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March 21, 2011
L-11-101

10 CFR 50.90

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

SUBJECT:
Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
Supplemental Information for Beaver Valley Power Station Unit 2 Spent Fuel Pool Rerack License Amendment Request (TAC No. ME1079)

By correspondence dated April 9, 2009 (Reference 1), as supplemented by correspondence dated June 15, 2009 (Reference 2), January 18, 2010 (Reference 3), March 18, 2010 (Reference 4), May 3, 2010 (Reference 5), May 21, 2010 (Reference 6), June 1, 2010 (Reference 7), August 9, 2010 (Reference 8), October 7, 2010 (Reference 9), October 18, 2010 (Reference 10), January 5, 2011 (Reference 11), February 18, 2011 (Reference 12), February 18, 2011 (Reference 13), and March 18, 2011 (Reference 14), FirstEnergy Nuclear Operating Company (FENOC) requested a license amendment for Beaver Valley Power Station, Unit No. 2 (BVPS-2). The proposed amendment would revise the Technical Specifications to support the installation of high density fuel storage racks in the BVPS-2 spent fuel pool.

During February 28, 2011, March 9, 2011, and March 11, 2011 teleconference meetings, FENOC discussed supplemental information related to References 11 and 12. Supplemental information discussed during the teleconference meetings is provided in Attachment 1. Attachment 2 contains a summary of revisions to Chapters 5 and 7 of the Holtec International Licensing Report that contained information that had not been previously docketed.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – FENOC Fleet Licensing, at 330-761-6071.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 21, 2011.

Sincerely,

Paul A. Harden

Attachments:
1. February 28, 2011, March 9, 2011, and March 11, 2011 Supplemental Information
2. Summary of Revisions to Chapters 5 and 7 from Revision 8 of the Holtec International Licensing Report

References:

1. FENOC Letter L-09-086, "License Amendment Request No. 08-027, Unit 2 Spent Fuel Pool Rerack," dated April 9, 2009 (Accession No. ML091210251).
2. FENOC Letter L-09-162, "Additional Technical Information Pertaining to License Amendment Request No. 08-027 (TAC No. ME1079)," dated June 15, 2009 (Accession No. ML091680614).
3. FENOC Letter L-10-001, "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 (Accession No. ML100191805).
4. FENOC Letter L-10-082, "Response to NRC Staff Request for Additional Information Regarding Criticality Analyses Supporting a Spent Fuel Pool Rerack for Unit 2 (TAC No. ME1079)," dated March 18, 2010 (Accession No. ML100820165).
5. FENOC Letter L-10-121, "Response to Request for Additional Information Related to Beaver Valley Power Station Unit No. 2 Spent Fuel Pool Rerack License Amendment Request (TAC No. ME1079)," dated May 3, 2010 (Accession No. ML101260059).
6. FENOC Letter L-10-151, "Response to Request for Additional Information Related to Beaver Valley Power Station Unit No. 2 Spent Fuel Pool Rerack License Amendment Request (TAC No. ME1079)," dated May 21, 2010 (Accession No. ML101460057).
7. FENOC Letter L-10-130, "Remainder of Responses to NRC Staff Request for Additional Information Regarding Unit 2 Spent Fuel Pool Rerack Criticality Analyses (TAC No. ME1079)," dated June 1, 2010 (Accession No. ML101610118).

8. FENOC Letter L-10-235, "Response to Request for Additional Information for License Amendment Request No. 08-027, Unit 2 Spent Fuel Pool Rerack (TAC No. ME 1079)," dated August 9, 2010 (Accession No. ML102240256).
9. FENOC Letter L-10-282, "Supplemental Response to Request for Additional Information Related to Beaver Valley Power Station Unit No. 2 Spent Fuel Pool Rerack License Amendment Request (TAC No. ME 1079)," dated October 7, 2010 (Accession No. ML102860124).
10. FENOC Letter L-10-275, "License Amendment Request for Unit 2 Spent Fuel Pool Rerack (TAC No. ME1079)," dated October 18, 2010 (Accession No. ML102940454).
11. FENOC Letter L-10-329, "Supplemental Information for Beaver Valley Power Station Unit 2 Spent Fuel Pool Rerack License Amendment Request (TAC No. ME1079)," dated January 5, 2011 (Accession No. ML110110217).
12. FENOC Letter L-11-024, "Chapters 5 and 7 of Holtec Licensing Report, In Support of License Amendment Request for Unit 2 Spent Fuel Pool Rerack (TAC No. ME1079)," dated February 18, 2011 (Accession No. ML110530463).
13. FENOC Letter L-11-057, "Responses to NRC Staff Request for Additional Information Regarding Unit No. 2 Spent Fuel Pool Rerack Criticality Analyses (TAC No. ME1079)," dated February 18, 2011 (Accession No. ML110540328).
14. FENOC Letter L-11-103, "Supplement to Beaver Valley Power Station Unit No. 2 Spent Fuel Pool Rerack Amendment Request (TAC No. ME1079)," dated March 18, 2011.

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

By correspondence dated April 9, 2009, the FirstEnergy Nuclear Operating Company (FENOC) submitted to the Nuclear Regulatory Commission (NRC) a license amendment request (LAR) related to the Beaver Valley Power Station, Unit No. 2 (BVPS-2) spent fuel pool (SFP) storage racks. FENOC provided supplemental information to the NRC staff on January 5, 2011. Additionally, Chapters 5 and 7 from Revision 8 of the Holtec International Licensing Report (Licensing Report) were submitted on February 18, 2011. On February 28, 2011, March 9, 2011, and March 11, 2011 teleconference meetings were held between the NRC staff and FENOC to discuss the January 5, 2011 and February 18, 2011 submittals. The NRC questions are provided below in bold text and are followed by the FENOC response.

1. Clarify what the design code of record for the SFP liner is (January 5, 2011, submittal states that it is ASME Section III -Subsection NA). NRC staff is not confident that this is the correct code of record, given that Subsection NA is entitled, "General Requirements."

Per the January 5, 2011 response to Request for Additional Information (RAI) 8 Sub question 4, "At the time the Unit 2 spent fuel pool was designed and constructed, no existing code governed the design of the spent fuel pool liners. It was elected to use design criteria from ASME [American Society of Mechanical Engineers], Section III, Division 1 – 1974 Edition, Nuclear Plant Components, Subsection NA with Addenda up to Summer 1976 as applicable..."

The calculated maximum stresses induced in the liner were compared against stress limits located in Subsection NA. The portions of Subsection NA referenced in the original design basis calculation included Appendix I, Appendix XIII, and Appendix XIV. Mechanical properties and permissible stress intensities were referenced from Appendix I of Subsection NA. The basic stress limits were used from Appendix XIII of Subsection NA. If calculated stresses exceeded the stress limits, then the procedure in Appendix XIV of Subsection NA was used to evaluate fatigue.

The SFP is designated as non-safety related, Seismic Category II. The design of the SFP liner meets the criteria of Section III.3.B of the Standard Review Plan (SRP), Section 9.1.2, "New and Spent Fuel Storage." The requirements of SRP 9.1.2 are such that structural integrity can be demonstrated. As a means to demonstrate compliance with SRP 9.1.2, the design analysis guidance from Subsection NA has been conservatively applied to the SFP liner to show that the liner remains intact under the bounding load conditions.

The stresses induced in the SFP floor liner due to the seismic interactions with the SFP racks plus thermal loading were compared against the original design basis limits (that is, Subsection NA of the ASME Code Section III, 1974 Edition). The thermal loading applied to the liner is based on the peak SFP bulk water temperature following an abnormal full core offload. The minimum calculated safety factor for the liner is 1.29.

Since the seismic loads on the liner are time varying and repetitive in nature, a fatigue assessment of the liner was also performed following the methodology of Appendix XIV of Subsection NA. The fatigue analysis consisted of the following steps:

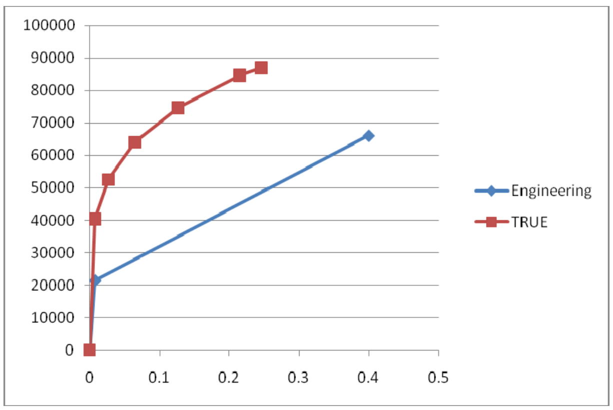
i) a finite element analysis of the liner was performed using ANSYS to determine the peak stress intensity in the liner due to seismic plus thermal loading;
ii) the number of load cycles was conservatively estimated for one safe shutdown earthquake (SSE) and a minimum of five operating basis earthquake (OBE) events based on the pedestal force time history results obtained from the whole pool multi-rack (WPMR) analysis;
iii) the cumulative usage factor for the liner was calculated based on the peak stress intensity from (i), the number of load cycles from (ii), and the fatigue life data provided in Appendix XIV of Subsection NA.

The calculated cumulative usage factor for the liner is 0.379, which is well below the allowable limit of 1.0 per Appendix XIV of Subsection NA and indicates that there is no credible risk of a liner fatigue failure due to one SSE and five OBE events.

For the postulated rack drop event, the structural integrity of the SFP liner was evaluated in accordance with the requirements of the 1978 Office of Technology (OT) Position Paper (Generic Letter 78-11), “Review and Acceptance of Spent Fuel Handling and Storage Applications,” and Appendix D to SRP, Section 3.8.4, “Other Seismic Category I Structures.”

2. Given that RAI 17 was focused on the evaluation performed for the shallow drop scenario, additional clarification regarding the use of stress-strain curve in the deep drop accident scenario is necessary.

The engineering stress-strain curve was used to represent the welds for the deep drop accident. This curve is conservative for this application. A comparison was made between the engineering stress-strain curve used for the deep drop analysis versus the true stress-strain curve used for the shallow drop analysis. For the deep drop analysis (which used engineering stress-strain), the failure strain limit is input as 0.4. For the shallow drop analysis (which used true stress-strain), the failure strain limit is input as 0.2465 for welds. The area under each curve represents the strain energy that can be absorbed prior to failure. A comparison of the curves is provided below. The strain energy determined from the engineering stress-strain curve is nearly equal to that of the true stress-strain curve, with the true-stress strain curve having slightly more capacity.



Strain Energy
True - 17289 Lbf-in/in3
Engr. – 17247 Lbf-in/in3

For the deep drop event, the limiting component is the cell-to-baseplate weld. The strength of the cell-to-baseplate welds is the determining factor for the deep drop event. Since the strain energy associated with the engineering stress-strain curve is almost identical with that of the true stress-strain curve, the length of cell-to-baseplate welds that plastically deform up to the failure limit would be the same as the current solution.

Subsequently, the limiting deep drop analysis (scenario 1) was reperformed using the true stress-strain curves for both the weld and the base material from the shallow drop analysis. The failure strain limits are also the same as those used in the shallow drop analysis. The material properties are defined in Section 7.4, “Mathematical Model,” of the Licensing Report. The peak baseplate vertical deflection remains the same as shown in Figure 7.5.3 (that is, 1.837 inches). In other words, the results are consistent with the strain energy comparison between the true stress-strain curve and the engineering stress-strain curve. Although the above evaluation supports the use of the engineering stress-strain curve, the updated analysis utilizing the true stress-strain curves will be used as the licensing basis.

3. Discuss the rationale for the fatigue analysis performed for the new rack structure, as it relates to the post-earthquake inspection requirements for these structures.

As noted in Licensing Report Section 5.6.9, "Assessment of Rack Fatigue Margin," the highest stress location of the rack is at the pedestal to rack baseplate junction. During a seismic event the rack produces loading on the support pedestals. Since the lower region of the rack is inaccessible for inspection following a seismic event, a fatigue analysis of the rack focusing on the pedestal to baseplate region was performed using the methodology provided in ASME Section III, Subsection NB. Detailed analytical modeling encompassed the pedestal, the pedestal to rack baseplate junction, the rack cell to rack baseplate junction, and the cell walls. The fatigue analysis was performed considering a fixed number of earthquake events (one SSE and five OBE), which is consistent with the BVPS-2 licensing basis (Updated Final Safety Analysis Report, Section 3.7, "Seismic Design"). The evaluation confirms that the peak stress intensities in the lower region of the rack will not cause fatigue due to the multiple earthquake events.

The fatigue analysis consisted of the following steps:

i) a three-dimensional finite element analysis of a spent fuel rack was performed to determine the peak stress intensity in the rack baseplate region per 1,000 pounds of force applied to the base of the support pedestal in each of three directions (x, y, and z);
ii) the force time histories for the most severely loaded pedestal (which are obtained from the WPMR analysis) are multiplied by the corresponding peak stress intensities from (i) and algebraically summed together to obtain a time history trace of the combined peak stress intensity in the rack;
iii) the cumulative usage factor for the rack is calculated according to the rules of Subsection NB based on the alternating stress intensities and the number of load cycles from (ii) and the fatigue life data provided in ASME Section III, Appendix I.

The results show that the usage factor is less than 1.0, which meets the ASME Code acceptance limit and indicates that there is no credible risk of a fatigue failure due to the cumulative effects of one SSE and five OBE events.

The highest stress locations are inaccessible for inspection given that they are located at the bottom of the rack. The pedestal to rack baseplate junction is under the baseplate located at the bottom of the cell. The baseplates of the racks also abut each other, thus restricting accessibility. Spent fuel located in the cells would further restrict accessibility.

The WPMR analytical results show that rack to rack interaction at the top of the cells is expected to occur under a seismic event. This will be in the vicinity of the bumper bars, which were added to stiffen the cell walls at the impact location. In addition, the as-installed configuration requires that sufficient gaps be provided between the individual racks as well as the racks and the walls. If exceedance of an OBE occurs, the accessible portion of the upper rack containing the bumper bars will be visually inspected for damage. Gap measurements will also be taken at preselected locations, which would be used to support a post event evaluation.

In addition, Beaver Valley Power Station has an operating procedure that defines actions for a post seismic event. This procedure currently delineates a requirement for the Beaver Valley Power Station, Unit No. 1 SFP that inter-rack and rack-to-wall gap measurements at pre-selected locations be performed following the exceedance of an OBE. As part of the LAR implementation activities, this procedure has been identified for an update to add the same requirement for BVPS-2. In addition, the procedure will require a visual inspection of the accessible areas of the racks following a seismic event for signs of physical damage. The latest industry guidance documents, Regulatory Guide 1.167, “Restart of a Nuclear Power Plant Shut Down by a Seismic Event,” and Electric Power Research Institute, NP-6695, “Guidelines for Nuclear Plant Response to an Earthquake,” will be used in the assessment of the SFP racks. If needed, based upon the results of the gap measurement results and the visual inspections, appropriate corrective actions will be taken.

4. The licensee should confirm the irrelevance of the cask pit drop accidents, as they relate to the current re-rack LAR, and note that the description of postulated accidents within the cask pit were provided for information only.

The information related to the rack drop in the fuel cask area contained in Attachment 1 of correspondence dated February 18, 2011 (Accession No. ML110530463) and Section 7.5.3, “Rack Drop Event,” of the Licensing Report was provided for information only.

Summary of Revisions to Chapters 5 and 7 from
Revision 8 of the Holtec International Licensing Report

By correspondence dated April 9, 2009, the FirstEnergy Nuclear Operating Company (FENOC) submitted to the Nuclear Regulatory Commission (NRC) a license amendment request (LAR) related to the Beaver Valley Power Station, Unit No. 2 (BVPS-2) spent fuel pool (SFP) storage racks. Additionally, Chapters 5 and 7 from Revision 8 of the Holtec International Licensing Report (Licensing Report) were submitted on February 18, 2011. Some of the information contained in Chapters 5 and 7 had not been previously docketed. The following is a summary of revisions included in the February 18, 2011 correspondence that had not been included in previously docketed correspondence.

1. **Section 5.5.2, Synthetic Time Histories:**

   The absolute value of each of three correlation coefficients was changed from 0.15 to 0.16. This clarification was made to align the acceptance criteria with Standard Review Plan (SRP) 3.7.1, "Seismic Design Parameters," Revision 3. There was no change to the original analysis or results.

2. **Section 5.6.9, Assessment of Rack Fatigue Margin:**

   The number of seismic events (one SSE and five OBE) was defined and is consistent with BVPS-2 Updated Final Safety Analysis Report, Section 3.7, "Seismic Design." There was no change to the analysis.

3. **Section 5.7, Cask Pit Rack Platform Analysis:**

   The cask pit platform minimum factor of safety (FS) is listed as 1.27. This FS is due to a change in the platform material from carbon to stainless steel and to changes in the component sizes made to compensate for the difference in material strength. The previously stated maximum rack support pedestal displacements are unchanged from those provided in correspondence dated May 21, 2010 (Accession No. ML101460057), Request for Additional Information (RAI) 13.

4. **Section 5.8, Bearing Pad Analysis:**

   a. The compressive strength of the concrete is updated from 4,000 pounds per square inch (psi) to 3,000 psi and the design code used is the American Concrete Institute, "Building Code Requirements for Reinforced Concrete, (ACI 318-71)." This aligns with the BVPS-2 design basis.

b. There are now seven types of bearing pads, instead of the three originally described. The bearing pad sizes were modified in order to obtain acceptable stresses. Additional sizes were provided due to physical limitations.
c. The average compressive stress in the concrete is now calculated based on the net bearing pad area, where the previous analysis utilized an ANSYS model to determine the average compressive stress. Strength of materials calculations are an acceptable method of analysis.

5. Section 7.3, Incident Impact Velocity:

Revision bars were included due to a change in font and line spacing only.

6. Section 7.5.2, Deep Drop Events:

Two clarifications were made. First, deep drop scenario 1 is associated with an interior cell. Second, a sentence was added to state that deep drop scenario 2 is bounded by a rack drop.

7. Section 7.5.3, Rack Drop Event:

A discussion was added to Section 7.5.3 of the Licensing Report (submitted February 18, 2011 (Accession No. ML110530463)) to provide a conclusion that a rack drop in the cask pit area and a cask pit rack platform drop in the cask area are bounded by a rack drop in the SFP. The discussion was provided for information only.