Docket Nos. 50-438
50-439

JAN 2 6 1976

Tennessee Valley Authority
ATTN: Mr. James E. Watson
Manager of Power
818 Power Building
Chattanooga, Tennessee 37401

Gentlemen:

The NRC staff has completed its evaluation of the TVA report numbered TVA-DED-01-12, "Post-Tensioned Anchor Tendons in Rock--Retest on Tendons Supplied by Inland-Ryerson Construction Products Company" for the Bellefonte Nuclear Plant. This report satisfies your commitment in Section 3.8.5.7.1 of the FSAR and we considdr this post CP item complete.

Attachment 1 contains the results of the Site Analysis Branch review of the report. The Structural Engineering Branch evaluation is enclosed as Attachment 2.

The impact of the decrease in the effective free length of the anchors on the margin of safety of the containment foundation should be discussed in the Bellefonte FSAR. The adequacy of TVA's tendon surveillance program will be reevaluated during the FSAR review. This evaluation will be based on the results of additional lift-off tests performed by TVA as the tendons are installed, and results of other construction experiences.

Sincerely,

Original Signed by
Karl Kniel

Karl Kniel, Chief
Light Water Reactors Branch No. 2
Division of Project Management

Attachments:
1. Results by Site Analysis Branch
2. Evaluation by Structural Engineering Branch

cc: See next page

OFFICE ➤	LWR #2	LWR #2				
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DATE ➤	1/ /76	1/ /76				

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

Docket Nos. 50-438
50-439

January 26, 1976

Tennessee Valley Authority
ATTN: Mr. James E. Watson
Manager of Power
818 Power Building
Chattanooga, Tennessee 37401

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Sincerely,

Karl Kniel, Chief
Light Water Reactors Branch No. 2
Division of Project Management

Attachments:
1. Results by Site Analysis Branch
2. Evaluation by Structural Engineering Branch

cc: See next page

cc: Mr. R. H. Marquis
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ATTACHMENT 1

TVA-DED-81-12
POST-TENSIONED ANCHOR TENDONS IN ROCK--
RETEST ON TENDONS SUPPLIED BY INLAND-RYERSON
CONSTRUCTION PRODUCTS COMPANY
SITE ANALYSIS BRANCH
EVALUATION REPORT

References:

1) "Post-Tensioned Anchor Tendons in Rock--Retect on Tendons Supplied by Inland-Ryerson," by R. E. Bullock, July 28, 1975, Tennessee Valley Authority, TVA-DED-81-12.

2) "Post-Tensioned Anchor Tendons in Rock, Installation and Testing of Tendons by Inland-Ryerson," by R. E. Bullock, December 19, 1973, Tennessee Valley Authority.

Reference 1 indicates that the effective free length of the test tendons has decreased during the loading period from 1973 to 1975. Tendon A decreased from 25.7 feet to 22.6 feet, and Tendon B decreased from 25 feet to 21 feet. The tendons are 40 feet long with 20 feet grouted into rock; thus, the effective rock embedment has decreased from 5.7 feet to 2.6 feet for Tendon A and from 5 feet to 1 foot for Tendon B. The cause of this change in effective length is stated (page 1, Reference 1) as: "continued hydration of grout and development of bond along the portion of the tendon length which slipped during the 1973 tests."

It is the reviewer's opinion that the change in effective embedment is mainly due to consolidation of bedding plane materials and shales. This opinion is supported by Appendix C of Reference 2 (page 3) which states: "The creep measured over a 34-day-period at 70 percent of ultimate indi-

cates a tendency for continued closure of micro-cracks and consolidation within the shale beds." This appendix contains test data and analyses on stress-steel tendons.

Further support for the actual consolidation of embedment rock can be gleaned from the data for the creep measurements in Appendix C of Reference 2. Interpretation of the data shows that at least 5 ksi of prestress was lost by rock consolidation in the 34-day-period following the initial loading. Reference 1 indicates that a total of about 15 ksi of prestress was lost in the two-year-period, 1973 to 1975; rock consolidation during this period probably contributed significantly to the total loss of prestress.

The purpose of the above comments is to call attention to the evidence that the distribution of bond stresses along the embedded test tendons has changed due to consolidation of the rock and that the bond stresses near the top of the grouted hole have increased and the bond stresses near the bottom of the grouted hole have decreased. The significance of such changes may influence design assumptions for stability and structural stress analyses.

TVA-DED-81-12
POST-TENSIONED ANCHOR TENDONS IN ROCK
RETEST ON TENDONS SUPPLIED BY INLAND RYERSON
CONSTRUCTION PRODUCTS COMPANY
STRUCTURAL ENGINEERING BRANCH
EVALUATION REPORT

The applicant performed two additional rock anchor lift-off tests at the existing rock anchor test facility on June 3, 1975. These tests were performed on rock anchors (designated Tendon A and Tendon B) which were previously installed and tested in 1973.

The lift-off tests indicated prestress losses of 15 ksi for Tendon A and 18 ksi for Tendon B which compare favorably to the assumed prestress loss of 24 ksi in the design of the rock anchors. Tendon A was also successfully cycled 100 times between 0.6 f_{pu} and 0.7 f_{pu}, increased in load to 0.8 f_{pu} and finally reduced to 0.7 f_{pu} and shimmed. These tests further demonstrate that the post-tensioned rock anchor tendons used in the containment structures will perform in a satisfactory manner.

During the course of the tests 23 out of the 170 wires in Tendon B fractured at a stress of 0.78 f_{pu}. For the past two years, both tendons were not protected above the first stage grout and were subjected to surface water and associated contaminations. A number of wires were taken from the tendon and examined by a metalurgist who confirmed that the tendon wire failures were associated with corrosion. We have reviewed this report and concur with its conclusion. The rock anchor tendons installed in the containment structure will not be subjected to the above corrosive environment since they will be completely protected by grout with specified chemical limitations. During installation, the rock anchors will be completely submerged in lime water until second stage grouting is completed.

The retests also indicated a decrease in the effective free length of the anchors. The significance of this decrease with respect to the margin of safety of the containment foundation should be more

fully discussed in the FSAR. During the FSAR evaluation, the staff will review the results of additional lift-off tests made by the applicant. Based on the results of such tests and other construction experiences, we intend to reassess the adequacy of the tendon surveillance program presently proposed by the applicant.