UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 19, 2010

Mr. Paul A. Harden
Site Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Mail Stop A-BV-SEB1
P.O. Box 4, Route 168
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT NO. 2 - REQUEST FOR ADDITIONAL INFORMATION RE: SPENT FUEL POOL RERACK LICENSE AMENDMENT (TAC NO. ME1079)

Dear Mr. Harden:

By letter dated April 9, 2009, as supplemented by letters dated June 15, 2009, and January 18, 2010, FirstEnergy Nuclear Operating Company (licensee) submitted a license amendment for Beaver Valley Power Station, Unit No. 2 (BVPS-2). The proposed amendment would modify Technical Specifications (TSs) to support the installation of high density fuel storage racks in the BVPS-2 spent fuel pool.

The Nuclear Regulatory Commission (NRC) staff is reviewing the submittals and has determined that additional information is needed to complete its review. The specific questions are found in the enclosed request for additional information (RAI). The NRC staff is requesting a response to the RAI within 45 days of receipt.

The NRC staff considers that timely responses to RAIs help ensure sufficient time is available for NRC staff review and contribute toward the NRC goal of efficient and effective use of staff resources.

If you have any questions regarding this issue, please contact me at (301) 415-1016.

Sincerely,

Nadiyah S. Morgan, Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-412

Enclosure:
RAI

cc w/encl: Distribution via Listserv

REQUEST FOR ADDITIONAL INFORMATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE SPENT FUEL POOL RERACK LICENSE AMENDMENT

FIRSTENERGY NUCLEAR OPERATING COMPANY

FIRSTENERGY NUCLEAR GENERATION CORP.

OHIO EDISON COMPANY

THE TOLEDO EDISON COMPANY

BEAVER VALLEY POWER STATION, UNIT NO. 2

DOCKET NO. 50-412

By letter dated April 9, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML091210251), as supplemented by letters dated June 15, 2009 (ADAMS Accession No. ML091680614) and January 18, 2010 (ADAMS Accession No. ML100191805), FirstEnergy Nuclear Operating Company (licensee) submitted a license amendment for Beaver Valley Power Station, Unit No. 2 (BVPS-2). The proposed amendment would modify Technical Specifications (TSs) to support the installation of high density fuel storage racks in the BVPS-2 spent fuel pool (SFP). In order to complete the review, the Nuclear Regulatory Commission (NRC) staff needs the following additional information:

Mechanical and Civil Engineering Branch Review

1. Table 1.9-1 of the BVPS-2 Updated Final Safety Analysis Report (UFSAR) indicated that, for the design of other Seismic Category I Structures, Section 3.8.4 of the Standard Review Plan (NUREG-0800 or SRP) Revision 1, is the guidance associated with the design of BVPS-2. Section 9.1.2 of the BVPS-2 UFSAR indicates (through BVPS-2 UFSAR Section 3.8.4) that the SFP, SFP liner, and associated structures, including the SFP racks, are Seismic Category I structures designed against the criteria found in SRP Section 3.8.4, Revision 1. Enclosure C of Reference 1 indicates that Section 3.8.4 of the SRP, including Appendix D, was utilized in the analysis of the replacement SFP racks; however, the revision used by Holtec is not indicated in the Reference section of this report. Please indicate the revision of SRP Section 3.8.4 criteria for which the analyses were compared against and if this revision differs from the BVPS-2 licensing basis, please provide justification regarding any variations.

2. In response to the NRC request for additional information (RAI) regarding the impact load analysis, the licensee indicated in Response 11 of Reference 2, that upon review of the original analyses in support of developing the RAI response, the reinforcement bars that are located near the top portion of the proposed racks were altered due to non-conservatisms present in the original analyses used in Reference 1. The NRC staff requests the following information related to the RAI Question No. 11 response:

   a) Describe the non-conservatisms identified during the review of the impact load analyses performed in support of the response to the aforementioned RAI.

   b) Based on the non-conservatisms identified, RAI response 11.c on page 17 of Reference 2, indicated that additional reinforcement was added to the top of the rack structures. Please indicate whether a revised Whole Pool Multi-Rack (WPMR) analysis was performed with the revised design to determine a revised value for the maximum impact force utilized in the LS-DYNA analysis performed to demonstrate the structural adequacy of the rack structures. If a new WPMR analysis was not performed, provide justification indicating what factors negated the need to re-perform a WPMR analysis for the revised rack structures.

   c) Section 5.6.10.1 of Enclosure C in Reference 1 stated that the allowable local buckling stresses in the fuel cell walls is obtained using classical plate buckling analysis, as taken from Section 9.2 of *Theory of Elastic Stability* (Timoshenko and Gere). Revision 1 of SRP Section 3.8.4, Appendix D, states that when the new SFP rack design considers buckling loads, the criteria provided in American Society of Mechanical Engineers Code, Section III, Division 1, Appendix XVII should limit the structural acceptance criteria. Discuss the relationship between the buckling criteria used in Section 5.6.10.1 and the criteria provided in the SRP and provide justification that the buckling criteria used in the BVPS-2 re-rack analysis provided an adequate level of conservatism.

3. Page 5-22 of Enclosure C of Reference 1 indicated that all seven simulations performed for the proposed re-rack of the BVPS-2 SFP modeled fully-loaded racks. Page 5-8 of Enclosure C of Reference 1 indicated that partially-loaded racks can be modeled within DYNARACK. Given that interim conditions will exist in which the BVPS-2 SFP is partially-loaded with various rack configurations, provide a justification that the fully-loaded rack condition induces the most limiting conditions with respect to the seismic analysis and the structural adequacy of the SFP, the SFP liner, the SFP racks, the SFP cask pit, and the SFP cask pit platform.

4. Section 2.3 of Enclosure C of Reference 1 indicated the codes and standards applicable to the proposed re-rack of the BVPS-2 SFP. In this section, Electric Power Research Institute Report NP-60415L, *A Methodology for Assessment of Nuclear Power Plant Seismic Margin*, Revision 1, was indicated as one of the codes and standards documents utilized in the analysis for the proposed re-rack. Discuss the applicability of this report to the current licensing basis of BVPS-2 and its applicability to the design and analysis of the proposed re-rack.

5. Section 7.5.3 of Enclosure C of Reference 1, the analyses summary of the "Rack Drop Event" mechanical accident, only discussed the local damage of the SFP floor slab in the

event of rack drop. Provide information relative to the global behavior of the SFP floor slab in absorbing the imparted energy.

6. Section 3.8.4 of the SRP and the NRC position paper on spent fuel storage and handling applications (Reference 3) indicated that differential thermal expansion loads under normal conditions (T_o) and differential thermal expansion loads under abnormal conditions (T_a) are to be used in combination with primary stresses in loading combinations, when determining the structural adequacy of the SFP rack structures. Section 5.6.10.2 of Enclosure C of Reference 1 stated that thermal stresses are not combined with primary stresses from other loading conditions for welds at cell-to-cell joints in the replacement racks at BVPS-2. Please provide justification for evaluating the secondary and primary stresses separately in the structural analyses of the cell-to-cell welds for the proposed replacement rack structures. Additionally, please confirm that the guidance of SRP 3.8.4 and Reference 3, relative to combining thermal and primary loads, has been considered in the BVPS-2 SFP re-rack analysis and design.

7. Section 5.8 of Enclosure C of Reference 1, "Bearing Pad Analysis," indicated that the design code of record used in the structural qualification of the three bearing pad types is American Concrete Institute (ACI) 349-85, *Code Requirements for Nuclear Safety Related Concrete Structures*. Discuss the applicability of ACI 349-85 to the BVPS-2 current licensing basis.

8. Section 5.9 of Enclosure C of Reference 1, "Interface Loads on SFP Structure," included a table summarizing the SFP structure safety factors following the proposed re-rack of the pool at BVPS-2. As stated in this section, the safety factors have been determined based on the moment capacity of the individual walls and slab of the pool structure. Please provide a tabulated summary of the safety factors based on one-way and two-way shear capacity of the aforementioned elements or provide justification for utilizing only moment capacities as the structural qualification measure. Additionally, provide more information relative to the temperature rise in the pool and its effects on determining the BVPS-2 safety factors for individual walls, the slab, and the liner of the SFP structure.

9. Section IV(1)(b) of Reference 3 specified that an inclined drop of a fuel assembly must be postulated for the purposes of assessing the structural adequacy of the rack structures. While it is understood by the NRC staff that the impact of the vertical component of an inclined fuel assembly drop remains bounded by the shallow drop scenario and the kinetic energy imparted on the rack is maximized when the fuel assembly is completely vertical, provide justification regarding the effects of the horizontal component of impact of an inclined fuel assembly, i.e., the effects on the lateral rack displacements and/or deformation.

10. Section IV(3) of Reference 3 specified that seismic excitation along three orthogonal directions should be imposed simultaneously when the new racks are subjected to seismic loading. Confirm that seismic excitation along three orthogonal directions were imposed simultaneously for the proposed new rack design and analysis.

11. Section 5.6.7(a) of Enclosure C in Reference 1 stated that a simple conversion factor, based on area ratios, was used to determine weld stresses using a corresponding stress factor in the rack material. The stress factor R6, for example, is for the combined flexure and tension (or compression) condition. Ordinarily, section modulus is used to determine flexural stresses and area is used to determine axial stress. Provide some information to validate

the conservatism within the aforementioned approach of converting stress factors for members to welds, using a factor based on area ratios, to take into account both flexural stresses and axial stresses.

12. Section 7.5.4 of Enclosure C in Reference 1, "Uplift Force Evaluation," stated that the fuel racks are adequate to withstand 5000 pounds uplift load, due to a stuck fuel assembly. Section 9.1.4.2.3.2 of the BVPS-2 UFSAR indicated that each of the two trolley and hoist sets on the motor-driven platform crane in the BVPS-2 fuel-handling area has a capacity of 10 tons. Confirm that adequate administrative controls or other means are in place to ensure that, in the actual event of a stuck fuel assembly, the BVPS-2 motor-driven platform crane uplift force will be maintained below this value, such that the rack will continue to meet the acceptance criteria outlined in Reference 3 for postulated fuel handling accidents (FHAs).

13. Section 5.7 of Enclosure C in Reference 1, "Cask Pit Rack Platform Analysis," stated that a single rack analysis is performed to evaluate the seismic loads induced on the cask pit rack platform. Due to the dynamic characteristics of the cask pit platform, there may be possible amplification of seismic input motion. Provide justification relative to the decoupling of the rack and the cask pit platform in the seismic analysis.

14. Section 5.8 of Enclosure C in Reference 1, "Bearing Pad Analysis," indicated that a number of the existing beam structures resting on the BVPS-2 SFP will be providing structural support to a few of the new racks. Please provide information relative to this beam structure (configuration, connection of rack to the beam (if any), load path to the supporting concrete floor, safety margins, etc.), such that a determination can be made regarding the structural adequacy of these beam structures.

15. Considering the dynamic model of the fuel building, as shown in Figure 3.7B-10 of the BVPS-2 UFSAR, discuss the effects of SFP reracking on the overall seismic analysis of the fuel-handling building.

16. As stated in Section 3.8.4.1.4 of the BVPS-2 UFSAR, the fuel building is supported on a continuous foundation mat. Please discuss the effects of the SFP re-racking on the soil bearing pressure, overall sliding and overturning of the building, and the associated safety factors determined in accordance with the BVPS-2 current licensing basis.

17. In response to an NRC RAI regarding the analysis methodology for the shallow drop accident (Response 3.c, Reference 2), it was indicated that the true stress-strain relationship was used as an input to the LS-DYNA computer code to model the replacement rack material behavior under the shallow drop loading conditions. Furthermore, Response 2 of Reference 2 indicated that the true stress-strain curve used in this analysis yields a failure strain of 1.204. Please provide justification regarding the appropriateness of using a failure strain magnitude that does not account for standard deviations from the mean failure strain, triaxiality factors and safety factors, which must be present when performing these design basis evaluations using a strain based criteria.

18. Table 5.4.3 of Enclosure C in Reference 1 provided the material property data (SA-240-304L Stainless Steel at 200 degrees Fahrenheit) for the rack material used in the rack

structural analyses in support of Reference 1. Table 7.4.2 of Enclosure C in Reference 1 also included material properties data for various materials used in the mechanical accident analyses performed. This table also included data for the proposed rack design material (SA240-304L Stainless Steel). However, Table 7.4.2 contains material data which does not appear to be consistent with the material data for the rack structural materials in Table 5.4.3. Please provide justification for this discrepancy and confirm that the material data used in both the rack structural analyses (Section 5.0 of Enclosure C in Reference 1) and the mechanical accident analyses (Section 7.0 of Enclosure C in Reference 1) is consistent with the spent fuel pool environment following the proposed rerack.

19. Table 7.4.2 of Enclosure C in Reference 1 provided the concrete properties utilized for the mechanical accidents performed. Additionally, Section 5.9 of Enclosure C of Reference 1 outlined the analyses performed to demonstrate the BVPS-2 SFP structure's ability to withstand the additional loading imposed by the proposed reracking. However, the concrete properties associated with the analyses summarized in Section 5.9 are not provided. Section 3.8.4.6 of the BVPS-2 UFSAR indicates that, "The 28-day minimum compressive strength of the concrete is predominantly 3,000 psi in these [Other Seismic Category I] structures, with 4,000 and 5,000 psi being used in a limited number of areas." Please confirm that concrete properties utilized in the proposed reracking LAR are in compliance with the BVPS-2 licensing basis.

20. As discussed in Section 5.4.2.1 of Reference 1, a simplified 3-D lumped mass dynamic model of the single rack structure is used in the whole pool multi-rack analysis. Response 6 in Reference 2 indicated that the use of a single-beam and two-node to model a BVPS-2 rack module is justified because the lowest natural frequency of the rack cellular structure is above 33 Hertz. Please provide more information relative to benchmarking of this model against a detailed finite element model to demonstrate the adequacy of the simplified mass model to predict the anticipated time history seismic responses.

21. Section 7.2 of Enclosure C in Reference 1 indicated that the resistance of the rack to deformation at the peripheral surfaces is much less than the interior panels which make up the replacement racks. Please provide justification for concluding that the outer panels are the most limiting locations for the shallow drop FHA scenario given that the welded interior panels may be more susceptible to the crushing forces due to a dropped fuel assembly, due to a lower failure strain value of the weld material (Type 308 Stainless Steel) as compared to the base material (Type 304 Stainless Steel).

22. Reference h.18 in Section 2.3 of Enclosure C in Reference 1 indicated that guidance from Revision 1 of Regulatory Guide (RG) 1.124, "Service Limits and Loading Combinations for Class 1 Linear-Type Supports" was utilized in the development of the LAR submitted in support of the proposed spent fuel pool rerack at BVPS-2. However, Section 1.0 of Reference 1 makes no mention of the use of RG 1.124 as it relates to the structural acceptance criteria utilized in the design of the proposed racks for BVPS-2. Please confirm that the guidance on the use of Subsection NF of Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code found in RG 1.124 was considered in Reference 1.

Accident Dose Branch Review

23. In Section 7.5.5, "Fuel to Fuel Drop Event", of Reference 1, Enclosure B, it is stated that the Fuel-to-Fuel Drop Event is bounded by the existing FHA analysis. Please provide additional information regarding how many feet of water coverage there will be above the damaged fuel during the postulated Fuel-to-Fuel Drop event, and the associated decontamination factor, compared to that of the design-basis FHA analysis.

References

1. Letter from P. P. Sena, FirstEnergy Nuclear Operating Company, to NRC Document Control Desk, "Beaver Valley Power Station, Unit No. 2 Docket No. 50-412, License No. NPF-73, License Amendment Request No. 08-027, Unit 2 Spent Fuel Pool Rerack," with Enclosure B (proprietary) and Enclosure C (non-proprietary), "Licensing Report for Beaver Valley Unit 2 Rerack," dated April 9, 2009. (ADAMS Accession Nos. ML091210251 (letter) and ML091210263 (Enclosure C))
2. Letter from R. A. Lieb, FirstEnergy Nuclear Operating Company, to NRC Document Control Desk, "Beaver Valley Power Station, Unit No. 2 Docket No. 50-412, License No. NPF-73, Response to Request for Additional Information for License Amendment Request No. 08-027, Unit 2 Spent Fuel Pool Rerack (TAC No. ME1079)," dated January 18, 2010. (ADAMS Accession No. ML100191805)
3. Letter from B. K. Grimes, Nuclear Regulatory Commission, Position Paper: "Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978.

If you have any questions regarding this issue, please contact me at (301) 415-1016.

Sincerely,
/RA/

Nadiyah S. Morgan, Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-412

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RAI

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*See memos dated February 24 and March 12, 2010
**Via email

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