

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

February 6, 1985

IE INFORMATION NOTICE NO. 85-10: 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 alert recipients of current information relating to a potentially significant problem regarding recent failures of 170-wire posttensioned containment tendon anchor heads at Unit 2 of the Farley Nuclear Station. 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. However, suggestions contained in this information 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, an additional notification will be made.

Description of Circumstances:

Farley Unit 2

On January 28, 1985, while conducting a preintegrated leak rate test walkdown of the exterior of the containment structure at the Farley Unit 2 facility, an alert utility worker noted grease leakage and a deformed vertical tendon anchor grease cap on the top of the containment ring beam. When the grease cap on the same tendon was inspected in the tendon access gallery, it also revealed a deformed grease cap. Removal of the grease cap showed that the field anchor head had broken into seven pieces. The posttensioning force (approximately  $1.5 \times 10^6$  pounds) also had been released and numerous broken wires from the 170-wire tendon were found.

On the basis of this finding, the utility removed some additional tendon anchor grease caps. Of the first eight anchor heads uncovered for inspection, one was found to be cracked. Inspection was curtailed until the cracked anchor head can be detensioned. The tendon associated with this anchor head is still transmitting posttensioning force to the containment. The utility determined from their records that the broken anchor head and the cracked anchor head have the same fabrication lot control number.

Additionally, the utility has sent some of the pieces of the broken anchor head to two laboratories for a series of tests for failure analysis, including tests on metallurgical, mechanical, chemical and other physical properties. Testing of the corrosion inhibitor grease is under way.

Currently, the utility has personnel from the architect-engineer and the material supplier on-site in the continuing investigation. Neither the NRC nor the licensee has yet fully integrated the information regarding the results of previous tendon surveillance activities at the Farley site into this information notice. Oral information from the licensee indicates the tendons at Farley Unit 2 were posttensioned in early 1977. The unit has been operational since May 1981. The specific tendon whose anchor head failed and the one found with a cracked anchor head were not included in the sample of tendons that were subjected to surveillance activities since the plant began operation. Thus, there is no definitive information currently available on the time of occurrence of the breakup of the one anchor head or the crack formation in the other anchor head.

While no specific conclusions have been reached at this time regarding the cause of the failures, the NRC believes that based on the conversations with the supplier, INRYCO, that all material from the same fabrication lot control number as the failed heads was utilized exclusively at Farley Unit 2.

The previous history of anchor head failures before the event at Farley Unit 2, in nuclear applications, has been confined to occurrences during the construction phase (during or shortly after posttensioning). It is during this time that the tendon system, including the anchor head, undergoes the maximum loading force.

As background information, previous 170-wire tendon anchor head failures during construction at other facilities are briefly summarized below.

#### Bellefonte Units 1 and 2

During 1975 and 1976 a series of eight rock anchor heads, supplied by INRYCO for the containments at Bellefonte Units 1 and 2, failed during construction installation. In the phased construction process these 170-wire assemblies were sealed for long periods in a highly alkaline water environment. These anchor heads were to be coupled to the posttensioned containment vertical tendons to serve as a direct tie between the containment and the rock foundation material. In these instances the anchor head also broke into several pieces. The licensee's investigations completed on these failures cited several possible contributors. These included: (1) high anchor head stress as a result of a 1.4-inch-diameter hole in the head for grout passage, (2) inclusions in the steel found oriented parallel to the final failure plane, (3) bending of shims and anchor plate, and (4) unknown environmental conditions which facilitated stress corrosion cracking. The NRC had an independent study made that concluded possible stress corrosion cracking as the initiator.

The resolution of the problem resulted in the removal of all the anchor heads and replacement with new anchor heads made from a vacuum degassed (cleaner)

steel with the center grout hole eliminated and the anchor head coated for temporary environmental protection. The NRC is aware of no further failures at Bellefonte after this corrective action.

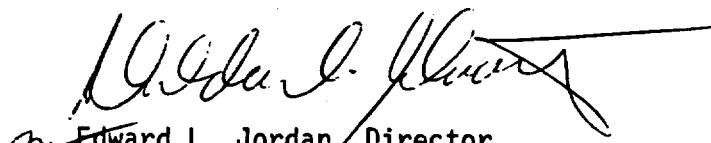
### Byron Units 1 and 2

In November of 1979 two 170-wire anchor heads on horizontal tendons were reported to have failed during construction of the Byron containments. One failure occurred one day after stressing and seating the tendon and the other occurred 13 days after stressing and seating. By the end of January 1980, two additional anchor heads had been reported as having failed. The supplier of the anchor heads was INRYCO. Investigations were made by INRYCO on the material from seven separate fabrication lots. It was found that the basic steel material used in several of the batches had been manufactured by a process that utilized vanadium grain refinement causing an incompatibility with the postfabrication heat treatment. This resulted in a different steel chemistry that would have required a higher temperature for proper heat treatment. As a result of this conclusion all anchor heads that had received improper heat treatment for the basic steel chemistry were removed and replaced. The NRC is not aware of any failures at Byron since the corrective action.

### Discussion

Because the integrity of the posttensioned concrete containment structure is based on a highly redundant system of numerous tendon elements (several hundred), the failure of one such element in a family of tendons does not jeopardize containment structural capability. It does, however, necessitate a determination that a mechanism or systematic problem has not arisen under service conditions when one such failure in a tendon is revealed. Specific tendon geometry, tendon size, containment design details, and location of individual tendons with lost or lowered strength properties would dictate the critical number of tendons that could be lost before containment integrity is jeopardized.

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

Technical Contact: R. Shewmaker, IE  
(301)492-7432

Attachment: List of Recently Issued IE Information Notices

LIST OF RECENTLY ISSUED  
 IE INFORMATION NOTICES

| Information Notice No. | Subject   | Date of Issue | Issued to  |
|------------------------|---|---------------|--|
| 85-09                  | Isolation Transfer Switches And Post-Fire Shutdown Capability             | 1/31/85       | All power reactor facilities holding an OL or CP   |
| 85-08                  | Industry Experience On Certain Materials Used In Safety-Related Equipment | 1/30/85       | All power reactor facilities holding an OL or CP   |
| 85-07                  | Contaminated Radiography Source Shipments                                 | 1/29/85       | All NRC licensees authorized to possess industrial radiography sources   |
| 85-06                  | Contamination of Breathing Air Systems                                    | 1/23/85       | All power reactor facilities holding an OL or CP   |
| 85-05                  | Pipe Whip Restraints  | 1/23/85       | All power reactor facilities holding an OL or CP   |
| 85-04                  | Inadequate Management Of Security Response Drills                         | 1/17/85       | All power reactor facilities holding an OL or CP, & fuel fabrication & processing facilities   |
| 85-03                  | Separation Of Primary Reactor Coolant Pump Shaft And Impeller             | 1/15/85       | All pressurized water power reactor facilities holding an OL or CP   |
| 85-02                  | Improper Installation And Testing Of Differential Pressure Transmitters   | 1/15/85       | All power reactor facilities holding an OL or CP   |
| 85-01                  | Continuous Supervision Of Irradiators                                     | 1/10/85       | All material licensees possessing irradiators that are not self-shielded and contain more than 10,000 curies of radioactive material |

OL = Operating License  
 CP = Construction Permit