier. Due to the differences in fire damper configurations identified during the plant walkdowns and design drawing review, the scope of the evaluation was expanded to include all areas listed in Approval Request 5, including those with combustible loading less than 1-hour.

With the exception of four areas (described below), all fire compartments listed in Table 1 of Approval Request 5 contain two 1.5-hour fire dampers that are located within the fire barrier. These damper configurations were evaluated and determined to be adequate and capable of withstanding the fire hazards associated with those areas. Specifically, for the fire compartments with fire loading greater than one hour, the bounding case (as described in 2701.620-000-169) was fire compartment 2-CV-1 "West Cable Vault & Rod Control Area," which has a fire loading of 2.25 hours. The fire damper configurations were determined to provide an equivalent fire resistance of three hours, due to both 1.5-hour fire dampers being located within the barrier. Therefore, the fire dampers are adequate in the most limiting compartment 2-CV-1 and will prevent fire spread through the fire barrier to adjacent areas.

In addition to the fire damper configurations located within the fire barrier, there were four Beaver Valley Power Station Unit No. 2 (BVPS-2) areas identified that contain fire damper configurations where one of the two 1.5-hour fire dampers is outside of the fire barrier. These four areas are the barriers between fire compartments:

- 2-ASP (alternate shutdown panel room) and 2-CV-3 (cable vault and rod control area);
- 2-WH-1 (waste handling building) and 2-PA-5 (auxiliary building, elevation 773 foot, 6 inch)

The fire dampers outside of the barrier are located in 2-CV-3 and 2-WH-1. In each of these areas, one of the fire dampers is located within the barrier and the other is directly outside of the barrier. These configurations were determined to be acceptable in evaluation 2701.620-000-169 based on the combustible loading, location of the fire dampers, and additional defense-in-depth provided by the 1.5-hour damper and ventilation ductwork located immediately outside of the fire barrier, resulting in reasonable assurance that an adequate fire barrier is provided.

During plant walkdowns of the fire damper configurations, it was identified that some areas referenced in Approval Request 5 did not contain fire wrap on ductwork within the area. This conflicts with the information listed in LAR Table 4-3, "Summary of NFPA

805 Compliance Basis and Required Fire Protection Systems and Features," which shows "wrap on exposed ductwork" as a credited feature for all areas listed in Approval Request 5. As a result, LAR Table 4-3 will be updated accordingly to remove "wrap on exposed ductwork" as a credited feature for the applicable areas. The updated table will be provided in a future submittal.

Approval Request 5 has been revised and is enclosed with this submittal. The revised request provides additional information on the fire damper configurations as explained in this response.

### **Safe Shutdown RAI 13.01**

- b) One of the requirements for the use of performance-based alternatives to demonstrate compliance under 10 CFR 50.48(c)(2)(vii) is that fire protection defense-in-depth (DID) must be maintained. In the approval request, the licensee stated that echelons 2 and 3 of DID are met through the use of fire prevention procedures, which maintain the functionality of the credited fire detection, and automatic and manual fire suppression systems. It is unclear how the fire prevention procedures maintain the functionality of active fire protection systems or the relevance of this when these features are not present. Clearly describe the fire prevention procedures and how the three elements of DID required by Section 1.2 of NFPA 805 are achieved in the fire areas described in the approval request.**

#### Response:

The revised Approval Request 5 included in this submittal clarifies how the three elements of DID required by NFPA 805 Section 1.2 are achieved. Specifically, echelon 1 is met through plant fire prevention procedures and is not adversely affected by the fire damper in series configurations. Echelon 2 is maintained due to the suppression systems located in the areas described in the approval request as well as manual detection and fire brigade manual suppression capability, which will limit the fire damage within these areas. Echelon 3 is met by rated fire barriers between adjacent areas, including the evaluated damper configurations as described in the approval request and evaluation 2701.620-000-169, which will prevent propagation of fire to other locations.

### **Safe Shutdown RAI 13.01**

- c) In LAR Table 4-3, "Summary of NFPA 805 Compliance Basis and Required Fire Protection Systems and Features," the licensee identified that "wrap on exposed ductwork" credited in licensing actions is a fire protection feature required to meet NFPA 805, Chapter 4, compliance in the fire areas that are described in the approval request. Explain why the two 1.5-hour fire rated dampers are not included in LAR Table 4-3 as required fire protection features**

**for these areas. Further, explain why "wrap on exposed ductwork" is not included as a required fire protection feature for fire area 2-ASP.**

**Response:**

LAR Table 4-3, "Summary of NFPA 805 Compliance Basis and Required Fire Protection Systems and Features," did not include the 1.5-hour fire rated dampers within the table because the dampers were considered to be general fire protection features similar to fire doors and penetration seals. LAR Table 4-3 did not include a list of all credited fire doors, fire dampers, or penetration seals, as these types of fire protection features are described in LAR Attachment A2 Records for the individual fire compartments.

As discussed in the response to SSD RAI 13.01(a), the "wrap on exposed ductwork" for fire area 2-ASP was not listed as a required fire protection feature in LAR Table 4-3 because there are not any configurations of exposed ductwork containing fire wrap within this fire area.

**Probabilistic Risk Assessment (PRA) RAI 01.f.ii.01.01**

**The responses to RAI 01.f. and RAI 01.f.ii.01 did not provide information that the NRC staff can use to conclude that the quantitative fire risk estimates exclude the impact of unrealistically low joint human error probabilities (HEPs) consisting of pairs of HEPs and longer strings. Instead, the responses indicate that many thousands of joint HEPs with unrealistically low probabilities may be embedded within the logic sequences frequencies. These low probabilities may lead to significant underestimates of affected sequence fire risks and have an indeterminate impact on the NFPA-805 change-in-risk estimates.**

**The reference to "two" HEPs in RAI 01.f.ii.01 is only a reflection that a "joint" HEP must have at least two individual HEPs and assigns no significance to pairs of HEPs. Longer strings of HEPs can occur frequently, and the error associated with simply multiplying individual probabilities in these longer strings can be many orders of magnitude.**

**The response states, in part, that the RISKMAN structure itself precludes dependency concerns; however, this is not entirely clear to the staff.**

**The staff has accepted applications, which have used the following:**

- 1. Minimum joint HEPs of 1E-05 within an accident sequence cutset; or**
- 2. Using joint HEPs in accident sequence cutsets:**

- a. Identifying the number of sequences (or the fraction of core damage frequency and large early release frequency) in which joint HEP values of less than 1E-05 contribute,**
- b. Describing the range of joint HEP values in sequences where the joint HEP value is less than 1E-05, and**
- c. Confirming that a justification (e.g., narrative) for each joint HEP value below 1E-05 has been documented, consistent with the scenario, and that the justification was developed by reviewing each applicable sequence and the joint HEP(s) contributing to the sequence.**

**Alternately, the Beaver Valley Power Station can use an alternative method to demonstrate that every joint HEP value less than 1E-05 is evaluated within the sequence that it is used, and confirm that an evaluation for each joint HEP is documented.**

**Please provide adequate justification that the quantitative fire risk estimates exclude the impact of unrealistically low joint HEPs. Summarize any review of dependency, in addition to a pairwise review, that is done on longer strings of HEPs to identify if a dependency exists between the full set of actions in these longer strings within the sequence.**

**Response:**

The previous response to PRA RAI 01.f.ii.01 on the thousands of joint HEPs (consisting of pairs of HEPs and longer strings) with values below 1E-5 may have seemed unrealistic, primarily due to using RISKMAN software-specific terminology and full non-minimal accident sequence results to answer the question. PRA RAI questions 01.f.ii and 01.f.ii.01 asked for specific examples of joint HEPs. FENOC provided the strings (multiple HEPs appearing in an accident sequence) of all HEPs potentially contributing to the failed split fractions of a full non-minimal accident sequence propagating through many linked event trees. Other licensees using different PRA software typically provide only the HEPs in an accident sequence that represent the minimal cutset resulting in core damage or large early release. The FENOC responses are appropriate in the context of the RISKMAN PRA software used at the Beaver Valley Power Station (BVPS), but the non-minimal, full sequence examples provided may seem unrealistically low when viewed from a different perspective with the expectation of accident sequence minimal cutsets.

To clarify, the BVPS human reliability analysis (HRA) dependency analysis was performed consistent with the guidance in NUREG-1792, "Good Practices for Implementing Human Reliability Analysis (HRA)," NUREG-1921, "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines – Final Report," and in accordance with established methods by increasing the HEP values to ensure lower joint HEPs appear in the reported split fraction minimal cutsets, then re-quantifying and saving the resulting accident sequences. Dependent HEPs are identified within the accident sequences.

Considerations of accident sequence minimal cutsets, including mutually exclusive relationships between operator action basic events, are effectively applied to the dependency analysis as necessary in the expert panel review of dependencies and in the final comparison against the 1E-05 floor value. As described in the response to PRA RAI 01.f.ii, joint HEPs identified in the dependency analysis (those containing two or more dependent HEPs) are then evaluated to determine the effects of the dependencies on each joint HEP, using both the general dependence tree and a detailed expert panel review.

The conclusion of the HRA dependency analyses is that the fire PRA models, as currently constructed, properly account for human failure event dependencies. Each joint HEP with a value less than 1E-05 has specific, documented justification why it is acceptable, consistent with the guidance in NUREG-1792.

#### **PRA RAI 08.01.01**

**The response to PRA RAI 08.01 explains that confined areas behind substantial cable tray stacks are excluded from evaluation of transient fires in the fire PRA. The response states:**

**These spaces are not part of any normal travel path through the plant. The crowded tray spacing and configuration completely encloses the area, making it extremely difficult to enter the space. The excluded locations in this fire compartment contain no equipment, significantly minimizing or eliminating maintenance and modification activities.**

**This exclusion is inconsistent with guidance in NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Final Report (NUREG/CR-6850, EPRI 1011989)." NUREG/CR-6850 states in Section 6.5.7.2 that areas not precluded by design or operation should be evaluated for transient fires, and although these areas are difficult to access, their access is not precluded. Additionally, transient combustibles placed in these areas could go unnoticed. NRC staff notes that Frequently Asked Question 12-0064, "Hot work/transient fire frequency: influence factors," provides guidance on the use of weighting factors for fire areas less likely to have transient combustibles. Include the evaluation of transient fires for these spaces in the integrated analysis in response to PRA RAI 03, dated March 4, 2015 (ADAMS Accession No. ML15049A507).**

#### **Response:**

Transient fires will be evaluated for the spaces behind substantial cable tray stacks. The revised fire modeling results will be included in the integrated analysis in response to PRA RAI 03.



Enclosure  
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Revised LAR Attachment L Approval Request 5 –  
NFPA 805 Chapter 3 Requirements for Approval

(9 pages follow)

**Approval Request 5****NFPA 805 Section 3.11.3 states:**

*“Fire Barrier Penetrations. Penetrations in fire barriers shall be provided with listed fire-rated door assemblies or listed rated fire dampers having a fire resistance rating consistent with the designated fire resistance rating of the barrier as determined by the performance requirements established by Chapter 4. (See 3.11.3.4 [sic] for penetration seals for through penetration fire stops.) Passive fire protection devices such as doors and dampers shall conform with the following NFPA standards, as applicable:*

- (1) NFPA 80, Standard for Fire Doors and Fire Windows*
- (2) NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems*
- (3) NFPA 101, Life Safety Code*

*Exception: Where fire area boundaries are not wall-to-wall, floor-to-ceiling boundaries with all penetrations sealed to the fire rating required of the boundaries, a performance-based analysis shall be required to assess the adequacy of fire barrier forming the fire boundary to determine if the barrier will withstand the fire effects of the hazards in the area. Openings in fire barriers shall be permitted to be protected by other means as acceptable to the AHJ.”*

FENOC is requesting approval for the use of fire damper configurations that do not contain a single 3-hour fire damper installed within the fire barrier. Many fire dampers located in BVPS-2 fire compartments contain two 1.5-hour fire dampers in series. These fire damper configurations consist of the following cases:

1. Two 1.5 hour fire dampers in series located within the fire barrier.
2. Two 1.5 hour fire dampers in series with one located within the fire barrier and one located close to, but outside of the fire barrier.

Although the fire damper assemblies were purchased as UL-labeled units, the manufacturer removed the UL label from the assemblies due to the untested configuration. A performance-based evaluation, 2701.620-000-169 “Analysis of Beaver Valley Power Station Unit 2 Ventilation Duct and Fire Damper Configurations”, was completed for the subject fire damper configurations and concluded that they are adequate and capable of withstanding the fire hazards associated within the areas identified in Table 1 below.

The areas containing configurations of two 1.5-hour fire dampers in series within the power block areas of BVPS-2 are listed below in Table 1:

| <b>Table 1</b>          |  |
|-------------------------|--|
| <b>Fire Compartment</b> | <b>Description</b>                                 |
| 2-ASP                   | Alternate Shutdown Panel Room                      |
| 2-CB-1                  | Instrument and Relay Room and Cable Spreading Room |

| <b>Table 1</b>          |  |
|-------------------------|--|
| <b>Fire Compartment</b> | <b>Description</b>                                 |
| 2-CB-5                  | Control Building Fan Room                          |
| 2-CB-6                  | West Communication Room                            |
| 2-CP-1                  | Condensate Polishing Building                      |
| 2-CV-1                  | West Cable Vault & Rod Control Area                |
| 2-CV-2                  | East Cable Vault & Rod Control Area                |
| 2-CV-3                  | Cable Vault & Rod Control Area                     |
| 2-CV-4                  | South Cable Vault & Rod Control Area               |
| 2-CV-5                  | North Cable Vault & Rod Control Area               |
| 2-CV-6                  | Cable Vault & Rod Control Relay Room               |
| 2-FB-1                  | Fuel Handling & Decontamination Building           |
| 2-PA-5                  | Auxiliary Building General Area, Elevation 773'-6" |
| 2-SB-1                  | Service Building Emergency Switchgear - Train A    |
| 2-SB-2                  | Service Building Emergency Switchgear - Train B    |
| 2-SB-6                  | Service Building Battery Room 2-1                  |
| 2-SB-7                  | Service Building Battery Room 2-3                  |
| 2-SB-8                  | Service Building Battery Room 2-2                  |
| 2-SB-9                  | Service Building Battery Room 2-4                  |
| 2-SG-1N                 | North Safeguards Area                              |
| 2-WH-1                  | Waste Handling Building                            |

#### **Basis for Request:**

Most fire damper configurations in the subject areas were identified to be within the fire barrier. As concluded in evaluation 2701.620-000-169, two 1.5-hour fire dampers in series located within the fire barrier are equivalent to that of a 3-hour fire damper. This conclusion is based on the following:

- In areas where the fire loading is greater than 1.5-hours, once actuated, the first fire damper will provide at least 1.5-hours of fire protection until it fails. The second fire damper will provide at least 1.5 -hours of additional fire protection, for a total of 3-hours fire protection for the two fire dampers in series. If the first fire damper fails (i.e., fire breaches through the damper), it will be in the closed position providing some level of shielding for the second fire damper from the full

effects of the fire event. Since the second fire damper will experience a lowered fire intensity, its fire-rating would likely be extended to a value greater than 1.5-hours providing additional defense-in-depth.

- The ventilation duct and fire damper configuration has been previously accepted by the NRC Staff in SSER-NUREG-1057 (Ref. pg. L-5) as equivalent to a 3-hour fire damper installed within the barrier interface.

Furthermore, additional defense in depth exists based on the following:

- Previous industry experience has indicated that not all combustibles within an area are likely to be consumed during fire events, which further shortens the required duration for the fire damper configuration to prevent fire spread to the adjacent fire compartment.
- In general, combustible materials located in each fire compartment are dispersed throughout, as opposed to being all located in one specific area, making it unlikely that the fire dampers will be directly exposed to the full fire severity represented by the total combustible loading of the area.

The guidance states that the ductwork from the fire barrier to and including the damper assembly should be enclosed with a fire-rated barrier material equivalent to the fire barrier. The majority of the areas in Table 1 comply with this requirement due to the equivalency of two 1.5-hour fire dampers to a 3-hour fire damper. Only a few areas were identified that contained one of the two 1.5-hour fire dampers outside of the fire barrier. These configurations were located in the following areas:

- Fire Barrier Between 2-ASP (Alternate Shutdown Panel Room) and 2-CV-3 (Cable Vault and Rod Control Area)
- Fire Barrier Between 2-WH-1 (Waste Handling Building) and 2-PA-5 (Auxiliary Building, Elevation 773'-6")

The fire dampers outside of the barrier are located in 2-CV-3 and 2-WH-1. Evaluation 2701.620-000-169 determined these fire damper configurations provided acceptable fire barriers for these areas. In both 2-ASP and 2-PA-5, one of the 1.5-hour rated fire dampers is located within the fire barrier and both areas contain combustible loading less than 0.5 hours and limited combustibles in the general vicinity of the fire dampers.

In 2-WH-1, one of the fire dampers is located outside of the barrier; however, the combustible loading is less than 0.5 hours which is shorter in fire duration than the 1.5-hour rating of the second fire damper installed in the barrier interface. Also, the ductwork and fire damper located outside of the fire barrier in 2-WH-1 will provide additional defense-in-depth.

In 2-CV-3, one of the fire dampers is located directly outside of the barrier interface from the 2-ASP ceiling. 2-ASP is located within 2-CV-3 at a partial elevation within the fire compartment. Permanent access to the area where the dampers are located is restricted, unless additional measures are taken (ladder, scaffold) to obtain access. Therefore, it is unlikely that a transient will be placed or a fire will ignite in close proximity to the ventilation duct and fire damper configurations. 2-CV-3 has a combustible loading of less than 2.0 hours; however, the area is very large with the

majority of combustibles located at the opposite side from where the fire dampers above 2-ASP are located. Thus, a fire event severe enough to actuate the fire dampers within the 2-CV-3/2-ASP barrier would likely only have a peak intensity at that location for a fraction of the total fire duration, then weaken as the fire event moves to igniting combustibles in other areas of the compartment. Additional defense-in-depth is also provided by the 1.5-hour fire dampers and ductwork located immediately outside of the barrier, resulting in reasonable assurance that an adequate fire barrier is provided.

As additional defense-in-depth, for configurations that contain ductwork connected to the dampers on each side of the barrier, the ductwork itself provides some level of fire protection. Certain configurations of ductwork of steel construction penetrating a fire barrier without a fire damper have been tested and shown to remain intact during exposure to a 1-hour fire duration on the ASTM E-119 time-temperature curve. Underwriters Laboratory (UL) tested HVAC duct which was 0.022" thick galvanized sheet steel, with an air-drop opening in the ductwork on the unexposed side of the barrier located 10' from the barrier. The UL results show that maximum temperatures on the unexposed side adjacent to the barrier were 499°F on uninsulated steel duct and 176°F on insulated steel duct. Maximum temperatures on the unexposed side, 9' from the barrier, were 175°F on uninsulated steel duct and 178°F on insulated steel duct. The testing demonstrates that the steel ducts without fire dampers are adequate and will not propagate a 1-hour fire through the barrier. In addition, the typical melting point for steel is between 2500-2800°F, which is greater than the ASTM E-119 furnace temperature of 1700°F during a 1-hour test, 1850°F during a 2-hour test, and 1925°F during a 3-hour test; therefore, the steel duct work will remain intact for longer durations. Typically, ductwork installed at BVPS is of a minimum thickness of 20 gauge (> 0.0359") which is thicker than the tested ductwork. Therefore, the robust construction of the steel ductwork provides a barrier to prevent the propagation of fire through the ductwork.

The NRC was made aware of the BVPS-2 fire damper in series configuration where one fire damper is installed within the plane of the fire barrier and the second fire damper is installed outside the plane of the fire barrier. This is described in NRC SSER - NUREG-1057, Supplement 3, dated November 1986, Section 9.5.1.4, "General Plant Guidelines:"

*In the SER, the staff stated that 3-hour fire-rated damper assemblies are provided in all ventilation ducts that penetrate 3-hour fire-rated barriers and that the damper assemblies are Underwriters Laboratories, Inc. (UL) labeled. By letter dated March 27, 1985, the applicant informed the staff that the 1 1/2-hour-rated fire damper assemblies are installed in series in each duct penetrating a 3-hour fire-rated barrier. Moreover, because the applicant redefined the fire area boundaries, some damper assemblies had to be installed within completed heating, ventilation, and air conditioning (HAVC)[sic] systems. These damper assemblies are located close to, but not within, the fire barrier penetration. To compensate for the damper location, the applicant enclosed the ductwork from the fire barrier to the damper assembly with 3- hour fire-rated barrier material.*

*In the March 27, 1985, letter, the applicant also informed the staff that although all of the fire damper assemblies were purchased as UL-labeled units, the*

*manufacturer had removed the UL label from the assemblies because they were not tested in the series configuration, and because they were not tested with carbon dioxide fire-suppression-system-actuated release devices.*

*For a fire to spread between fire areas through an HVAC system duct, it would have to burn through the duct in one fire area, through two 1 1/2-hour fire-rated dampers, and finally, through the duct in the adjoining area. In the staff's opinion, the two 1 1/2-hour fire-rated dampers will provide the equivalent fire resistance of one 3-hour fire-rated damper. The 3-hour fire-rated wrap around the ducts constitutes continuous fire-rated construction which will prevent fire spread through the ductwork between the fire barrier and the fire dampers. The release device is a plunger-operated pin that is in addition to the fusible link for damper actuation. The device is UL-listed for this service and, in the staff's opinion, will not reduce the effectiveness of the dampers actuated by the devices. The staff concludes that the fire dampers, as installed, will prevent fire spread from one fire area to another. The damper installation is, therefore, an acceptable deviation from Section C.5.a(4) of BTP CMEB 9.5-1.*

Additionally, the installation of 1-hour rated fire wraps was described in NRC SSER - NUREG-1057, Supplement 5, dated May 1987, Section 9.5.1.4, "General Plant Guidelines," that states:

*In SSER 3, the staff stated that some fire damper assemblies were located outside of the fire barrier because of a redefining of certain fire areas and that where this took place, the ductwork from the barrier to the fire damper assembly would be wrapped with 3-hour fire-rated material. Section C.5.a(4) of BTP CMEB 9.5-1 states that, 'penetration openings for ventilation systems should be protected by fire dampers having a rating equivalent to that required of the barrier.' In a meeting on November 5, 1986, the applicant stated that 3-hour wrap material could not be used because of weight limitations of the structural supports and stated that the ductwork would be wrapped with 1-hour rated material. This deviation was included in Amendment 14 to the FSAR following the meeting. Fire dampers requiring 1-hour wrap are used as fire barriers between Fire Areas PA-3 and PA-5, PA-4 and PA-5, SB-3 and SB-4, SB-4 and SB-5, and PT-1 and SG-1S. The fire loading is less than ½ hour on either side of the subject dampers. Smoke detection is provided in all areas where the 1-hour wrap will be installed and hose racks are provided for fire brigade use. It is expected that a fire would be detected in its incipient stage and the plant fire brigade would extinguish it using the installed hose racks. Providing additional structural support to the ductwork to accommodate 3-hour wrap would not significantly increase the level of fire safety. Therefore, wrapping ductwork from the barrier to the damper with 1-hour material is an acceptable deviation to Section C.5.a(4) of BTP CMEB 9.5-1.*

As described above, this approval request applies to other areas whose configuration is similar to the fire areas which received prior approval with 1 hour fire wrap extending from the fire barrier to and including the fire damper outside the plane of the fire barrier to create an equivalent 3-hour fire rated configuration. The primary difference in the configurations is that the majority of areas in this approval request contain fire damper

configurations that are within the fire barrier, with the exception of the few areas previously described, in which one of the two fire dampers in series is located outside of the fire barrier and no fire wrap is provided on the duct work between the dampers. These configurations do not pose a significant fire hazard in the areas listed below due to the following reasons:

- 2-ASP, 2-CV-2, 2-SB-1, 2-SB-2, 2-SB-6, 2-SB-7, 2-SB-8, 2-SB-9, and 2-SG-1N have low combustible loading (less than 1-hour) and are provided with fire detection and manual suppression. Additionally, the fire dampers are located within the fire barrier. The low combustible loading and presence of early warning detection ensures that a fire would be detected in its initial stage, thus the manual suppression from the fire brigade will minimize the likelihood of fire propagation through the barrier.
- Fire Compartments 2-CB-5, 2-CV-4, 2-CV-5, 2-FB-1, 2-PA-5, and 2-WH-1 have low combustible loading (less than 1-hour) and no credited fire detection or automatic suppression; however, manual suppression is available. Given the low combustible loading in these locations, an unmitigated fire would not challenge the fire rating provided by the fire damper configurations. Therefore, fire detection is not required to maintain the integrity of the fire barrier. Fire dampers are located within the fire barrier (with the exception of 2-WH-1), and the low combustible loading and manual suppression from the fire brigade will minimize the likelihood of fire propagation through the barrier. 2-WH-1 contains fire damper configurations with one fire damper outside of the barrier plane, which has been determined to be acceptable as described above and in evaluation 2701.620-000-169.
- Fire Compartment 2-CP-1 has combustible loading (less than 1.5 hours) and no credited fire detection or automatic suppression; however, manual suppression is available. Given the combustible loading in this location, an unmitigated fire would not challenge the fire rating provided by the fire damper configurations. Additionally, 2-CP-1 is a large fire compartment (i.e., the entire compartment spans from elevation 722'-6" to 774'-6") and combustible loading is calculated for the entire 2-CP-1 compartment. The fire damper configurations only exist on the 774'-6" elevation and this area of 2-CP-1 is not a safety significant area nor is the adjacent area (2-WH-1). Therefore, fire detection is not required to maintain the integrity of the fire barrier. Fire dampers located within the fire barrier, combustibles loading of less than 1.5 hours, and manual suppression from the fire brigade will minimize the likelihood of fire propagation through the barrier.
- Fire Compartments 2-CV-3 and 2-CV-6 have combustibles loading less than 1.5 hours and are provided with fire detection, automatic suppression, and manual suppression. It is expected that a fire in these areas would be detected in its initial stage and the early intervention from the fire brigade with manual suppression would minimize the likelihood of fire propagation through the barrier. Additionally, the fire dampers are located within the fire barrier (with the exception of a few configurations in 2-CV-3), along with the fixed automatic suppression provides additional defense-in-depth and reasonable assurance that

the growth of postulated fires will be controlled prior to fire propagating through the barrier. There are a few fire damper configurations in 2-CV-3 that have one fire damper outside of the barrier plane, which has been determined to be acceptable as described above and in evaluation 2701.620-000-169.

- Fire Compartments 2-CB-1 and 2-CV-1 have combustible loading less than 2.25 hours and are provided with fire detection, automatic suppression, and manual suppression. It is expected that a fire in these areas would be detected in its initial stage and the early intervention from the fire brigade with manual suppression would minimize the likelihood of fire propagation through the barrier. Additionally, the fire dampers are located within the fire barrier and fixed automatic suppression provides additional defense-in-depth and reasonable assurance that the growth of postulated fires will be controlled prior to fire propagating through the barrier.
- Fire Compartment 2-CB-6 has a combustible loading of less than 2 hours. Early warning fire detection is credited in the compartment and manual suppression is available. Additionally, the fire dampers are located within the fire barrier. Given the fire detection system and the near proximity of 2-CB-6 to the continuously occupied Control Room, it is expected that a fire would be detected and responded to quickly by the fire brigade to initiate suppression activities within 30 minutes, which will minimize the likelihood of fire propagation through the barrier.

#### **Acceptance Criteria Evaluation:**

##### **Nuclear Safety and Radiological Release Performance Criteria:**

Evaluation 2701.620-000-169 confirms that the use of two 1.5-hour fire dampers in series in steel ductwork does not adversely affect the nuclear safety performance criteria. As described in the evaluation, the majority of areas identified in Table 1 contain fire damper configurations consisting of two 1.5-hour fire dampers within the fire barrier, which was concluded to be equivalent to a 3-hour fire damper. The few areas that contain one of the two series 1.5-hour fire dampers outside of the barrier are further justified as described above and in evaluation 2701.620-000-169.

For a fire to spread from one compartment to another, it would have to propagate through two 1.5-hour rated dampers and in some cases through steel ductwork, which provides an additional level of fire protection. UL testing has demonstrated that the steel ducts without fire dampers are adequate and will not propagate an one-hour fire through the barrier. The two 1.5-hour fire-rated dampers in series will provide the equivalent fire resistance of one 3-hour fire-rated damper and the properties of steel demonstrate that the steel will stay intact. The fire damper configurations at BVPS-2 have no adverse impact on the radiological release performance criteria, since there will be no adverse impact on fire suppression activities. The radiological release review was performed based on the potential location of radiological concerns and is not dependent on the type of fire dampers or fire damper configurations used for the ventilation ductwork.



**Safety Margin and Defense-in-Depth:**

The fire damper configurations at BVPS-2 within the power block areas do not introduce additional fire hazards and the safety margin is maintained due to fire barrier rating and capability including the evaluated fire damper configurations, mitigating fire protection systems and features, availability of the fire brigade, and the ability to maintain safe and stable conditions. Therefore, the safety margin inherent in the analysis for the event of a fire has been preserved.

The three echelons of defense-in-depth are:

- (1) To prevent fires from starting;
- (2) Rapidly detect, control and extinguish fires that do occur, thereby limiting damage;
- (3) Provide adequate level of fire protection for systems and structures so that a fire will not prevent essential safety functions from being performed;

Per NFPA 805 Section 1.2, defense-in-depth is achieved when an adequate balance of each of these elements is provided.

Echelon 1 is met through plant fire prevention procedures and is not adversely affected by this configuration. Echelon 2 is maintained due to the suppression systems located in the areas as identified above. Additionally, manual detection and fire brigade manual suppression capability will limit the fire damage in these locations. Echelon 3 is met by rated fire barriers between adjacent areas, including the evaluated damper/ductwork configurations, which will prevent the propagation of fire to other locations. In addition, maintenance procedures are in place for the performance of periodic preventive mechanical maintenance of fire dampers. For the subject plant areas identified in Table 1, the deviation from NFPA 805 Section 3.11.3 does not result in compromising the credited fire protection systems or features, or post-fire safe shutdown capability.

A balance of the elements is provided; therefore, defense-in-depth is achieved.

**Conclusion:**

NRC approval is requested for fire damper configurations that contain two 1.5-hour fire dampers in series for ventilation ductwork in the power block areas listed in Table 1. The types of 1.5-hour damper configurations are described in the above analysis, with the technical details provided in evaluation 2701.620-000-169, "Analysis of Beaver Valley Power Station Unit 2 Ventilation Duct and Fire Damper Configurations". Based on the above analysis and evaluation 2701.620-000-169, the low level of risk encountered by maintaining this current configuration is acceptable. Additionally, similar configurations have previously been approved by the NRC.

BVPS has determined that the performance-based approach satisfies the following criteria:

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

- (B) Maintains safety margins; and
- (C) Maintains fire protection defense-in-depth (fire prevention, fire detection, fire suppression, mitigation, and post-fire nuclear safety capability).