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SUBJECT: Special rept: on 880701, hoop tendons measured lift-off force below value required by Reg Guide 1.35.1.

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. SPECIAL REPORT

LOW LIFT-OFF VALUES OF HOOP TENDONS

DESCRIPTION

On July 1, 1988, during the performance of the fifteenth year tendon surveillance of the Turkey Point Unit 4 containment post-tensioning system, one surveillance tendon, 13H51, of the horizontal tendon group, was found to have a measured lift-off force 0.3 percent below the lower bound predicted value calculated in accordance with the requirements of Regulatory Guide 1.35.1. Consequently, additional lift-off measurements on a tendon located below (13H50) and a tendon located above (13H52) were taken. As the measured lift-off force in tendon 13H51 was below the predicted lower bound value, the plant entered a 15 day action statement requiring restoration of the tendons to the required level of integrity within 15 days, performance of an engineering evaluation of the containment, and the submission of a Special Report to the Commission within 30 days. This action statement is part of procedure O-ADM-021, "Technical Specification Implementation Procedure," and not a part of the current Technical Specifications to which Turkey Point is licensed. As this report is not required by Turkey Point's current Technical Specifications, it is being submitted as a voluntary Special Report in accordance with O-ADM-021.

The Turkey Point Unit 4 reactor containment structure consists of a flat reinforced concrete base mat, an upright prestressed concrete cylinder and a shallow prestressed concrete dome. The prestressing force is provided by an unbonded post-tensioning system. The system consists of 180 vertical, 489 horizontal, and 165 dome tendons. Each tendon consists of 90 - 1/4 inch diameter wires. The tendons are inserted inside sheathing ducts embedded in the concrete, and anchored on both ends by means of steel anchor blocks. The wires are anchored to the anchor blocks by cold formed button heads. The tendon ducts are filled with a corrosion inhibiting grease, and the end anchorages are covered with tightly bolted caps.

The post-tensioning system for the Turkey Point Unit 4 containment has been in service since 1972. Periodic inspections have been performed previously on the tendon system in accordance with Technical Specification requirements.

Except for horizontal tendon 13H51, the lift-off forces measured in all vertical, horizontal and dome surveillance tendons were above the predicted lower limits. The lift-off force for tendon 13H51 was measured as 584.2 kips, while the lower bound predicted value is 585.7 kips. This is less than a 0.3 percent variation from the lower bound requirement. In accordance with O-ADM-021, lift-off forces in the tendons below (13H50) and above (13H52) tendon 13H51 were measured. Tendon 13H52 recorded a measured lift-off value of 607.1 kips, which is above its lower bound predicted value of 585.7 kips. The measured lift-off force in tendon 13H50 was 581.6 kips, or 0.55 percent below the lower bound predicted value of 584.8 kips. Since the lift-off force in tendon 13H50 was also below its predicted lower bound value, the lift-off force in the next adjacent tendon (13H49) was measured. This

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tendon had a lift-off value of 583.1 kips, which is 0.3 percent below its predicted lower bound value. In the same manner, the lift-off force in the next adjacent tendon (13H48) was measured. A lift-off value of 586.8 kips, which is 0.3 percent above its predicted value of 584.8 kips, was recorded and additional testing was therefore terminated.

ANALYSIS

The lift-off forces which are at variance with the predicted values occurred in one of the surveillance tendons and in two additional adjacent tendons. The average variation relative to the lower bound acceptable limit for the adjacent tendons (13H49, 13H50, 13H51) is 0.4 percent. Considering the lift-off forces in tendons 13H48 and 13H52, which physically bound the three tendons exhibiting low lift-off forces, the average reported lift-off for the group of five tendons is 0.6 percent above the average acceptable lower bound predicted limit. In both cases, the variation is extremely small and has occurred after the containment has already experienced the major portion of identified losses (shrinkage, creep, relaxation.)

Additionally, in the design of the Turkey Point post-tensioning system, losses due to concrete creep were calculated as a single conservative value of 19.2 ksi (or 11.4 percent) for all vertical, horizontal and dome groups of tendons. The actual value obtained by test as reported in the Final Safety Analysis Report (FSAR) is 14.8 ksi (or 8.8 percent) for the hoop and dome tendons and 7.4 ksi (or 4.4 percent) for the vertical tendons. In establishing the surveillance acceptance criteria, the lower bound predicted value of the tendon lift-off forces was determined based on a slightly more conservative concrete creep loss value of 8.6 percent. If the design creep loss value of 11.4 percent had been used, the lower bound predicted value of lift-off force for tendon 13H51 would have been 569.3 kips instead of 585.7 kips. As the measured lift-off force in tendon 13H51 was 584.2 kips, which is well above the design lower bound predicted value of 569.3 kips, the measured lift-off force for tendon 13H51 could have been considered acceptable without any further action. This rationale is also valid for tendons 13H50 and 13H49, which had a slightly lower measured lift-off force compared with the conservatively predicted lower bound lift-off forces. Similar conservative assumptions were also made for losses due to shrinkage.

In addition to the conservative assumptions regarding material behavior and the computation of system prestress losses, the containment post-tensioning system is designed to provide additional margins beyond the design criteria requirements.

As described in the FSAR, three 120 degree horizontal tendons comprising one complete hoop system have been provided over and above the structural requirements for the purpose of inspection and obtaining lift-off readings. In addition, as stated in the FSAR, any three adjacent horizontal tendons can be lost without significantly affecting the strength of the containment structure. This design feature considers the load redistribution capabilities of the containment shell.

The prestress level included in the design of containment post-tensioning systems similar to Turkey Point is typically 1.25 times the committed design pressure. In addition, this structural system is designed to maintain this prestress level at

the end of 40 years service when the assumed losses are estimated to have occurred. Therefore, at any time before the end of the 40 year service life, only part of the losses are expected to have taken place and the system would have additional capacity which exceeds 1.25 times the committed design pressure.

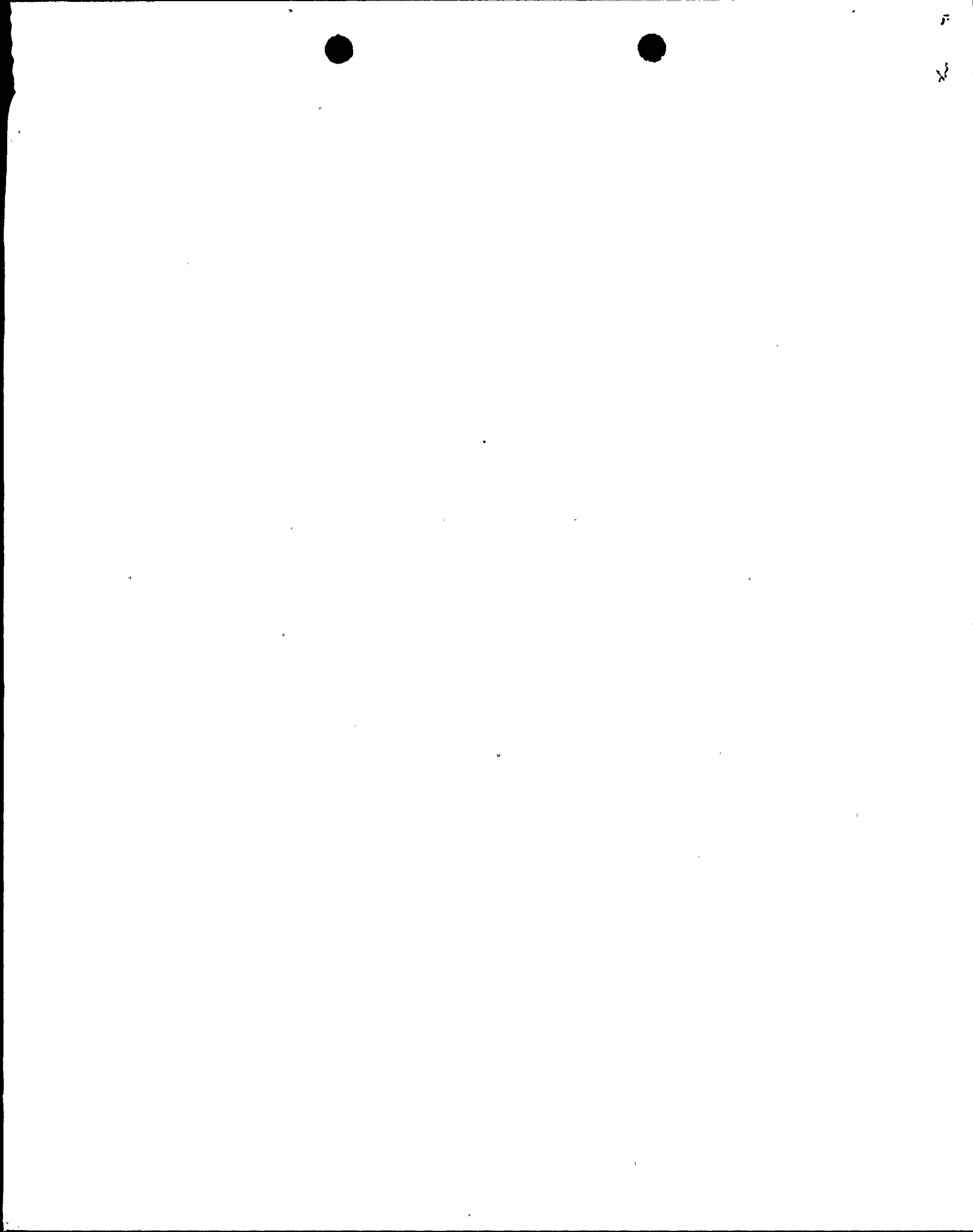
Recent evaluations and testing to assess the ultimate capacity of reactor building containment structures similar to the Turkey Point containment design have shown an ultimate capacity of 2.5 to 3.0 times the design pressure.

No abnormal conditions which could have resulted in this deviation were identified.

Based on the design margins incorporated in the post-tensioning system and the stress levels measure in the tendons, it can be concluded that the containment post-tensioning system will maintain its integrity and is capable of continued acceptable performance.

CORRECTIVE ACTIONS

- 1) The lift-off forces in tendons 13H49, 13H50, and 13H51 have been restored to their predicted lower bound lift-off values.
- 2) The lift-off values for tendons 13H48, 13H49, 13H50, and 13H51 will be obtained during the next scheduled surveillance, in addition to the normally selected surveillance tendons.





AUGUST 4 1988

L-88-336

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

Gentlemen:

Re: Turkey Point Unit 4
Docket No. 50-251
Special Report - Low Lift-Off
Values of Hoop Tendons

In accordance with Turkey Point Administrative Procedures the attached Special Report is provided for your information.

Should there be any questions on this information, please contact us.

Very truly yours,


W. F. Conway
Senior Vice President - Nuclear

WFC/RG/gp

Attachment

cc: Dr. J. Nelson Grace, Regional Administrator,
Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant

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