



UNITED STATES
NUCLEAR REGULATORY COMMISSION

REGION IV
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN
DOCKET NO. 50-267
PCRV TENDON CORROSION INVESTIGATION
AND PROPOSED REMEDY

PCRV Tendon Degradation - Background:

In 1984 during the scheduled PCRV tendon surveillance, the licensee discovered that certain PCRV tendons had broken and corroded wires. In order to determine the extent of this problem, the licensee increased the number of visual examinations of accessible tendons ends. He also performed a number of lift-off tests. Metallurgical examinations of the tendon wires and tests on the protective grease that were performed by the licensee indicate that the corrosion is the result of microbiological attack on the original tendon grease. The licensee has proposed to halt this degradation by filling the tendon sheaths with an inert nitrogen "blanket".

As a mechanism for monitoring the condition of the tendons, the licensee has proposed a surveillance program that increases the frequency of the visual inspection and lift-off tests. The surveillance program would compare an uncorroded tendon control group with a corroded tendons group to establish the effectiveness of the corrosion arresting method and the trend in the tendon wire degradation. The program would include samples of the longitudinal, circumferential, and crosshead tendons proportional to the population of the tendon types.

Evaluation:

1. Monitoring:

The staff evaluated the licensee's proposed program for monitoring the PCRV tendons and finds the proposal acceptable for assuring PCRV integrity in the near term with certain modifications, as discussed below:

The surveillance program, as proposed, would produce a sample of significant size to indicate the trend of the tendon wire degradation and the effectiveness of the corrosion arresting method. However, the information gathered by the licensee from the past and future surveillance activities should be integrated into a complete visual presentation covering all tendons. The purpose of this presentation format would be to provide better information of the extent and significance of the tendon degradation problem. The licensee has committed to incorporate the modified tendon surveillance requirements into the technical specifications.

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2. Corrosion Control:

The staff evaluated the integrity of the PCRV with the degraded tendons in a safety evaluation dated May 16, 1984. The staff findings were that the reactor vessel was capable of withstanding the operating pressures with the degraded tendons as determined at that time. Since May 1984, a few additional wires have broken but the reactor vessel remains able to adequately withstand the operating pressure. The licensee plans to use a nitrogen "blanket" in the tendon sheaths to halt the degradation of tendons; however, our earlier evaluation indicated concern with this approach. Accordingly, we recommend that the licensee carefully evaluate the effectiveness of other techniques, in terms of their ability to remove oxygen and moisture, and their long term effects on tendon corrosion.

3. Corrosion Problems at Other Plants:

The corrosion problem at Fort St. Vrain (FSV) appears to be different from the tendon problems recently experienced at some other nuclear plants. In the other plants, tendons are used in the containment structure which experiences ambient temperatures and the tendon sheaths are filled with grease. The tendons at Fort St. Vrain are located in the reinforced concrete reactor vessel. These FSV tendons experience higher temperatures than other plants and are in sheaths not filled with grease. The FSV tendon wires themselves are protected by a grease coating and the tendon sheath annulus is coated on the inside with a layer of grease.

A failure mechanism has been identified at the other plants related to stress corrosion cracking of the tendon wire stress washers when water was present, predominately in the lower end of the vertical tendons. The stress washers are manufactured from a high strength steel which is susceptible to stress corrosion cracking when exposed to a source of hydrogen.

The tendon wires at FSV appear to be corroding from the attack of formic and acetic acids generated from microbiological sources. The corrosion and failures seen to date at FSV seem to be limited to the wires themselves with only one incident of corrosion occurring on the stress washer. No evidence of failure of the stress washers has been detected to date. The licensee has visually examined 10 of the 34 accessible bottom stress washers of the longitudinal tendons and reported the results in a letter dated June 7, 1985. No evidence of cracking was found. However, the possibility of stress washers failing from corrosion cannot be ruled out. The continued presence of moisture in the tendon tubes could lead to failure of the stress washers as seen at other plants. The licensee has proposed an intensified surveillance program which consists of visual inspection of the anchorages and lift-off tests. The licensee proposed to incorporate these inspection requirements into the plant technical

specifications under Section 3/4.6.4 "PCRV Integrity". This intensified surveillance program will require a visual inspection and a report on a sample of 56 tendons at six month intervals. The surveillance program will also require 37 tendons to be lifted-off their shims to determine the amount of prestress available. A sample of 12 tendons are designated as a control set for visual inspection and 8 tendons are the control set for lift-off tests. The samples of 44 visual inspection and 25 lift off tendons will be rotated thru the tendon population.

4. Restart and Re-evaluation:

The staff has reviewed the licensee's proposed surveillance and the commitment to incorporate the surveillance requirements into the technical specification. The staff accepts the tendon surveillance proposal and find that the proposal would lead to maintaining the structural integrity of the reactor vessel. The staff also finds that the visual inspection of the tendon wire anchorage washer is currently sufficient to determine if failure of the washers has occurred. The increased tendon surveillance would be sufficient to show any tendency of the stress washers to fail similar to those at another nuclear plant. The staff finds the plant structurally ready for restart.

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