



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
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May 22, 2015

Mr. Eric A. Larson, 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 – REVIEW OF THE 2014  
STEAM GENERATOR TUBE INSPECTION REPORT (TAC NO. M4620)

Dear Mr. Larson:

The U.S. Nuclear Regulatory Commission (NRC) staff formally reviews all steam generator (SG) inservice inspection summary reports submitted by licensees in accordance with the plant's Technical Specification (TS) requirements. By letters dated August 11, 2014, November 5, 2014, February 16, 2015, and April 23, 2015, FirstEnergy Nuclear Operating Company (FENOC, the licensee), submitted information summarizing the results of the SG tube inspections performed during the 2014 refueling outage at Beaver Valley Power Station, Unit No. 2 (BVPS-2). In addition to this report, the NRC staff summarized a conference call about the 2014 SG tube inspections at BVPS-2 in a letter dated June 9, 2014.

The NRC staff has completed its review of the submittals pertaining to the BVPS-2 SG inspections, and the associated review summary is enclosed. The NRC staff finds that the licensee has provided the information required by the TS and that no additional follow-up is required at this time.

If you have any questions, please contact me at (301) 415-7128 or via e-mail at [Taylor.Lamb@nrc.gov](mailto:Taylor.Lamb@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "Taylor A. Lamb".

Taylor A. Lamb, Project Manager  
Plant Licensing Branch I-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-412

Enclosure:  
As stated

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OFFICE OF NUCLEAR REACTOR REGULATION  
REVIEW OF THE 2014 STEAM GENERATOR TUBE INSERVICE INSPECTION REPORT  
PERFORMED DURING REFUELING OUTAGE 17  
FIRSTENERGY NUCLEAR OPERATING COMPANY  
BEAVER VALLEY POWER STATION, UNIT NO. 2  
DOCKET NO. 50-412

By letters dated August 11, 2014,<sup>1</sup> November 5, 2014,<sup>2</sup> February 16, 2015,<sup>3</sup> and April 23, 2015,<sup>4</sup> FirstEnergy Nuclear Operating Company (FENOC, the licensee) submitted information summarizing the results of the 2014 steam generator (SG) tube inspections at Beaver Valley Power Station, Unit No. 2 (BVPS-2). These inspections were performed during the 17th refueling outage (RFO). In addition to this report, the U.S. Nuclear Regulatory Commission (NRC) staff summarized a conference call about the 2014 SG tube inspections at BVPS-2 in a letter dated June 9, 2014.<sup>5</sup>

BVPS-2 is a 3-loop plant with Westinghouse Model 51M SGs. Each SG contains 3,376 mill-annealed Alloy 600 tubes with a nominal outside diameter of 0.875 inches and a nominal wall thickness of 0.050 inches. The tubes are supported by a number of carbon steel tube support plates (TSPs) and Alloy 600 anti-vibration bars. The tubes were roll expanded at both ends for the full depth of the tubesheet. The entire length of tube within the tubesheet was shot-peened on both the hot-leg and cold-leg side of the SG, prior to operation. In addition, the U-bend region of the small radius tubes were in-situ stress relieved prior to operation.

The licensee provided the scope, extent, methods, and results of their steam generator tube inspections in the documents referenced above. In addition, the licensee described corrective actions (i.e., tube plugging or repair) taken in response to the inspection findings.

Based on the staff's review of the information submitted by the licensee, the staff have the following observations/comments:

- As part of implementing the alternate repair criteria from Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," in RFO 16 (2012), portions of two tubes from the hot-leg side of SG C were removed for destructive examination, which included two flow distribution baffle intersections (01H) and four TSP intersections (02H, 02H, 03H, and 04H). Of the four TSP intersections, two had confirmed eddy current indications of cracking. The two intersections with confirmed eddy current indications were tested for leakage and neither sample showed any sign of leakage. All four TSP intersections were burst tested and all four sections passed the structural integrity performance criteria. The

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1 Agencywide Documents Access and Management System (ADAMS) Accession No. ML14224A573.

2 ADAMS Accession No. ML14309A245.

3 ADAMS Accession No. ML15047A015.

4 ADAMS Accession Nos. ML15119A103, ML15119A104, and ML15119A105.

5 ADAMS Accession No. ML14142A087.

two intersections with confirmed cracking burst at the TSP elevation, whereas the two other intersections burst in the freespan. However, all four TSP intersections had indications of cracking (based on post-testing laboratory examination). The two TSP regions with no confirmed cracking from the eddy current data had cracks with maximum depths of 14.2 percent through-wall and 4.4 percent through-wall. No cellular cracking was observed. No cracking was observed outside the TSP regions.

- Since BVPS-2 is the only unit with 7/8-inch diameter tubing that still applies the voltage-based repair criteria, the licensee does not intend to update the databases supporting the methodology. The NRC staff qualitatively assessed whether including these data points would have a significant effect on the correlations and concluded that inclusion would not significantly affect the correlations.
- The 2014 inspections (RFO 17) were the second outage in which the voltage-based alternate repair criteria were applied.
- Ninety-seven tubes had sleeves installed during RFO 16 (2012). Three of these 97 tubes with sleeves were plugged in RFO 17 (2014). Two of these three tubes had volumetric indications approximately 2-inches above the top of the tubesheet. It could not be conclusively determined if the indications were associated with the tube inside diameter or the sleeve outside diameter, although it was the analyst's best judgment that the indications were on the tube inside surface. The parent tube between the sleeve joints is not considered part of the pressure boundary. The cause of these indications is not known. No investigation into whether there was water accumulating between the tube and sleeve wall was performed.
- No sleeves were installed during RFO 17.
- For tubes with hot-leg tubesheet sleeves in row four and lower (two tubes in SG B and one tube in SG C), all hot-leg TSP elevations were examined with a 0.630-inch diameter bobbin probe due to the inability of a 0.720-inch diameter bobbin probe to traverse the U-bend region of the lower row tubes. Any indications detected with a 0.630-inch bobbin probe at the TSP elevations were removed from service.
- A visual inspection of the inside diameter (ID) of the feedring at selected J-nozzles was performed in SGs B and C. In general, these inspections showed that there was little change in the visual condition of the feedrings at the J-nozzle entrance from the last inspection during refueling outage 12. For SG B, J-nozzle 11 was found to have experienced additional erosion of the feedring at the nozzle entrance. The affected area of the feedring did not encompass the entire circumference. The erosion observed was considered normal for this vintage of SGs, and no corrective actions were taken. Visual comparison of the nozzle-to-feedring weld showed that the size of the weld extends well beyond the area of the feedring ID erosion. For SG C, J-nozzle 13 was found to have experienced additional erosion of the feedring at the nozzle entrance. The extent of the erosion was localized. Patterns of erosion stripes were observed on this reducing union. This condition was evident on this reducer only. These stripes appear to have a small amount of penetration into the reducer wall. The orange colored deposit that was observed

was believed to be rust. Similar observations on the exterior of the feed ring were wiped away. No corrective actions were taken.

- Ultrasonic thickness (UT) measurements of the feedwater header were taken along the axis and around the circumference of the feedwater header in SGs B and C. The minimum reported thickness was 0.401 inches. Although there is no specified minimum permissible material thickness for the feedring complex, the licensee considers this value sufficient to preclude corrective action, and none was taken. The licensee stated minimum thicknesses as small as 0.12 inches have been developed by Westinghouse for other plants that have experienced significant erosion of the feedring. The licensee considers the feedring erosion at BVPS-2 minor compared to these other plants. Future inspections of the steam drum region and feedwater header will coincide with the secondary manway gasket replacement schedule.
- One tube (in row 25, column 45 of SG B) had an indication in the U-bend region approximately 3.7 inches from anti-vibration bar number one. The total flaw length was estimated to be 0.38-inches and the maximum depth was estimated to be 67 percent through-wall. The indication was axially oriented within a ding and was attributed to outside diameter stress corrosion cracking. This indication was in-situ pressure tested and confirmed to have adequate integrity. The tube was plugged and removed from service.
- Based upon the inspection history of distorted support plate signals and support plate mix residual signals, the licensee has concluded that BVPS-2 is not susceptible to extreme cases of voltage growth for Cycle 18.
- The calculated accident induced leakage for each SG, from all sources of accident induced leakage (sleeves, plugs, indications left in service under Generic Letter 95-05, and other degradation within the tube bundle) following a design basis accident, is less than the accident induced performance criteria.
- Ten tubes on the hot-leg side of the three SGs have expansion transition locations that are lower than nominal elevations. Similarly, seven tubes on the cold-leg side of SG B have expansion transition locations that are lower than nominal elevations. All 17 of these tubes are inspected to a depth of 5 inches below the top-of-the-tubesheet, to ensure the F\* (F-star) distance is adequately examined.

Based on a review of the information provided, the staff concludes that the licensee provided the information required by their technical specifications. In addition, the staff concludes that there are no technical issues that warrant follow-up action at this time, since the inspections appear to be consistent with the objective of detecting potential tube degradation and the inspection results appear to be consistent with industry operating experience at similarly designed and operated units.

Principal Contributor: Andrew Johnson, DE

Date: May 22, 2015

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Sincerely,  
**/RA/**  
Taylor A. Lamb, Project Manager  
Plant Licensing Branch I-2  
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**ADAMS Accession No.: ML15132A496 \*via memo dated \*\*via e-mail**

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