



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

NRC Assessment Report  
Fifteenth Year Tendon Surveillance  
Virgil C. Summer Unit 1

1. INTRODUCTION

Title 10 Part 50 of the Code of Federal Regulations, Appendix A, General Design Criterion 53(2) requires the licensee to have a periodic containment structure surveillance program. At the NRC's request, South Carolina Electric and Gas Company (SCE&G, the licensee) submitted a V. C. Summer Unit 1 containment building 15-year physical tendon surveillance report to the NRC on August 8, 1996. The licensee performed the surveillance in accordance with V. C. Summer Nuclear Station's Technical Specification (TS), SCE&G Specification SP-228-044461-000 Rev. 10, Proposed Rev. 3 to Regulatory Guide (RG) 1.35, and the Precision Surveillance Corporation Surveillance Manual. Both the TS and the RG specify performing periodic tendon surveillance as follows:

- inspecting tendon sheathing filler material
- measuring tendon lift-off force
- inspecting anchorage components
- inspecting tendon wires and performing tensile testing
- checking grease leakage
- detensioning and retensioning tendons
- refilling and resealing grease caps

The surveillance involved nine tendons (three from each tendon group, i.e., dome, vertical and horizontal) that the licensee selected randomly.

The licensee concluded that the post-tensioning system, as a whole, is in a satisfactory condition, based on an analysis of the surveillance results. The NRC requested the licensee to submit the report for NRC review to assure that tendon system performance is as designed. After a careful review of the report, the NRC had reservations about the licensee's test procedure and method of analyzing the tendon lift-off test data. The NRC conveyed its concerns to the licensee in two Requests for Additional Information (RAIs).

Enclosure

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The licensee's October 28, 1997, RAI response included a tendon surveillance data re-analysis. Re-analysis results indicated that the dome and hoop tendons will go below the minimum required value about 32 years after performing the structural integrity test (SIT). The licensee concluded that the V. C. Summer Nuclear Power Plant does not have any abnormal containment building post-tensioning system degradation, based on the information obtained from the 15-year tendon surveillance.

## 2. EVALUATION

The NRC staff reviewed the licensee's report, and found that the results of the 15-year post-tensioning system tendon surveillance generally conform with the relevant TS and Regulatory Guide 1.35, Proposed Revision 3, acceptance criteria. However, after a careful examination of the licensee's tendon tests and its analysis, the staff had some reservations about the licensee's test procedure and analysis method. A discussion of this, and our conclusions, follow.

### 2.1 Tendon Lift-Off Force

The licensee did not detension and retension the tendons as specified in Sections 4.2 and 7.2 of RG 1.35, Proposed Rev. 3, even though they claimed to have done this. Section 4.2 requires that during retensioning, the simultaneous measurement of elongation and jacking force should be made at a minimum of three approximately equally spaced levels of force between zero and lock-off force. It appears that during installation, the licensee recorded only the seating force and its corresponding elongation, and did the same during the retensioning, disregarding Section 4.2 recommendations. The purpose of Section 4.2 is to check how well the lift-off was done. If the information specified by Section 4.2 is available, the linear relationship between force and elongation can be used for such a check. Section 7.2 specifies recording elongation corresponding to a specific load during detensioning and retensioning, and then comparing this with values obtained during the initial tendon installation. The purpose of Section 7.2 is to ensure that the difference between the elongations at detension and at initial installation is not related to wire failures or a slippage of wires in the anchorage. With the button head system used, the latter is not likely. However, the potential for wire failure exists. Section 7.2 specifies that the licensee should identify any difference of more than 10% in their tendon surveillance report. From the tendon retensioning data which the licensee provided in its October 28, 1997, response, the difference for one tendon (D220) was 20.48% and the difference for the other (V69) was 12.8%. The licensee did not identify any wire failures in their report, nor did they

provide a reason for the differences. Without the information specified in Section 4.2, it becomes difficult to determine the source of the differences. One plausible explanation is that there was an error in making the measurements.

The licensee used the average of the lift off forces for each surveillance and plotted this on a graph to determine the trend of the prestressing forces for each group of tendons. There are five points on the graph to represent the five surveillances. The five points are joined by line segments. On the basis of such a graph, the licensee determined visually that the tendon force level will be acceptable beyond the 20th year, i.e., the next surveillance for each group of tendons. Such a method of forecasting the tendon forces is too simplistic and lacks a good theoretical basis. The staff requested the licensee to perform a linear regression analysis using the individual lift-off forces from each surveillance instead of the average of the lift-off forces. The licensee performed this analysis, and found that the hoop and dome tendons will not go below the minimum required force until approximately 32 years after performing the SIT. For the vertical tendons which have been retensioned, the time that they are predicted to go below the minimum required force is 42 years after performing the SIT. Therefore, there should not be any concern with respect to the level of tendon forces before the next surveillance.

## 2.2 Grease Voids

Table XIII of the licensee's physical tendon surveillance report indicates that there is barely any tendon grease leakage. However, for one vertical tendon (V-40) the grease replaced is 10.75 gallons less than that removed. The licensee attributed this shortfall to an error in the recorded amount of grease removed. A subsequent licensee evaluation determined that the difference was actually only 1.5 gallons. Chemical tests of the grease as shown in Table I of the licensee's report fully met the acceptance criteria. The licensee removed wires from the detensioned tendons and found them to be either in excellent or good condition, i.e., no corrosion or barely any. No water was found either in the grease can or around the anchorages.

## 2.3 Anchorage Assembly and Tendon Wire

The licensee inspected the button heads of the wires. The only abnormalities found were three broken or missing button heads. Anchor-heads, bushings, shims and end bearing plates were also visually examined for cracking and corrosion, and only some minor corrosion and pitting were found. The licensee took wire samples in accordance with its specified procedure, and subjected

them to tensile testing. The tests revealed there was no significant change in ultimate strength. The licensee also examined the concrete around the bearing plates, and no cracks greater than 0.010 inch were evident. On the basis of the information provided, the staff concludes that anchorage components and the tendon wire are in good condition.

### 3.0 CONCLUSION

On the basis of the staff's review of the information provided by the licensee, the staff concurs with the licensee's conclusion that the overall condition of the containment tendon system is satisfactory. However, we recommend that the licensee follow the guidance in Section 4.2 of RG. 1.35, Rev. 3, for future tendon surveillance. This will provide a method for determining how well they perform the surveillance. It also can be used to trace the source of any errors in the tendon lift-off tests without much additional effort. Further, in determining the trend of the tendon forces of a group through the use of linear regression analysis, the individual tendon forces in the group, not their average, should be used. The licensee's 20-year surveillance results might indicate that the hoop and dome tendon forces will go below the minimum required values prior to the 32nd year after the structural integrity test. The licensee should have a long-term plan for this. The licensee has indicated that prior to the next (sixth) tendon surveillance, the tendon surveillance program will be updated to comply with 10 CFR 50.55a, which requires licensees to incorporate ASME Section XI Subsections IWE and IWL into their Inservice Inspection Program.

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