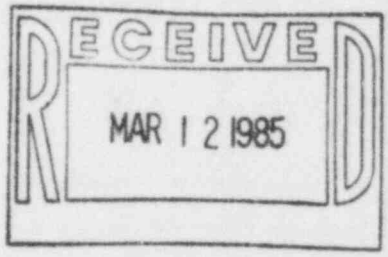
Public Service
2420 W. 26th Avenue, Suite 100D, Denver, CO 80211

Public Service
Company of Colorado
P.O. Box 840
Denver, CO 80201 - 0840
(303) 571 - 7511

March 5, 1985
Fort St. Vrain
Unit No. 1
P-85071



Regional Administrator
Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive Suite 1000
Arlington, Texas 76011

Attn: Mr. Eric Johnson

DOCKET NO. 50-267

SUBJECT: Fort St. Vrain Unit No. 1
Revised Tendon Surveillance
Program

REFERENCES: 1) P-85039, Gahm to Johnson,
dated January 31, 1985

2) P-84523, Warembourg to
Johnson, dated
December 14, 1984

Dear Mr. Johnson:

As a result of our porposal for a PCRV tendon surveillance program presented at the February 20-22, 1985 site meetings and subsequent telephone conversations, we are transmitting herewith our written description of this program.

The basis for our proposal is as follows:

A. Surveillance Frequency and Tendon Population

Our original interim surveillance program as proposed by P-85039, established an 18 month frequency for the visual inspection and liftoff test programs. While it is felt that this program would provide adequate monitoring of the prestressing system, we recognize that the present data base is not sufficient to define a corrosion rate. Based on present information, the corrosion rate appears to be relatively slow, but we feel it is necessary to develop a more sufficient data base. On this basis we have proposed the accelerated inspection/testing program for

65-29

RIV Official File Copy

H005
RETURN ORIGINAL
TO RIV 1/1

the next three (3) year period or until such time that effective corrosion control is established. The program changes the previously proposed 18 month frequency for visual inspection to a six (6) month frequency. The proposed program also establishes a larger control group of tendons to permit a better assessment of corrosion rate.

The liftoff frequency for the new tendon population remains the same as previously proposed; however, a control group has been established to provide a liftoff assessment every six (6) months for tendons in this group.

This substantial increase in the surveillance program together with a very high percentage of tendons that we have already inspected/tested provides the necessary assurance that PCRV prestressing system is capable of performing its design function.

B. Engineering Evaluations/Failed Wire Criteria

As indicated in the proposed surveillance program, we will be continuously assessing the PCRV prestressing system from an engineering viewpoint as data is obtained in the surveillance program. We expect the surveillance program to be continuous over the frequency cycle specified.

Within the proposed program, we did specify a mandatory engineering evaluation based on $\geq$ 15% failed wires for circumferential barrel tendons and $\geq$ 20% failed wires for all other tendons. It should be noted that the program outlined on February 22, 1985, during the NRC site meetings established a general criteria of $\geq$ 20% failed wires for all tendons. That original criteria did not recognize the two sub-groups of circumferential tendons, one of which is the 152-wire circumferential barrel tendons. As a result, this surveillance program has established a $\geq$ 15% failed wire criteria for the circumferential barrel tendons.

Design Criteria DC-11-1 (FSAR, Appendix E) requires the PCRV be designed to resist a cavity pressure of 2.1 RP (1775 psig) for Limit Condition 2 which is the governing case. The allowable stress/strength limits for this condition are:

Longitudinal tendons - Guaranteed ultimate tensile strength provided that strain compatibility is satisfied.

Circumferential tendons in barrel - Same as above.

Top and bottom head tendons (circumferential and crosshead) - 0.9 fsy where fsy is the minimum guaranteed steel yield strength at 1% elongation, and is equal to 204 ksi (FSAR, Fig. 5.6-1).

In this calculation, in order to assure the participation of rebars, the allowable stress for the longitudinal tendons and the circumferential tendons in the barrel section is limited to fsy.

The PCRV ultimate load analysis (FSAR Section 5.3.3.3 and Appendix E, Section E.10, Figs. E.10-23 through E.10-25) indicates that at a cavity pressure of 1775 psig the stresses in typical tendons are still elastic as given below:

1. Longitudinal tendons: 156 ksi.
2. Circumferential tendons at barrel: 170 ksi.
3. Circumferential tendons at heads: 138 ksi.
4. Crosshead tendons = 139.5 ksi.

These tendon stresses expressed as ratios of the respective allowable stress/strength limits are as follows:

1. Longitudinal tendons: 156/204 = 0.76
2. Circumferential tendons at barrel: 170/204 = 0.83
3. Circumferential tendons at heads: 138/(0.9 x 204) = 0.75
4. Crosshead tendons: 139.5/(0.9 x 204) = 0.76

It follows that the minimum acceptable tendon steel areas to resist the overpressure condition expressed as ratios of original areas specified in design are as follows:

	Area Required	Permissable Loss	Wire Failure Evaluation Criteria
Longitudinal Tendons	76%	24%	20%
Circumferential Barrel	83%	17%	15%
Circumferential Head	75%	25%	20%
Crosshead, Top or Bottom	76%	24%	20%

Based on the above percentages, we established the $\geq$ 15% and $\geq$ 20% wire failure criteria as a conservative point for mandatory engineering evaluation. The conservative nature of the criteria is based on the following:

1. Although the above calculations are based on minimum guaranteed yield strengths, they are also based on a hypothetical reactor vessel pressure of 2.1 Reference Pressure (1775 psig). The plant protective system action which monitors reactor pressure, trips the reactor at 107.5% of the normal working pressure of 688 psig. In addition, two redundant safety relief valves provide overpressure protection with setpoints of ~ 812 psig and 832 psig respectively.

2. The criteria assumes uniform degradation of all tendons. This is obviously not representative of how

corrosion will proceed, and is most certainly ultra conservative based on our inspection findings. The criteria will be utilized to provide a trigger for engineering evaluations on a tendon by tendon basis.

3. The design of the prestressing system (see FSAR Appendix E Section E.14.2.5) permits complete detensioning and removal of a tendon at power operation which represents a 100% loss of wires for that tendon when applied to the prestressing system as a whole. Obviously an evaluation of an individual tendon using the proposed criteria if $\geq$ 15% and $\geq$ 20% is conservative.

4. The inspection findings to date do not reveal any specific tendency for tendon corrosion on a cluster basis. The corrosion is random in nature and there is no immediate concern for cluster failure of several tendons that would result in localized PCRV concrete tension.

C. Overall Conclusion

It is our opinion that the proposed surveillance program will provide adequate monitoring of the PCRV prestressing system to permit assessment of the PCRV integrity on a continuous basis to ensure the health and safety of the public.

Very truly yours,

Don W Warembourg

Don W. Warembourg
Manager Nuclear Engineering Division

DWW:pa

corrosion will proceed, and is most certainly ultra conservative based on our inspection findings. The criteria will be utilized to provide a trigger for engineering evaluations on a tendon by tendon basis.

3. The design of the prestressing system (see FSAR Appendix E Section E.14.2.5) permits complete detensioning and removal of a tendon at power operation which represents a 100% loss of wires for that tendon when applied to the prestressing system as a whole. Obviously an evaluation of an individual tendon using the proposed criteria if $\geq$ 15% and $\geq$ 20% is conservative.

4. The inspection findings to date do not reveal any specific tendency for tendon corrosion on a cluster basis. The corrosion is random in nature and there is no immediate concern for cluster failure of several tendons that would result in localized PCRV concrete tension.

C. Overall Conclusion

It is our opinion that the proposed surveillance program will provide adequate monitoring of the PCRV prestressing system to permit assessment of the PCRV integrity on a continuous basis to ensure the health and safety of the public.

Very truly yours,

Don W. Warembourg
Manager Nuclear Engineering Division

DWW:pa

Reviewed By: M. H. Holmes

Fort St. Vrain
PCRV Tendon Surveillance Program

CONDITIONS

The following PCRV Tendon Surveillance Program is to be implemented, effective April 22, 1985, for a period of three (3) years or until such time that effective tendon corrosion control is established, whichever occurs first. An ongoing PCRV Tendon Surveillance Program will be established thereafter, subject to NRC review and approval.

DEFINITIONS

For the purpose of this surveillance test, the following definitions are applicable:

VISUAL INSPECTION: Removal of the tendon end cap and an in-place visual examination of the anchor assembly to include tendon wire button heads, anchor/bushing assembly, shims and bearing plates.

LIFTOFF TESTS: A physical liftoff of the tendon to determine the load being carried by that tendon. Liftoff tests for tendons that have not previously been lifted off would include removal of the shim plates to permit visual examination and as necessary reapplication of grease to the accessible areas of the tendon. Repetitive liftoff tests on the same tondon not in a control group may not include removal of shim plates for visual examination. Liftoff tests for tendons in designated control groups will include removal of shim plates and visual examination.

NEW TENDONS: A tendon population selected at random for visual inspection or liftoff testing over the next specified surveillance period. Selection shall be such that the total population of accessible tendons in that group shall be inspected/tested before beginning any repeat inspections/tests.

CONTROL TENDONS: A population of tendons in each tendon group that will be selected and will remain constant for each inspection/test surveillance cycle. The criteria for selection of these tendons shall be to select those tendons which represent conditions in which corrosion is most pronounced tempered by ready accessibility. Selection must necessarily be based on inspection data available on or before April 15, 1985.

TENDON GROUP: Four tendon population groups defined as

1. Circumferential-----310 ea
2. Top Cross Head------ 24 ea
3. Bottom Cross Head--- 24 ea
4. Longitudinal-------- 90 ea

The circumferential tendon group consists of two subgroups consisting of 210 Circumferential Barrel Tendons and 100 Circumferential Head Tendons. In terms of inspection/testing, there will be no attempt to address these subgroups as separate entities in selecting inspection/test population.

NUMBER OF TENDONS: The number of tendons to be inspected or tested shall represent a predesignated number of tendons in that group. With the exception of the longitudinal tendon group, all tendons designated for inspection or liftoff testing shall be inspected or lifted off to include both end anchor assemblies if accessible. Longitudinal tendons will be inspected and lifted off only from the top end. (Inaccessible tendons have been designated as such in PSC letter P-84523 dated December 14, 1984).

ENGINEERING EVALUATION: A technical evaluation based on visual examinations, liftoff tests, load cells and other pertinent information to determine tendon acceptability and PCRV performance.

FAILED WIRES: Wires within a tendon bundle that have failed as identified by raised button heads in the anchor assembly or as may have been previously identified as failed by visual inspection.

For tendons which are not accessible on both ends, it shall be assumed that 20% of the number of failed wires identified on the accessible end have failed on the inaccessible end in determining the total population of failed wires.

VISUAL INSPECTION PROGRAM

Once every six (6) months visual inspection shall be performed for the following tendon population.

Tendon Groups	Total Number of Tendons	Total Number of New Tendons	Total Number of Control Tendons
Circumferential	16	13	3
Top Cross Head	2	1	1
Bottom Cross Head	8	6	2
Longitudinal	30	24	6

LIFTOFF PROGRAM

Liftoff tests shall be performed on all "new" tendons once every 18 months and on all control tendons once every six (6) months as follows:

Tendon Group	Total Number of Tendons	Total Number of New Tendons	Total Number of Control Tendons
Circumferential	16	13	3
Top Cross Head	2	1	1
Bottom Cross Head	4	3	1
Longitudinal	15	12	3

ENGINEERING EVALUATION

Engineering evaluations will be made on a continuous basis as the tendon inspection/testing program progresses with the intent of ensuring that the prestressing system is performing its design function. Specific engineering evaluations will be mandatory for any circumferential barrel tendon with $\geq$ 15% failed wires and for any tendon in any of the remaining tendon groups with $\geq$ 20% failed wires.