UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

March 8, 1985

IE INFORMATION NOTICE NO. 85-10, SUPPLEMENT 1: POSTTENSIONED CONTAINMENT TENDON ANCHOR HEAD FAILURE

Addressees:

All nuclear power reactor facilities holding an operating license (OL) or a construction permit (CP).

Purpose:

This information notice is provided to supplement Information Notice 85-10 by advising addressees of (1) the failure of an additional anchor head (from a different fabrication lot control number), (2) discovery of water within the greased tendon system, and (3) the preliminary determination of the cause of the failures as provided by Alabama Power Company for Farley Unit 2. It is expected that recipients will review the information for applicability to their facilities and consider actions, if appropriate, to detect a similar problem at their facilities. Suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

NRC is continuing to obtain and evaluate pertinent information. If specific actions are determined to be required by NRC, an additional notification will be made.

Background:

Information Notice 85-10 described conditions that were recently discovered at the Farley Unit 2 facility after the anchor heads had been installed and sealed in grease for nearly 8 years. Additionally, the information notice described anchor head failures that occurred during construction at Bellefonte Units 1 and 2 and at Byron Units 1 and 2.

Description of Circumstances:

On February 26, 1985 while continuing the tendon inspection program that Alabama Power Company had underway, an additional field anchor head (the third vertical tendon anchor head) was found in a failed condition at the bottom of a vertical tendon. In the as-found condition the anchor head was broken, but it was still carrying an estimated 25-30% of the original load. While detensioning the anchor head, it separated into five pieces. This anchor head was from a fabrication lot different than the two failed anchor heads that had

been reported earlier in Information Notice 85-10. The anchor head that was noted to be cracked in the earlier report has now been detensioned, the anchor head removed, and the anchor head examined metallographically.

As of March 1, 1985, the licensee had completed the visual inspection of many of the anchor heads by removing the grease caps, cleaning grease from the anchor head, and visually inspecting for cracks, moisture, or other evidence of distress. All 130 field anchor heads (bottom) of vertical tendons have been inspected; nearly one-half of those were reported being found with moisture. Approximately one-half of the horizontal (hoop) tendon anchor heads have been inspected; of those, less than 10% were reported being found with moisture. About one-fourth of the dome tendon anchor heads have been inspected; moisture was found on nearly 5%. As discussed below, moisture may be a significant contributor to the failure of the three anchor heads discovered broken or with major cracks.

Water was found in the grease cap or on the anchor head in each case of the three failed vertical tendon field anchor heads. The quantity of water found associated with these varied from a few ounces to 1/2 pint. The maximum amount of water reported, to date, by the licensee was 1-1/2 gallons, which was found in one grease cap when it was removed from a vertical tendon field anchor head.

The licensee obtained preliminary results from two laboratories, on the analysis of failed anchor head material, that indicated the failures have been caused by hydrogen-stress cracking (HSC). The conditions necessary for HSC to occur include a high-strength steel subjected to sustained tensile stresses and a source of atomic hydrogen. Testing, to date, reveals evidence that a corrosion cell was established between steel and zinc in the presence of the available water. The zinc source may have been particles from the inside of the galvanized tendon sheaths that were abraded during tendon installation and tensioning or from the inside of the galvanized grease caps, some of which showed evidence of surface etching which points to an active corrosion cell. The corrosion cell produced the atomic hydrogen that was then apparently adsorbed by the steel, resulting in cracks and their growth by hydrogen-stress cracking.

The resulting cracking surfaces exhibited intergranular separation and the magnitude of the cracking could continue to grow as the corrosion cell continued to produce hydrogen until a critical crack size was reached. Rapid section failure then would occur as a result of increased stresses (same load but on a reduced area).

At the present time the licensee is proceeding to remove and inspect, by magnetic particle testing (MT), the vertical tendon field anchor heads (located at the bottom of the verticals in the tendon gallery) that have not yet been replaced with new heads. Hoop and dome tendon anchors found with significant amounts of water will be detensioned and the heads removed for MT. If cracking is found, they will be replaced; if no cracking is found the old head will be reused. As of March 1, 1985, there had been 28 field anchor heads replaced. The licensee is now precoating the anchor head, installing wires, buttonheading, and regreasing the completed anchor head assembly prior to retensioning the tendon.

The licensee also conducted load tests on 4 removed field anchor heads. One was found by MT to have 3 ligament cracks before load testing, and 2 of the 4 had water reportedly found with them. The cracks typically occur between two holes (a ligament crack) and may extend fractions of an inch into the anchor head. Each anchor head was able to carry a minimum load of 140% of the guaranteed ultimate tensile strength of the tendon without failure. Three of the field anchor heads exhibited additional cracks after the load tests. The anchor head with the 3 original ligament cracks was determined to have intergranular separation.

Discussion:

Current plant technical specifications, where posttensioned concrete containments are used with greased tendons, typically state that during required surveillance periods the sheath filler material (grease) is to be checked to verify that it has not undergone a "change in physical appearance." The intent of such a statement is not just to ascertain that the filler material continues to meet the original material specifications, but also that the filler material is performing its original function, which is to preclude moisture from entering the tendon assembly. Therefore, the presence of moisture or free water during any surveillance activity should be considered evidence of an abnormality and require further action.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the Regional Administrator of the appropriate regional office or this office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

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Attachment:
List of Recently Issued IE Information Notices

LIST OF RECENTLY ISSUED IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
85-18	Failures Of Undervoltage Output Circuit Boards In The Westinghoust-Designed Solid State Protection System	3/7/85	All Westinghouse PWR facilities holding an OL or CP
83-70 Sup. 1	Vibration-Induced Valve Failures	3/4/85	All power reactor facilities holding an OL or CP
85-17	Possible Sticking Of ASCO Solenoid Valves	3/1/85	All power reactor facilities holding an OL or CP
85-16	Time/Current Trip Curve Discrepancy Of ITE/Siemens-Allis Molded Case Circuit Breaker	2/27/85	All power reactor facilities holding an OL or CP
85-15	Nonconforming Structural Steel For Safety-Related Use	2/22/85	All power reactor facilities holding an OL or CP
85-14	Failure Of A Heavy Control Rod (B4C) Drive Assembly To Insert On A Trip Signal	2/22/85	All power reactor facilities holding an OL or CP
85-13	Consequences Of Using Soluble Dams	2/21/85	All BWR and PWR facilities holding an OL or CP
85-12	Recent Fuel Handling Events	2/11/85	All power reactor facilities holding an OL or CP
85-11	Licensee Programs For Inspection Of Electrical Raceway And Cable Installation	2/11/85	All power reactor facilities holding a CP
85-10	Posttensioned Containment Tendon Anchor Head Failure	2/6/85	All power reactor facilities holding an OL or CP

OL = Operating License
CP = Construction Permit