



Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

March 29, 2011

10 CFR 50.55(e)

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, D.C. 20555

Bellefonte Nuclear Plant, Units 1 and 2  
Construction Permit Nos. CPPR-122 and CPPR-123  
NRC Docket Nos. 50-438 and 50-439

Subject: **CONTAINMENT VERTICAL TENDON COUPLING FAILURE – FOURTH  
INTERIM REPORT**

- Reference(s):
1. U.S. Nuclear Regulatory Commission Operations Center Event Report No. 45559, dated December 10, 2009 [ML093490942].
  2. Letter from TVA to NRC, "Bellefonte Nuclear Plant (BLN) Units 1 (CPPR-122) and 2 (CPPR-123) – Containment Vertical Tendon Coupling Failure – First Interim Report," dated December 10, 2009 [ML093480158].
  3. Letter from TVA to NRC, "Bellefonte Nuclear Plant (BLN) Units 1 (CPPR-122) and 2 (CPPR-123) – Containment Vertical Tendon Coupling Failure – Second Interim Report," dated March 29, 2010 [ML100900090].
  4. Letter from TVA to NRC, "Bellefonte Nuclear Plant (BLN) Units 1 (CPPR-122) and 2 (CPPR-123) – Containment Vertical Tendon Coupling Failure – Third Interim Report," dated September 20, 2010 [ML102660164].

The purpose of this letter is to provide the NRC with the fourth interim report on the subject matter which was initially reported to the NRC Operations Center on December 10, 2009 (Reference 1) as Problem Evaluation Report 200119. TVA has submitted three interim reports on this subject matter (References 2, 3, & 4).

Enclosure 1 of this letter contains the fourth interim report. Enclosure 2 provides the list of commitments made in this submittal.

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TVA expects to submit the next report by March 31, 2012, or earlier if new information becomes available.

Sincerely,

Handwritten signature of Raymond A. Hruby, Jr. in black ink.

Raymond A. Hruby, Jr.  
General Manager  
Bellefonte Project

Enclosure(s):

1. 10 CFR 50.55(e) Fourth Interim Report Bellefonte Nuclear Plant (BLN)  
Containment Vertical Tendon Coupling Failure
2. List of Commitments

cc: See page 3

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**10 CFR 50.55(e) FOURTH INTERIM REPORT  
BELLEFONTE NUCLEAR PLANT (BLN)  
CONTAINMENT VERTICAL TENDON COUPLING FAILURE**

**Description of Deficiency**

Inspection of failed Unit 1 reactor building containment vertical tendon V9 rock anchor coupling indicates a potential for an unknown common mode failure mechanism for BLN containment vertical tendon rock anchor couplings. Unit 1 reactor building containment vertical tendon V9 experienced failure of the rock anchor/tendon anchor coupling on August 17, 2009, at approximately 1400 CDT. The time of failure was identified based on a loud noise being reported by several individuals. Initial investigation failed to reveal the source of the noise. The failed tendon was discovered on August 24, 2009, during a tour of the U1 tendon gallery, elevation 607. Potentially unsafe conditions delayed inspection of the failed coupling for proper installation or component specific damage until November 23, 2009. That inspection showed no signs of component-specific damage or improper installation, thus indicating the potential for an unknown common mode failure.

**Safety Significance**

TVA made a determination of the mechanism of failure and a preliminary assessment of the extent of the condition. If multiple containment tendons had been found to be losing the capability to carry tendon design force, and this condition was left uncorrected, this could have reduced the capability of the containment structure to perform its design function. TVA has completed an analysis of containment structure integrity considering both the single tendon coupler failure and the detensioning performed to date to support the extent of condition assessment and determined that the containment structure is maintaining its design capability. Thus, the interim condition is not causing structural degradation.

**Cause of Deficiency**

The failure mode was determined to be hydrogen-induced stress corrosion cracking (SCC). The root cause of the failure was determined to be water in contact with the grease surrounding the failed coupling in a high stress area. Required conditions for this morphology to occur include both a high stress level in the coupling and the presence of sulfides and water in the grease.

**Interim Progress**

To determine extent of condition, TVA conducted grease analysis consistent with NRC Regulatory Guide 1.35 (Rev. 3), reviewed and evaluated tendon history, and performed non-destructive evaluation (NDE) testing of two potentially high risk tendons and two randomly selected tendons, as detailed in the third interim report (Reference 4). Since that report, TVA has completed a failure analysis and tensile testing of the tendon wire from V-121, and testing of the couplings from V-41 and V-121, which showed no signs of SCC. Extent of condition remains limited to the one tendon that has experienced SCC. There has been no indication of SCC of any other tendon component.

### **Actions Taken Since Last Report and Results**

To determine the extent of condition, the following actions have been completed since the September 20, 2010 report:

- One failed tendon wire from V-121 was identified during inspection following detensioning, as noted in the third interim report (Reference 2). A detailed failure analysis was conducted in conjunction with tensile testing as defined in RG 1.35 (Rev. 2), section C.5. The results of the tendon wire metallurgical failure analysis and tensile test results showed that the wire broke due to tensile overload and showed no signs of SCC.
- The couplings from V-41 and V-121 underwent mechanical testing, chemical analysis and microstructure characterization, and the results showed no signs of SCC.
- Work has been authorized for the development of a containment vertical tendon detensioning plan, taking into consideration the Crystal River containment concrete delamination experience in which the sequence of detensioning was found to be a factor in concrete cracking. Once a detensioning plan has been developed, an independent review will be conducted prior to the start of containment detensioning activities. After approval of the final detensioning plan, TVA will detension the tendons according to the plan to perform the remaining NDE to support completion of the extent of condition evaluation.

### **Further Action Planned**

- Evaluate potential coupling design changes intended to improve the corrosion resistance of replacement couplings.
- Complete a containment vertical detensioning plan, taking into consideration the Crystal River containment concrete delamination experience.
- Following the detensioning plan approval, detension the tendons prior to performance of NDE to support completion of the extent of condition evaluation.
- Issue design drawings and initiate procurement of replacement couplers for tendons that must be retensioned before additional tendons are detensioned to continue the extent of condition evaluation.

BLN corrective action program Problem Evaluation Report (PER) number 200119 continues to be used to document and manage the V-9 coupling failure assessment and the corrective actions that will be implemented to prevent recurrence.

**10 CFR 50.55(e) FOURTH INTERIM REPORT  
BELLEFONTE NUCLEAR PLANT (BLN)  
CONTAINMENT VERTICAL TENDON COUPLING FAILURE**

**LIST OF COMMITMENTS**

1. TVA will submit an update to this interim report by March 31, 2012.