



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

March 29, 2010

10 CFR 50.55 (e)

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

In the Matter of)
Tennessee Valley Authority)

Docket Nos. 50-438 and 50-439

TENNESSEE VALLEY AUTHORITY (TVA) – BELLEFONTE NUCLEAR PLANT (BLN)
UNITS 1 (CPPR-122) AND 2 (CPPR-123) – CONTAINMENT VERTICAL TENDON
COUPLING FAILURE – SECOND INTERIM REPORT

The purpose of this letter is to provide the NRC with the second interim report on the subject matter which was initially reported to the NRC Operations Center on December 10, 2009 as Problem Evaluation Report 200119. The enclosure to this letter contains the second interim report. The attachment to the enclosure provides the list of commitments made in this submittal. TVA expects to submit the next report by September 30, 2010.

Sincerely,

Jack A. Bailey
Vice President, Nuclear Generation Development
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Enclosure:

1. 10 CFR 50.55(e) Second Interim Report Bellefonte Nuclear Plant (BLN)
Containment Vertical Tendon Coupling Failure

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cc: (w/Enclosure)

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**10 CFR 50.55(E) SECOND 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 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 a 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 previously precluded an inspection of the failed coupling for proper installation or component specific damage. The failed tendon coupling was inspected on November 23, 2009, and showed no signs of component-specific damage or improper installation, thus indicating the potential for an unknown common mode failure.

Safety Significance

TVA has made a determination of the mechanism of failure and actions to determine the extent of the condition are in progress. If multiple containment tendons are found to be losing the capability to carry tendon design force, and this condition was left uncorrected, this could jeopardize the ability of the containment structure to perform its design function.

Cause of Deficiency

The failure mode has been determined to be hydrogen-induced stress corrosion cracking (SCC). The root cause of the failure is water in contact with the grease surrounding the failed coupling in a high stress area. For this morphology to occur, a high stress level in the coupling combined with sulfides and water in the grease must exist.

Interim Progress

Metallurgical analysis of the failed coupling at the TVA Central Services Metallurgical Laboratory, with support from Oak Ridge National Laboratory, has been completed. Listed below are the actions taken since the last meeting, including the metallurgical analysis of the coupling, non-destructive examination (NDE) of V-9 field anchor and tendon wires, and chemical analysis of the grease removed from the V-9 tendon anchor assembly. Additionally, planned future actions are provided.

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- Actions Taken Since Last Report
 - Physical work
 - V-9 field anchor, coupling and tendon wires removed
 - Examinations performed
 - NDE Examinations
 - Florescent magnetic particle examination of the V-9 field anchor head, rock anchor head and coupling
 - Dye penetrant examination of thirteen V-9 tendon wires
 - Metallurgical analysis of the V-9 coupling and field anchor head
 - Visual examination and dimensional documentation
 - Chemical analysis
 - Scanning Electron Microscopy (SEM) fractography and Energy Dispersive Spectroscopy (EDS)
 - SEM and EDS of thread surfaces
 - Metallographic examination
 - Hardness and microhardness testing
 - Tensile and Charpy impact testing of coupling and field anchor head
 - Tensile testing of tendon wires
 - Grease Analysis
 - Chemical analysis per RG 1.35 guidelines
 - X-ray photoelectron spectroscopy (XPS) of grease removed from the V-9 tendon anchor assembly.
- Results
 - Examination of coupling

Laboratory testing found no deficiencies in the coupling material that would have contributed to the failure. Fractography and metallographic examination determined that the primary fracture had a mixture of transgranular and intergranular stress corrosion cracking (SCC) separation, with little branching. For this low alloy steel (AISI 4142H quenched and tempered), such fracture features are associated with SCC in which the presence of hydrogen acts as a driving mechanism. This high strength steel is known to be susceptible to SCC at room temperature in certain environments, such as one including hydrogen sulfide. Examination of the fracture surface and corrosion deposits in the cracks found the presence of sulfur. In addition, results of the examination of the grease taken from this location, as discussed below, discovered that the presence of sulfide combined with calcium, as well as other species, including free sulfur and sulfur in an oxide form, possibly sulfite.

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- Examination of anchor heads -
The field anchor head was made of AISI 4140 quenched and tempered steel, which is susceptible to hydrogen-induced SCC at room temperature. Florescent magnetic particle examination of the V-9 field anchor head identified multiple circumferential and axial indications in the thread area in contact with the field anchor.
Florescent magnetic particle examination of the V-9 rock anchor head was completed with no indications identified.
- Examination of tendon wires -
Thirteen tendon wires, including button heads, were penetrant tested with no indications identified.
- Grease
XPS is a surface analysis technique which can also differentiate between the molecular states of the elements present. The XPS finding indicates the presence of sulfide combined with calcium, as well as other species including free sulfur and sulfur in an oxide form. The content of Regulatory Guide 1.35 identified properties against the limits of reportability are shown below.

| Property | Result | RG 1.35 Limits of Reportability | Standard |
|-------------------------|--------------|---------------------------------|--------------|
| Water content by weight | .4% | > 10% by weight | ASTM D95 |
| Chlorides | .9 – 3.8 PPM | > 10 PPM | ASTM D512 |
| Nitrates | < 3.8 PPM | > 10 PPM | ASTM D3867 |
| Sulfides | < 1 PPM | > 10 PPM | APHA 4500 S2 |
| Reserve alkalinity | 56.4 | < 50% of installed | ASTM D974 |
| Presence of free water | NA | zero | RG 1.35 |

- Further Actions Planned to Determine Extent of Condition
 - Perform further sampling of grease from vertical, horizontal and dome tendon grease cans using criteria of RG 1.35.
 - Develop containment de-tensioning plan to support vertical tendon NDE testing, including lessons learned from recent industry experience with containment concrete voiding.
 - Perform an approved magnetic particle and ultrasonic testing (UT) examination on a sample of vertical tendon anchor heads and couplings using a sampling plan designed to obtain a 95% confidence and 95% reliability level based on ANSI/ASQCZ1.4-1981.

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

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**ATTACHMENT TO
10 CFR 50.55(E) SECOND INTERIM REPORT
BELLEFONTE NUCLEAR PLANT (BLN)
CONTAINMENT VERTICAL TENDON COUPLING FAILURE**

LIST OF COMMITMENTS

1. TVA will submit an update to this interim report prior to September 30, 2010.