DUKE POWER COMPANY

OCONEE NUCLEAR STATION

# UNIT 3

# REACTOR BUILDING

# POST-TENSIONING SYSTEM

# SIXTH SURVEILLANCE

July 1995

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## 1.0 Introduction

The surveillance program for Oconee Nuclear Station, Unit 3, reactor building post-tensioning system was defined, and is executed, in order to assure continued quality of the system. Program consists of periodic inspections of nine pre-selected tendons - three hoop tendons, three vertical tendons, and three dome tendons - for symptoms of material deterioration or force reduction in excess of predicted values. Program assesses condition and functional capability of the system and, therefore, verifies adequacy of the system and provides an opportunity to take proper corrective action should adverse conditions be detected.

Requirements for the program are detailed in Oconee Technical Specifications, Section 4.4.2. Surveillance was conducted 13 June 1995 through 20 July 1995 in accordance with approved procedure MP/0/A/1400/022, Tendon - Reactor Building - Surveillance, and results of this sixth inspection are reported herein.

## 2.0 Summary and Conclusions

### 2.1 Summary

No significant discoloration and/or change in consistency of sheathing filler was observed.

End anchorage components were found to be in satisfactory condition with no sign of development of adverse conditions such as cracking or excessive corrosion, or missing buttonheads.

Mean lift-off force for each surveillance tendon group - hoop, vertical, and dome - exceeded required values.

Tendon wires were in excellent condition and no corrosion along the length of the wires was observed. It was determined that no wire breaks had occurred during the interval since the fifth inspection.

Mechanical tests of specimens showed no significant changes in ultimate strength of the wire as compared to results obtained during initial acceptance tests.

### 2.2 Conclusions

Based on the tests and inspections described herein, it is concluded that the post-tensioning system for Oconee Nuclear Station, Unit 3, is in satisfactory condition, that the functional capability of the system has not diminished, and that the system shows no detectable evidence of the occurrence of any adverse deterioration.

## 3.0 Results

### 3.1 Sheathing Filler

Sheathing filler at the ends of each inspected tendon was visually examined. Filler coating on end anchorage components, and color and consistency of filler, were found to be acceptable, with no evidence of water being present - see Table 1.

Samples of sheathing filler were obtained from each of three tendons from which a wire was removed. This filler was visually examined and no sign of water nor any discoloration of sheathing filler was evident.

### 3.2 End Anchorage Components

Results of end anchorage component inspections are shown in Tables 1 and 2. Buttonheads were inspected for acceptable shape, general appearance, cracks, and corrosion. No missing buttonheads were observed. Stress washers, shims, and bearing plates were visually inspected for cracking and corrosion. Some minor surface corrosion was present on edges and faces of stress washers, shims, and bearing plates; however, this condition existed at time of installation and no further deterioration has occurred in subsequent interval.

### 3.3 Lift-Off Forces

Lift-off forces were obtained for each inspected tendon - see Table 3. From these readings an average force per wire was determined. Long-term trends of these wire forces, considering effects of elastic shortening, steel relaxation, and concrete creep and shrinkage, are shown graphically in Figures 1, 2, and 3. Mean lift-off force for each surveillance tendon group - hoop, vertical, and dome - exceeded required values.

### 3.4 Wire Surveillance and Testing

One surveillance tendon from each directional group was relaxed - 3D28, 13H9, and 61V16. One wire was removed from each of these tendons. Removed wires were visually checked for corrosion and pitting. General condition of the wires was determined to be equivalent to their condition at time of initial installation - see Table 1.

Three specimens were cut from each of the extracted wires for tensile testing.

Samples were taken from the ends and middle of each of the wires. Ultimate strength and elongation of each of the specimens were determined by tensile testing by the Metallurgy Laboratory, Duke Power Company. These tests are summarized in Appendix A and revealed no significant changes in ultimate strength or elongation of the wire as compared to results obtained during initial acceptance tests.

## 3.5 Retensioning and Filler Replacement

Following wire removal the relaxed tendons were retensioned, as closely as possible, to the same stress level indicated by the lift-off force data obtained during this surveillance. Sheathing filler which was removed during the surveillance process was replaced with new filler conforming to requirements of original specification.

The volume of grease replaced exceeded that which was removed for each of the vertical tendons. This observation is attributed to minor voids in the sheathing filler caused during previous surveillance activities. As evinced by the fact that tendon wire samples for all surveillance tendons have consistently been free of corrosion and exceeded the mechanical requirements of ASTM A421, the sheathing filler continues to adequately protect the post-tensioning system.

# Table 1

## Duke Power Company
## Oconee Nuclear Station, Unit 3
## Post-Tensioning System Sixth Surveillance

### Post-Tensioning System Component Corrosion Documentation

| | Shop End[2] | | | | | Field End[2] | | | | | | Grease Filler | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tendon | Bearing Plate | Shims | Button-heads | Stress Washer | Wires[1] | Bearing Plate | Shims | Button-heads | Stress Washer | Wires[1] | Free Water Removed (gal.) | Vol. (gal.) Removed | Vol. (gal.) Replaced | Color/ Consistency |
| 1D28 | B | A | A | A | N/A | B | A | A | A | N/A | none present | 1/2 @ each end | 0 | good/good |
| 2D28 | B | A | A | B | N/A | B | A | A | B | N/A | none present | 1 @ each end | 0 | good/good |
| 3D28[3] | B | A | A | A | A | B | A | A | A | A | none present | 1 @ Shop End | 0 | good/good |
| 13H9[3] | B | B | A | A | A | B | A | A | A | A | none present | 0 | 0 | good/good |
| 51H9 | B | A | A | A | N/A | B | B | A | A | N/A | none present | 0 | 0 | good/good |
| 53H10 | B | B | A | A | N/A | B | B | A | A | N/A | none present | 0 | 0 | good/good |
| 23V14 | B | A | A | A | N/A | A | A | A | A | N/A | none present | 4 | 18 | good/good |
| 45V16 | B | A | A | A | N/A | B | A | A | A | N/A | none present | 3 | 15 | good/good |
| 61V16[3] | B | A | A | A | A | A | B | A | B | A | none present | 2 | 8 | good/good |

**Notes:**
1. Material condition can only be verified for detensioned tendons.
2. Corrosion Levels:
   - A. Metal is bright with no visible oxidation.
   - B. Metal is reddish-brown in color with no pitting.
   - C. Metal is pitted: 0.0" < pitting <= 0.003"
   - D. Metal is pitted: 0.003" < pitting <= 0.006"
   - E. Metal is pitted: 0.006" < pitting <= 0.010"
3. Tendon detensioned for wire removal during current surveillance period.

## Table 2

### Duke Power Company
### Oconee Nuclear Station, Unit 3
### Post-Tensioning System Sixth Surveillance

### Post-Tensioning System Component Conditions

| | Shop End | | | Field End | | |
|---|---|---|---|---|---|---|
| Tendon | Shim Thickness | Shim/Bearing Plate Damage | Buttonheads Unseated/Damaged | Shim Thickness | Shim/Bearing Plate Damage | Buttonheads Unseated/damaged |
| 1D28 | 3 3/4" | N/A | N/A | 3 3/4" | N/A | N/A |
| 2D28 | 2 7/8" | N/A | N/A | 2 3/4" | N/A | N/A |
| 3D28[1] | 3 1/2" | N/A | N/A | 3 1/2" | N/A | N/A |
| 13H9[1] | 4" | See Note 2. | N/A | 3 7/8" | N/A | N/A |
| 51H9 | 3 5/16" | N/A | N/A | 3 1/4" | N/A | N/A |
| 53H10 | 3" | N/A | N/A | 3" | N/A | N/A |
| 23V14 | 3 3/4" | N/A | N/A | 4 1/4" | N/A | N/A |
| 45V16 | 3 7/16" | N/A | N/A | 3 3/4" | N/A | N/A |
| 61V16[1] | 2 3/4" | N/A | N/A | 2 7/8" | N/A | N/A |

**Notes:**
1. Tendon detensioned for wire removal during current surveillance period.
2. One improperly formed buttonhead identified on outside row at 5 o'clock position.

# Table 3

## Duke Power Company
## Oconee Nuclear Station, Unit 3
## Post-Tensioning System Sixth Surveillance

### Tendon Lift-Off Forces

| Tendon | Shop End Lift-off Force (kips)[2] | | Field End Lift-off Force (kips)[2] | | Average Lift-off Force (kips)[2] | | Total Number of Wires Missing/Removed | Initial Number of Wires[1] | Effective Number of Wires | Average Force Per Wire[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1D28 | 695.5 | | 716.6 | | 706.1 | | 2 | 93 | 91 | 7.76 | |
| 2D28 | 671.2 | | 685.9 | | 678.6 | | 2 | 93 | 91 | 7.46 | |
| 3D28[3] | 661.4 | 710.4 | 695.5 | 671.2 | 678.5 | 690.8 | 2 | 93 | 91 | 7.37 | 7.59 |
| 13H9[3] | 671.2 | 683.3 | 661.4 | 661.4 | 666.3 | 672.4 | 3 | 93 | 90 | 7.32 | 7.47 |
| 51H9[4] | 683.3 | | 722.7 | | 703.0 | | 2 | 93 | 91 | 7.73 | |
| 53H10[5] | 624.7 | 673.7 | 622.7 | 659.1 | 623.7 | 666.4 | 5 | 93 | 88 | 6.85 | 7.57 |
| 23V14 | 710.4 | | 725.8 | | 718.1 | | 2 | 93 | 91 | 7.89 | |
| 45V16 | 698.2 | | 719.7 | | 709.0 | | 2 | 93 | 91 | 7.79 | |
| 61V16[3] | 636.9 | 673.7 | 689.4 | 665.1 | 663.2 | 669.4 | 2 | 93 | 91 | 7.21 | 7.36 |

**Notes:**

1. Reference: Prestressing Report, Reactor Building, Duke Power Company, Oconee Nuclear Station, Unit 3, dated October 1973 by Bechtel Corporation.
2. Double entries represent as-found and as-left conditions, respectively.
3. Tendon detensioned for wire removal during current surveillance period.
4. Testing suspended at documented force, 'Field End' only. Safety concerns prohibited increased ram pressures necessary to achieve lift-off. (Reference Proposed Resolution to OEP IN 91-80)
5. Two attempts were made to remove a wire from this tendon. In each case, the field-end wire buttonhead was cut off. Neither wire sample was successfully extracted. Upon retensioning the tendon, a single unseated buttonhead was also identified at each end (field and shop). A wire sample was obtained from tendon 13H9.

**Figure 1**

**Dome Tendon Group Force-Time Plot**

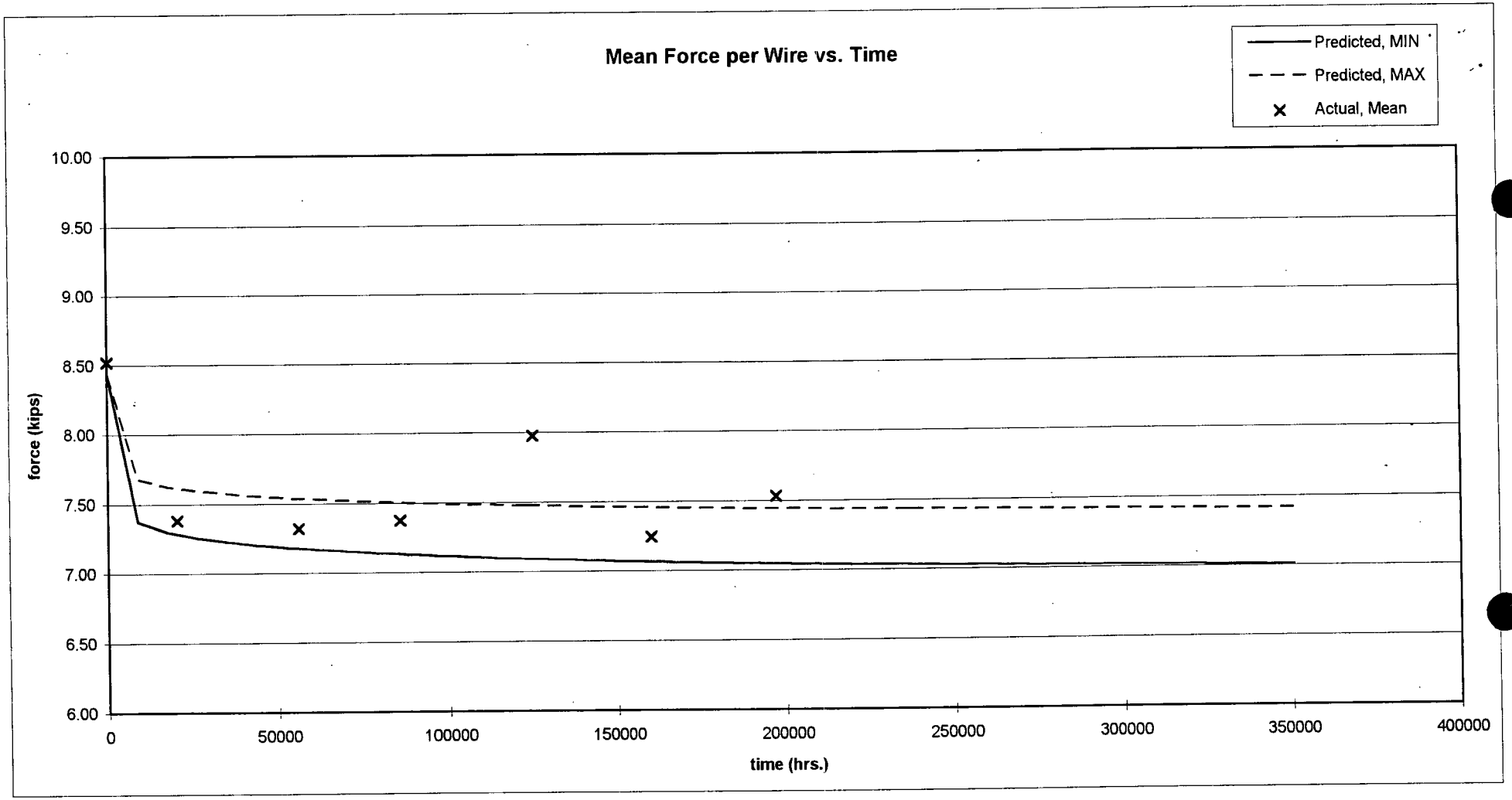


**Figure 2**

**Hoop Tendon Group Force-Time Plot**

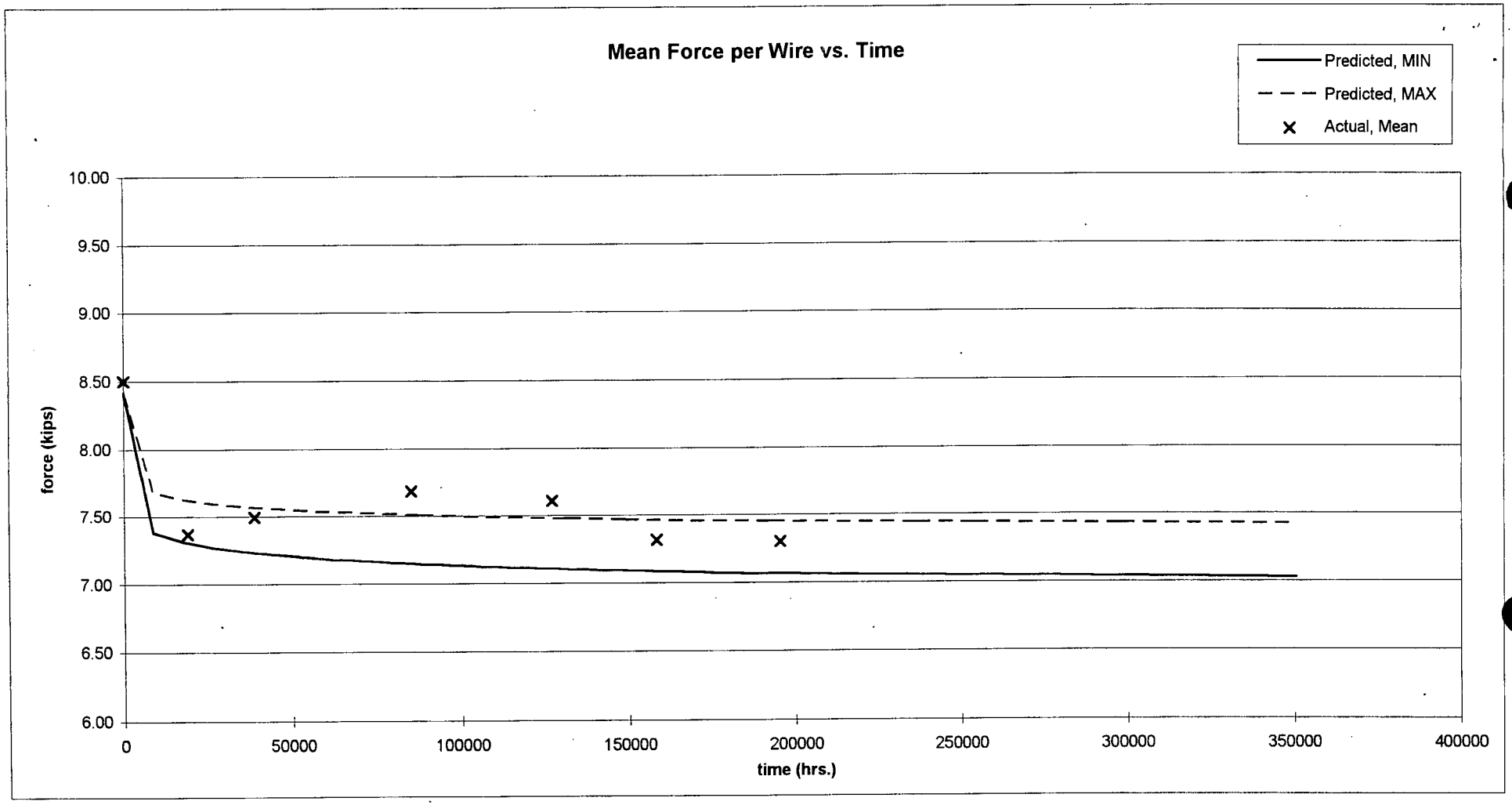
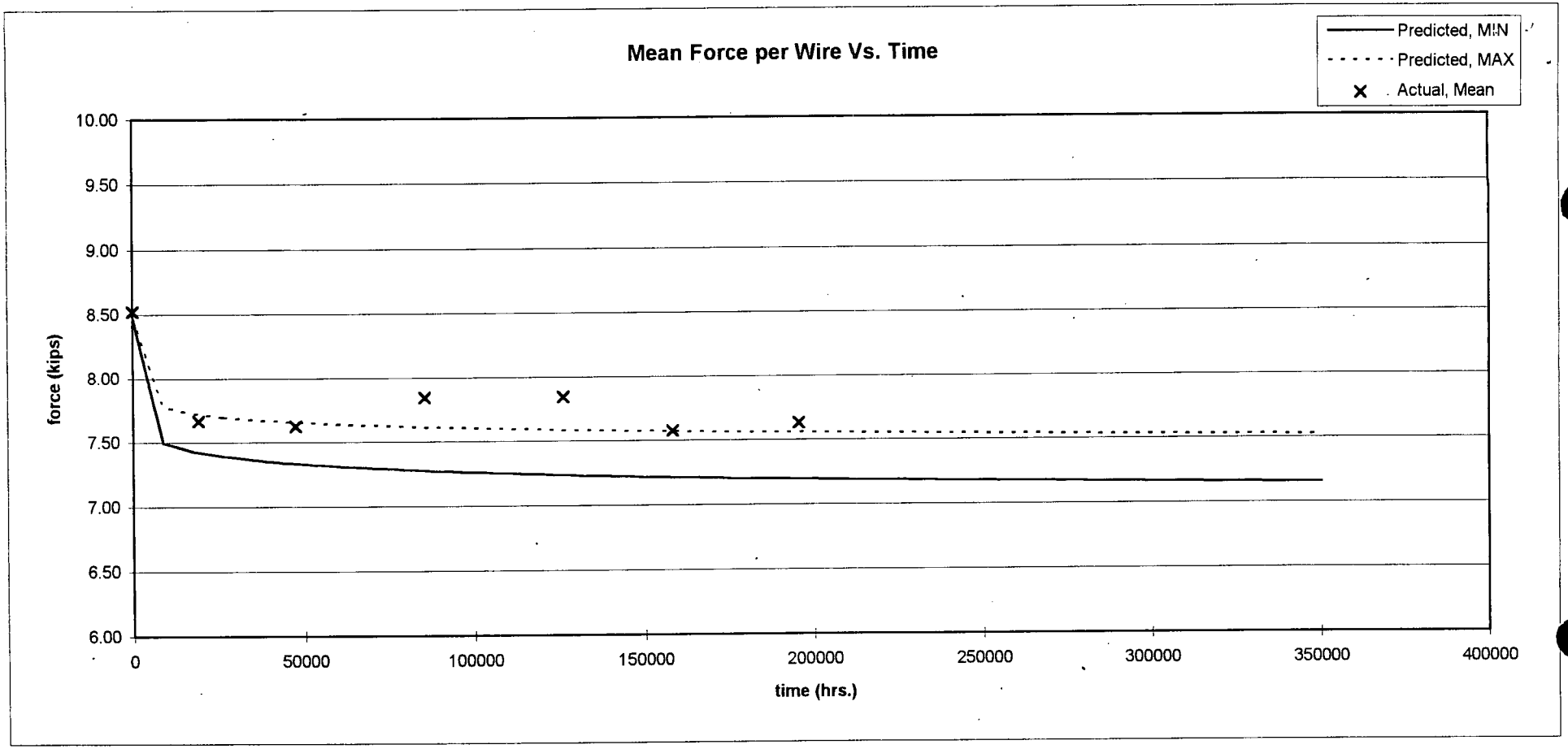


**Figure 3**

**Vertical Tendon Group Force-Time Plot**



Appendix A

Metallurgical Analysis Report

ELECTRIC SYSTEM SUPPORT
DUKE POWER COMPANY

**Diversified Services**

METALLURGY DUKE POWER FAILURE ANALYSIS

# Oconee 3
# Surveillance Tendons Tensile Testing

## Metallurgical Analysis Report

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**Equipment Description:**
Reactor building surveillance tendons 3D28, 13H9, 61V16

**Background Information:**
Periodic tensile testing is performed on selected tendons to assure their conformance to ASTM A421, as required by station technical specification 4.4.2.

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36" sections of each tendon were supplied as described below. Each was sectioned in half to create an 18" specimen; one sample was too deformed to produce two samples. A 10" gage length was used for elongation measurements taken directly from the fractured tendon. A 220,000-lb load cell was used, calibrated in 12/94 to be within a tolerance of ±0.5%.

| ID/Location | Diameter (in) | Percent Elongation | Maximum Load (lb) | Tensile Strength (ksi) |
|---|---|---|---|---|
| 3D28 - Shop end | 0.2501 | 4.7 | 12,380 | 252.0 |
| - " | 0.2500 | ** | 12,060 | 245.7 |
| - Center | 0.2501 | 4.7 | 12,440 | 253.3 |
| - " | 0.2500 | 5.2 | 12,420 | 253.1 |
| - Field end | 0.2500 | 4.8 | 12,460 | 253.9 |
| - " | 0.2499 | 5.0 | 12,520 | 255.4 |
| 13H9 - Shop end | 0.2510 | 5.8 | 12,350 | 249.7 |
| - " | (specimen not available) | | | |
| - Center | 0.2510 | ** | 12,340 | 249.4 |
| - " | 0.2508 | ** | 12,300 | 248.9 |
| - Field end | 0.2510 | 5.7 | 12,320 | 249.0 |
| - " | 0.2507 | 6.0 | 12,290 | 248.9 |
| 61V16 - Shop end | 0.2494 | 5.1 | 12,170 | 249.2 |
| - " | 0.2496 | ** | 12,200 | 249.4 |
| - Center | 0.2495 | 5.3 | 12,210 | 249.8 |
| - " | 0.2495 | ** | 12,140 | 248.3 |
| - Field end | 0.2496 | 5.6 | 12,250 | 250.9 |
| - " | 0.2498 | 6.0 | 12,240 | 249.8 |

** : specimen broke outside gage marks

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**Conclusions:**
ASTM A421 requires a minimum tensile strength of 240 ksi and 4.0% elongation. The tendons exceeded those mechanical requirements. There were no signs of corrosion or other deterioration of the tendons.

If the Metallurgy Lab can be of further assistance, please call us at (704) 875-5275.