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

May 31, 2012

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 – CORRECTION LETTER TO THE REVISED STEAM GENERATOR INSPECTION SCOPE USING F* INSPECTION METHODOLOGY AMENDMENT SAFETY EVALUATION (TAC NO. ME3498)

Dear Mr. Harden:

By letter dated February 24, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML110350162), the Nuclear Regulatory Commission (NRC) issued Amendment No. 172 to Renewed Facility Operating License (FOL) No. NPF-73 for the Beaver Valley Power Station, Unit No. 2, to modify the Technical Specifications to revise the scope of the steam generator (SG) tube inspections for the portion of the tube in the tubesheet on the cold-leg side of the SG by using the F* methodology. A correction letter was subsequently issued on April 6, 2012 (ADAMS Accession No. ML120940576), correcting several discrepancies in the amendment and supporting safety evaluation. By letter dated May 18, 2012 (ADAMS Accession No. ML12142A151), you identified three items of note in the corrected safety evaluation.

The NRC staff has reviewed your May 18, 2012, letter and concurs that the three items noted require correction. Therefore, enclosed with this letter are the applicable corrected pages of the safety evaluation for Amendment No. 172 to Renewed FOL No. NPF-73 for the Beaver Valley Power Station Unit, No. 2.

Please contact me at 301-415-2833, if you have any questions.

Sincerely,

Peter Bamford

Peter Bamford, 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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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 172 TO RENEWED

FACILITY OPERATING LICENSE NO. NPF-73

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

1.0 INTRODUCTION

By application dated February 26, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100630422), as supplemented by letters dated November 30, 2010 (ADAMS Accession No. ML103370240) and January 26, 2011 (ADAMS Accession No. ML110320242), FirstEnergy Nuclear Operating Company (FENOC, the licensee), requested changes to the Technical Specifications (TSs) for Beaver Valley Power Station, Unit No. 2 (BVPS-2). The supplements dated November 30, 2010, and January 26, 2011, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the Nuclear Regulatory Commission (NRC) staff's original proposed no significant hazards consideration determination as published in the Federal Register on January 11, 2011 (76 FR 1648).

The changes would revise the scope of the steam generator (SG) tube inspections for the portion of the tube in the tubesheet on the cold-leg side of the SG by using the F* methodology. Previously, the NRC staff approved the use of the F* methodology for use on the hot-leg side of the SGs by letter dated September 27, 2006 (ADAMS Accession No. ML062580419). The existing TS 5.5.5.2.c.1 states that, "tubes found by inservice inspection (ISI) to contain a flaw in a non-sleeved region with a depth equal to or exceeding 40% of the nominal tube wall thickness shall be plugged or repaired except if permitted to remain inservice through application of the alternate repair criteria discussed in Specification 5.5.5.2.c.4 or 5.5.5.2.c.5." TS 5.5.5.2.c.5 currently specifies that the 40 percent depth criterion for tube repair does not need to be applied in the hot-leg tubesheet region below the "F* distance" in the tubesheet. The license amendment request (LAR) adds the cold-leg tubesheet region to hot-leg region already

Enclosure
Corrected by letter dated, Friday, April 6, 2012
Corrected by letter dated May 31, 2012

Based on these considerations, power reactor licensees have proposed, and the NRC has approved, alternate repair criteria for SG tube defects located in the lower portion of the tubesheet, when these defects are a specific distance below the expansion transition or the top of the tubesheet (TTS), whichever is lower. The F* methodology defines a distance, referred to as the F* distance, such that any type or combination of flaws below this distance (including flaws in the tube-to-tubesheet weld) is considered acceptable. That is, even if inspections below the F* distance identify flaws, the regulatory requirements pertaining to tube structural and leakage integrity would be met provided there were no significant flaws within the F* distance. The F* distance is measured from the TTS or the bottom of the roll transition (BRT), whichever is lower.

Determination of the F* distance includes a nondestructive examination (NDE) uncertainty value of 0.25 inch, which was established in the F* evaluation for Farley Unit 2 and subsequently approved as part of the staff's safety evaluation for that repair criteria. It also includes an adjustment for the location of the BRT in relation to the TTS. The value of F* calculated for structural and leakage integrity, without adjustments for NDE uncertainty and BRT location, is called the F* length. That is, the F* distance is the sum of the F* length, the NDE uncertainty, and the BRT adjustment.

The F* evaluation presented in WCAP-16385, "F* Tube Plugging Criterion For Tubes With Degradation In The Tubesheet Roll Expansion Region Of The Beaver Valley Unit 2 Steam Generators," Revision 1 (ADAMS Accession No. ML051040084), was performed for the expected operating conditions at BVPS-2 (including an 8-percent extended power uprate (EPU) which was subsequently approved by the NRC on July 19, 2006) and for DBAs. The F* value determined for the limiting faulted condition (SG feedwater line break (FLB)) bounds the current normal operating conditions and EPU conditions, with up to 22 percent tube plugging.

The F* analysis considered the forces acting to pull the tube out of the tubesheet (i.e., from the internal pressure in the tube) and the forces acting to keep the tube in place. These latter forces are a result of friction and the forces arising from (1) the residual preload from the installation (rolling) process, (2) the differential thermal expansion between the tube and the tubesheet, and (3) internal pressure in the tube within the tubesheet. In addition, the effects of tubesheet bow, due to pressure and thermal differentials across the tubesheet, were considered since this bow causes dilation of the tubesheet holes from the secondary face to approximately the midpoint of the tubesheet and reduces the ability of the tube to resist pullout. The amount of tubesheet bow varies as a function of radial position, with locations near the periphery experiencing less bow. The effects of tubesheet hole dilation were analyzed using the worst-case hole (location) in the tubesheet.

3.2 FENOC Proposal

The licensee's basis for revising the criteria for tube repair within the cold-leg tubesheet region is documented in its LAR, in WCAP-16385, Revision 1, and in the November 30, 2010, and January 26, 2011, supplemental letters. These documents also referred to WCAP-11306, "Tubesheet Region Plugging Criterion for the Alabama Power Company Farley Nuclear Station Unit 2 Steam Generators," Revision 2, April 1987, which describe the analysis and testing performed to justify a similar modification in the tube repair criteria for the Farley Nuclear Station, Unit 2.

For tubes with no portion of a lower sleeve joint in the hot-leg or cold-leg tubesheet region, TS 5.5.5.2.c.5.a specifies that the tube must be repaired or plugged if any flaw is detected within 3 inches below the TTS or 2.22 inches below the BRT, whichever elevation is lower. For tubes which have any portion of a sleeve joint in the hot-leg or cold-leg tubesheet region, TS 5.5.5.2.c.5.b specifies that the tube must be plugged if any flaw is detected within 3 inches below the lower end of the lower sleeve joint. Any flaw located below the elevations specified in proposed TSs 5.5.5.2.c.5.a and 5.5.5.2.c.5.b would be allowed to remain in service regardless of size.

The following sections summarize the NRC staff's evaluation of the proposed BVPS-2 F* proposal in terms of maintaining SG structural and leakage integrity.

3.3 Tube Structural Integrity

The amendment would permit tubes with flaws to remain in service; therefore, the licensee must demonstrate that the tubes kept in service using the F* methodology will maintain adequate structural integrity for the period of time between inspections. Tube rupture and pullout of a tube from the tubesheet are the two potential credible modes of structural failure considered for tubes returned to service under the F* methodology.

In order for a tube to rupture, a flaw would need to grow above the tubesheet's secondary face. If the entire flaw remains within the tubesheet, the reinforcement provided by the tubesheet will prevent tube rupture. The F* methodology proposed by the licensee for BVPS-2 requires an inspection of the top portion of the tube within the hot-leg or cold-leg tubesheet and the plugging of any flaws in this region. Therefore, any known flaws remaining in service following the inspections will be located a minimum of 3 inches below the TTS or the lower joint of a sleeve. Industry operating experience shows flaw growth rates within the tubesheet are well below those necessary to propagate a flaw from 3 inches below the TTS to outside the tubesheet in one operating cycle (typically 18 months). Therefore, it is unlikely that any of these flaws will grow in an axial direction and extend outside the tubesheet during one operating cycle. Similarly, it is unlikely that a flaw would propagate upward to a sleeve joint from 3 inches below the joint during one operating cycle. Thus, tube burst is precluded for these flaws due to the reinforcement provided by the surrounding tubesheet.

In the event that undetected flaws are present in the F* distance, or that new flaws initiate in the F* distance during the operating cycle following an inspection, it is possible that these flaws could grow in the axial direction and extend outside the tubesheet. As a result, the NRC staff considered the conditions that would be necessary to structurally fail a tube with this type of flaw. Steam generator tube rupture is primarily a function of flaw geometry, the differential pressure across the tube wall, and the flaw location. Axial through-wall flaws may result in a tube failing to maintain adequate margins for burst under all operating conditions. However, this would require the flaws to exceed a certain length, typically on the order of one-half inch or longer, and have no external restraint (i.e., occur in the free span). Partially through-wall flaws would require additional length (beyond the one-half inch postulated above) in order to become susceptible to spontaneous rupture based on empirical models for tube burst. Thus, these flaws would have to extend a significant distance above the tubesheet to degrade the margins of structural integrity for the affected tube (i.e., tubes with undetected flaws slightly below the TTS).

In addition, constraining a flaw at one end by the tubesheet would further elevate the burst pressure of this tube (compared to an identical flaw with no constraint). Flaw growth rates

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