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July 29, 1986
Fort St. Vrain
Unit No. 1
P-86491

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTN: Mr. H. N. Berkow, Director
Standardization and Special
Projects Directorate

Docket No. 50-267

SUBJECT: Responses to Request for Additional Information on PCRV Tendons

REFERENCE: Docket No. 50-267, C. S. Hinson to R. F. Walker, dated June 12, 1986 (G-86314)

Dear Mr. Berkow:

Attached are the Public Service Company of Colorado (PSC) responses to the request for additional information on PCRV tendons per the above referenced letter.

If you should have any questions concerning these responses, please contact Mr. M. H. Holmes at (303) 480-6960.

Sincerely,

D. W. Warembourg

D. W. Warembourg, Div. Manager
Nuclear Engineering Division

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Attachment

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PSC Responses to the "Request for Additional Information on Fort St. Vrain Tendon Surveillance" (Docket No. 50-267, Hinson to Walker, dated June 12, 1986 G-86314)

I. Questions pertaining to the report, "Tendon Surveillance", submitted to the NRC with PSC Letter P-85084, dated March 18, 1985.

General Question

1. Question: Provide the specific outline of the extent of the intended mandatory engineering evaluation. The response should describe the time limit for completion as well as more information with regard to the depths and methodology of the evaluation.

   Answer: The engineering evaluation committed to in the March 18, 1985, "Tendon Surveillance" report (P-85084) and mandated in the current draft of the Technical Specification Upgrade for PCRV Integrity (P-85448, dated November 30, 1985) would be a technical evaluation report submitted as a Special Report. The evaluation would consist of an analysis of all relevant tendon data, including visual inspections, liftoff tests, load cell information, etc., of the tendon in question and adjacent tendons, as applicable, available from past surveillances and/or current surveillances performed as a direct result of the event mandating the evaluation, and/or any other pertinent information available. Conclusions regarding tendon acceptability and PCRV integrity would then be made based on the results of this analysis.

   PSC will submit a preliminary report of the finding of the event including a preliminary assessment of this finding with respect to PCRV operational integrity within thirty (30) days after the discovery of the event. In the event that the preliminary report does not arrive at final conclusions concerning tendon acceptability, PCRV integrity and corrective actions, the preliminary report will state the further necessary investigations/actions required to complete the evaluation, and the estimated time required for completion.

   Upon completion of the evaluation, a final Special Report will then be submitted. The final report will include a description of the event, an analysis of the event based on the pertinent information/data available and/or collected, the conclusions of the analysis relative to tendon acceptability and PCRV integrity, and actions taken or planned.

Specific Questions

1. Section 1.4 - Margin of Safety

Question: Describe the type of analysis performed to determine the number of tendons that could fail without reducing the safety factor against failure at 845 psig. In your response, specify the postulated loading conditions, the compliance with the FSAR Section E.1 - "Prestressed Concrete Reactor Vessel Design Criteria," the computer programs used, and other pertinent information which illustrates the depth and completeness of the analysis.

Answer: Sections 1.4.2, 1.4.3, 1.4.4, and 1.4.5 of the March 18, 1985, "Tendon Surveillance" report are taken directly from the FSAR Update, Appendix E, Section E.14.2 The information given in Section E.14.2 is the answer to Question No. D.3 from AEC Letter, Docket No. 50-267, P.A. Morris to L. R. Patterson, dated Dec. 27, 1967. The question was stated as follows: "Submit the results of the quantitative analysis which determines the permissible number of tendons which may fail before a definite hazard would exist. The failure of both adjacent and parallel tendons as well as adjacent but nonparallel tendons should be considered."

The answer to this question, as summarized in the FSAR Section E.14.2, was originally presented in Amendment No. 9, Attachment D, Pages D.3-1 thru D.3-3 of the PSAR (see Attachment 1 to these responses).

PSC has been informed by GA Technologies that the analysis performed, of which the results were reported as indicated above, was a hand calculation with the inputs and postulated loading conditions in full compliance with the FSAR, Section E.1 (Document No. DC-11-1).

Experimental confirmation of the calculated number of tendons that could fail was made with a series of tests on PCRV Model 2. The results of the Model 2 tendon detensioning tests were first reported in Amendment No. 10 to the PSAR, as Supplemental Answer to AEC Question V.5 (Reference 1). This information is also supplemental to the answer mentioned above to AEC Question D.3, contained in Amendment No. 9. Subsequently, this same information was summarized in the FSAR, Appendix E.18. Reference 1 is attached to this response for the convenience of the reviewer (see Attachment 2). Nine prestressing tendons in one location of the Model 2 vessel were completely detensioned: four crosshead, one circumferential, and four vertical tendons - (One Model 2 tendon is approximately equal to four Fort St. Vrain PCRV tendons). Strain and load measurements were monitored to observe the vessel behavior during pressurization. During a 48-hour hold test at Model

2 Reference Pressure (RP) with all nine tendons fully detensioned, the vessel behavior was stable. Load cells indicated a maximum load increase of three percent. The test demonstrated that with a large percentage of prestressing tendons unloaded to cause eccentric loading, the vessel would still safely withstand RP in the cavity. Reference 2 provides a detailed description of PCRV Model 2, the design, analytical methods and analysis, construction, instrumentation, validation, and the tests completed up to the time of writing (which was prior to the tendon detensioning tests).

The quantitative analyses performed in 1968 in response to PSAR Question D.3 were hand calculations to conservatively establish the approximate number of tendons that could fail during operation of the reactor before a hazardous condition would exist. As stated in FSAR Section E.14.2.5 it was concluded that more refined analyses are not justified in view of the large margin of vessel capacity available even with this loss of the significant number of tendons of each type.

The hand calculations described above performed in 1968 for PSAR Amendment No. 9 are no longer retrievable. However, a recent similar set of hand calculations performed at GA Technologies Inc. were provided to the NRC by PSC's Letter P-85053, dated February 14, 1985 (Reference 3). Reference 3 and its enclosure, GA Report 907738, entitled "FSV-Tendon Requirement Based on Safety Considerations", are attached to this response for convenience of the reviewer (see Attachment 3). In this report, the minimum number of tendons required for safely supporting the core cavity pressure of 845 psig (Reference Pressure, RP) and 1268 psig (1.5 RP) without breaching the liner of the Fort St. Vrain PCRV were determined for: 1) circumferential tendons in the PCRV wall, and 2) crossheads and circumferential tendons in the heads of the PCRV. Hand calculations based on the concept of ultimate load analysis were used. The results indicate that the core cavity pressure of 1.0 RP can be safely resisted with considerably less number of tendons than is actually provided. At a core cavity pressure of 1.5 RP, the number of head (crosshead and circumferential) tendons required is still less than is actually provided. The required numbers of crosshead and circumferential tendons in either the top or bottom head of the PCRV, derived under a conservative assumption that no vertical tendons are functional, are given in the report. (The presence of functional vertical tendons will reduce the required number of head tendons as given in the report to resist 1.0 and 1.5 RP.) The procedure used is described in Sections 2 through 5 of the report, and detailed calculations are given in the appendices.

References for the Answer to Specific Question No. 1:

Ref. 1 Amendment No. 10 to Application of Public Service Company of Colorado for Construction Permit and Class 104 License for the Fort St. Vrain Nuclear Generating Station, Attachment D, Supplemental Reply to Question V.5, pp V.5-84, -87.

Ref. 2 Prestressed Concrete Reactor Vessel Model 2, USAEC Report GA-7150, General Dynamics, General Atomic Division, November 4, 1966.

Ref. 3 PSC Letter P-85053 from D. W. Warembourg to E. H. Johnson, Regional Administrator, Region IV, NRC, Subject: "FSV - Tendon Requirements Based on Safety Considerations", dated February 14, 1985, transmitting GA Technologies' analyses Document GA 907738 N/C, entitled "FSV - Tendon Requirements Based on Safety Considerations", December 17, 1984.

2. Section 3 - Analyses of Cause of Corrosion

Question: Indicate what remedial action was undertaken by the Central Electricity Generating Board (CEGB) in the United Kingdom as a result of the corrosion problem CEGB experienced and to what extent such action has been adopted by PSC.

Answer: The CEGB Dungeness B Plant visited by GA Technologies and PSC was found to have tendons identical to FSV except that the tendons are left open instead of sealed like FSV. Sulfonated grease was utilized at Dungeness B until corrosion was discovered; the FSV grease is also sulfonated.

During a 1968 surveillance, water was observed discharging from a tendon at Dungeness B. That tendon was removed and examined as well as other tendons. Detailed examinations of the wires revealed areas of corrosion beneath the grease with pits up to .08 inches deep. The grease was found to be emulsified and contain up to 15% water by weight. The analysis and testing performed by CEGB determined that, during construction, welding machines were grounded to the tendon ducts producing stray dc currents, causing pitting attack in tendons containing emulsified grease. The sulfonates in the grease were postulated to be a contributing factor in the corrosion process. Corrective action was to limit dc welding in the areas of the tendons and not allow any grounding to the tendon tubes. Non-sulfonated grease was used in place of the original grease.

The surveillance requirements which are performed to comply with the requirements of the INI (Inspectorate of Nuclear

Installations) includes lift-off tests every two years on 2 bottom, 2 side, 3 top and 3 vertical tendon assemblies plus 6 random wire withdrawals selected from 1 vertical, 1 top, 2 side and 2 bottom. These wires are replaced with new wire supplied by Richard Johnson and Nephew. The removed wires are then visually examined for pitting (they allow a maximum of 0.020"), and then are sent to Richard Johnson and Nephew for load testing. In all the surveillance work CEGB has performed since the installation of the tendons, no wires or tendons have failed and none have been rejected for pitting or failure of a load test.

At Fort St. Vrain none of the corrosion has been attributed to stray welding currents. The current interim surveillance program requirements at FSV exceed the surveillance requirements at CEGB as a result of the corrosion found at Dungeness B.

3. 4.1.2.6.1 - Examination of Sample Wires

Question: The proposed acceptance criteria are noncommittal with respect to installation of additional sample wires. Specify whether, and describe how and when, more of the sample wires will be installed.

Answer: Letter P-85039, dated January 31, 1985 (see Attachment 4), states that no action concerning insertion of sample wires into tendons with areas of known corrosion will be initiated during the interim tendon surveillance period.

Section 4.1.2.6.1 of the March 18 Surveillance Report refers to the future surveillance program to be set up following implementation of an improved tendon corrosion protection system. Details of any sample wire program to be implemented at that time will be worked out as the new corrosion protection program evolves.

4. 4.1.2.6.2 - Tendon Atmosphere Sampling

Question: The proposed criteria are not specific as to whether tendon sampling is to be conducted or not and, if so, whether an inert gas such as nitrogen will be utilized. The proposed installation of a nitrogen blanket is discussed in Section 4.5, but Section 4.1.2.6.2 fails to make a firm commitment to utilize an inert gas atmosphere in the tendon tubes to inhibit corrosion. Indicate if an inert gas will be used and if so, what measures will be taken to prevent its leakage.

Answer: Letter P-85039, dated January 31, 1985 (see Attachment 4), states that no action concerning atmospheric sampling of tendon tubes will be initiated during the interim tendon surveillance period.

Section 4.1.2.6.2 of the March 18 Surveillance Report refers to the future surveillance program to be set up following implementation of an improved tendon corrosion protection system. Details of any tendon atmosphere sampling program to be implemented at that time will be worked out as the new corrosion protection program evolves.

PSC did investigate the possibility of utilizing an inert gas atmosphere in the tendon tubes to inhibit corrosion. Several tests were conducted, but the leakage rate from the tendon tubes was excessive. Several alternatives to reduce the leakage rate to an acceptable level were attempted without success. PSC is therefore pursuing other corrosion protection alternatives with the leading candidate being the use of a grease-filled tendon-tube system.

5. 4.1.2.6.3 - Examination of Anchor Assemblies

a) Question: This section lacks specific criteria regarding procedures and evaluation of the examination of anchor assemblies; therefore the proposed criteria cannot be meaningfully assessed.

Answer: A controlled maintenance procedure (MP-2233) is used to inspect the anchorheads. Defined terminology has been included in the procedure for Quality Control personnel to use to report the relative degrees of anchorhead corrosion encountered during anchorhead surveillance. The terminology used, "discoloration", "scaling" and "oxidation", have been defined in Section 4.1.2.3 of the March 18 Surveillance Report.

From March 1, 1984, through June 20, 1986, a total of 533 tendon ends of the total 896 PCRV tendon ends have been surveilled. Anchorhead corrosion serious enough to potentially lead to structural failure has not been found in any of these 533 anchorheads surveilled. Inspections are continuing or are planned for the remaining accessible anchorheads not yet surveilled.

Detailed anchorhead examination was spawned at FSV as a result of anchorhead failures reported by Alabama Power Company at its Joseph M. Farley Nuclear Plant in the early part of 1985 (Reference: IE Information Notice No. 85-10, dated February 6, 1985). Five(5) longitudinal bottom-end anchorheads (similar to those that failed at Farley) were randomly selected and magnetic particle tested for cracks. As reported in Letter P-85193, dated June 7, 1985 (see Attachment 5), no apparent discontinuities were found in any of the five heads tested. As a result of these tests, the continuing visual inspections from the interim surveillance program, and the fact that the chemical components leading to the corrosion mechanism at Farley are nonexistent at FSV, it has been concluded that the FSV anchorheads are not likely to be susceptible to the Farley-type structural failures.

For the above reasons, it has been determined at FSV that specific anchorhead evaluation criteria beyond the corrosion description currently required by MP-2233 is not warranted. It should be noted that the FSV QC inspectors performing the anchorhead inspections are qualified to ANSI N45.2.6-1973, Level II, for visual inspection; therefore, if anchorhead failure or any abnormal signs of degradation were to exist on FSV anchorheads, this would be documented during routine anchorhead inspection with a Non-Conformance Report (NCR), which would also then document the ensuing engineering evaluation.

b) Question: Provide the basis for the assumption of uniform degradation of all tendons.

Answer: The basis is that uniform degradation of all tendons is a very conservative assumption used in establishing failed wire criteria for initiating mandatory engineering evaluation.

What is meant by "uniform degradation of all tendons" and the conservatism it represents is probably best illustrated by an example: Per Letter P-85071 (see Attachment 6), the wire failure criterion for longitudinal tendons, for instance, is that if a longitudinal tendon is observed with 20 percent or greater failed wires (34 or more non-effective wires) then an engineering evaluation of the specific consequences and corrective action required is mandated. The basis for the establishment of the 20 percent failed-wire criterion for the longitudinal tendons assumes that all of the longitudinal tendons have degraded to the same level; i.e., that all have at least 20 percent failed wires.

The same argument is true for each of the other tendon types.

Based on past tendon inspection results, it has been found that corrosion is random in nature among the tendons of each tendon type; i.e., some tendons are corroded worse than others and some tendons may not be corroded at all; therefore, "uniform degradation of all tendons" has not been the case. Obviously, "uniform degradation of all tendons" is not representative of how corrosion has proceeded or can be expected to proceed in the tendons. For this reason, it is simply utilized as a very conservative assumption to determine failed wire criteria since the exact rate and to what level each tendon is corroded is impossible to measure or deduce.

c) Question: Explain how an evaluation of wire failure criteria will be performed.

Answer: The determination of the percentages of failed wires which mandate an engineering evaluation is presented in Letter P-85071, dated March 5, 1985 (see Attachment 6).

Please reference the response to General Question 1 concerning the evaluation to be performed as triggered by the failed wire criterion having been met or exceeded by a particular tendon.

6. 4.1.2.6.4 - Liftoff Testing

a) Question: This section states that a tendon is considered acceptable if its tension is above the minimum design level. A more appropriate criterion is that a tendon is acceptable if its tension is within the specified limits at the time of the liftoff test. An engineering evaluation to determine the cause of deviation from the above criterion, and any remedial action to be taken, should be done within an appropriate period of time following the test when the above criterion is violated. Recommendations contained in Regulatory Guide 1.35 could be used for guidance.

Answer: The guidelines contained in Proposed Regulatory Guide 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments", dated April, 1979, for establishing a lower bound for prestressing forces in tendons is useful in locating tendons with possible corrosion degradation. At Fort St. Vrain, it is already known from past surveillances that some of the tendons have lost prestress load to a level below the original prestress load minus the predicted maximum prestress losses (FSAR, Table 5.6-4) for the time of the liftoff surveillance. It is also already known that the reason for this additional load loss is due to tendon degradation from microbiologically-induced corrosion, as previously reported.

Therefore, for the Fort St. Vrain PCRV tendons, the most appropriate criterion to use for minimum tendon load at the jacking end is the load obtained at the time of liftoff from Figure 4, 5, 6 or 7 (depending on the type of tendon lifted off) of GA Document No. 907441, entitled "FSV-PCRV Tendon Evaluation". A copy of this document is enclosed (see Attachment 7). The minimum tendon load required at the jacking end at the end of PCRV life as determined in the above GA document was reported to the NRC in Letter P-84135, dated May 7, 1984 (see Attachment 8), as the "minimum design" lines.

Proposed Regulatory Guide 1.35.1 states that the upper bound of the established tolerance band for tendon prestress "is not critical from a safety point of view."

It is important, however, that the tendon not be overstressed relative to the yield strength of the tendon. Per the FSAR, Section 5.6.2.3, the specified minimum yield strength of the FSV tendons is 180,000 psi, or 75 percent of the minimum Guaranteed Ultimated Tensile Strength (GUTS) of 240,000 psi. Therefore, in the controlled maintenance procedure utilized for tendon liftoff tests (MP-2233), a cautionary statement has been included so that the tendon is not stressed beyond 75 percent of the GUTS of the effective wires remaining in that tendon.

As previously reported, investigation is under way for a long-term remedial solution to prevent corrosion in the PCRV tendons for the remainder of PCRV life. Remedial methods being studied are on a tendon <u>system</u> basis, not on a tendon-by-tendon as-needed basis.

Until such time as effective corrosion control is established, PSC is continuing to surveil tendons under the current accelerated interim surveillance program in order to assure PCRV integrity. This accelerated surveillance program far exceeds the surveillance guidelines of Regulatory Guide 1.35, Proposed Revision 3, with respect to number of tendons surveilled and frequency of surveillance.

b) <u>Question</u>: Provide the pertinent information regarding the equipment used in tendon liftoff testing, as well as the applicable procedures, the equipment calibration methods, and training and qualification of the personnel performing the tests.

<u>Answer</u>: A liftoff demonstration was given to NRC representatives on April 23, 1986. Hydraulic jacks (rams) with periodically calibrated pressure gauges are used for the liftoffs. Jack pressure versus applied force is established via a characteristic calibration of the jacks on a calibration test block utilizing a pressure test gauge and a load cell with calibration traceable to the National Bureau of Standards. A controlled maintenance procedure (MP-2233) is used to

perform the liftoffs. A Maintenance Quality Control representative is present for every liftoff.

Training is on-the-job for carrying out the liftoff procedure and installing and operating the jacking equipment. Every jack-to-tendon installation situation is unique depending on the nature and degree of tendon accessibility. Data-taking involves only the ability to read a pressure gauge correctly.

7. 4.6 - Replacement and Testing of Existing Tendons

Question: There is an apparent contradiction in the proposed tendon testing program. The last paragraph on p. 4-18 states that: "A chemical solvent will be injected through a tendon tube to remove the old grease from a tendon." A paragraph on p. 4-19 states that: "A tendon shall be installed, if possible, with the old grease intact." Please clarify this apparent contradiction.

Answer: The two paragraphs in question are describing two independent tests which could be performed on two different tendons.

II. Questions pertaining to the "PCRV Tendon Interim Surveillance and Status Report" dated January 1986.

1. Section 2.1, p. 3 of 52

Question: The paragraph describing "Control Tendons" states that: "Selection of control tendons is based on the observance of corrosion..." Review of Table 2.3-1 discloses that there are a number of tendons which have a number of wires broken (e.g. BILU3 (16 and 20), BILU4 (28 and 3), and CO 2.5 (3 and 16)) but have not been selected as "control tendons." Explain your reasoning for not including the above damaged tendons as part of the "control tendon" group.

Answer: The total number of control tendons was prespecified as part of the interim surveillance program requirements (P-85071, dated March 5, 1985 (see Attachment 6)). The control tendon selection criteria was then used to select this specified number of tendons. The control tendon group was selected to be representative of all PCRV tendons--not to be the tendons in the worst condition.

As an additional commitment independent from the current interim tendon surveillance program, PSC proposes the following: The worst-case tendons, as evidenced by the current number of non-effective wires, will be visually inspected on a semiannual basis. It is the position of PSC that frequent periodic exercising (lifting off) of degraded tendons may have the undesirable effect of degrading the tendons further and unnecessarily; i.e., the benefit gained from the liftoff test (determination of tendon load) may not be worth the possible additional tendon degradation caused by the liftoff.

The following worst-case tendons will be included in this new inspection group:

Tendon No.	Number of Non-Effective Wires
VM-30	22(Top end); bottom end not accessible
BILU3*	18(End I-II); 20(End IV-V)
BILU4	28(End I-II); 3(End IV-V)
CO 2.5**	16(End I); 2(End V)
CM 4.6***	20(End II); 0(End IV)

* Two(2) additional non-effective wires have been observed in Tendon BILU3, End I-II, since the January, 1986, Surveillance Report.

** The number of non-effective wires reported here for Tendon CO 2.5 is a correction to the number reported in Table 2.3-1 of the January, 1986, Surveillance Report.

*** Tendon CM 4.6 was surveilled after the January, 1986, Surveillance Report.

No other tendon surveilled to date has been observed with more than seven(7) non-effective wires.

The visual inspections will include inspection of the anchor assembly parts for signs of severe degradation and potential failure, and for additional failed wires as evidenced by tendon wire buttonheads raised off the stressing washer face. Signs of moisture will also be noted.

The existing tendon inspection maintenance procedure (MP-2233) will be utilized to perform the inspections and document the findings.

Each of the above specified tendons will be inspected on both ends except Tendon VM-30, to be inspected on the top end only. The semiannual inspection periods for these worst-case tendons will coincide with the six-month periods of the current interim tendon surveillance program. The findings of the worst-case tendon surveillances will be reported along with the findings of the interim program tendon surveillances as currently submitted on a semiannual basis.

2. Section 2.3.4, p. 32 of 52

Question: It is noted that, for a period of time, several of the tendons did not have valid load cell readings. Indicate if any corrective measures have been undertaken or planned which would rectify this situation. If not, provide justification for the adequacy of your load cell surveillance program.

Answer: The load cells which were not providing readings during the period of time indicated are now providing valid readings. The load cell on Tendon TIRM1 is currently the only suspect load cell. Plans are to repair or replace this load cell during tendon replacement. Corrective action for any future load cell problems would be dealt with on an individual basis at the time the problem occurs. Load cell problems would become readily apparent during the current monthly monitoring program.

Load cell loads are currently being monitored on a monthly basis per Procedure SR-RE-42-M, Issue 3. Checks on possible load cell zero shifts are performed periodically per Procedure SR 5.2.3a-X, Issue 15. Load cell zero shifts outside of the acceptance criteria have not been observed for any load cell.

III. Question pertaining to the FSAR

1. Question: Section 5.13.8 of the FSAR states that if there is any deterioration of the wire, the tendon in question will be detensioned and pulled out for detailed examination. Since there is already evidence of an extensive degradation of tendons, describe the future action planned which would satisfy this FSAR commitment.

   Answer: The statement in question from Section 5.1.3.8 of the FSAR has been taken out of context. This section of the FSAR (Page 5.13-26 of FSAR Update, Revision 3) clearly states that the tendon in question will be detensioned and pulled out for detailed examination only after all of the following have occurred:

   1) A change in tendon load which actuates the load cell alarm and cannot be ascribed to mechanical or electrical difficulties.

   2) The wire sample is pulled out and inspected for corrosion.

   3) If the wire sample is corroded, the mechanical properties of the wire are evaluated.

   4) Action Items (2) and (3) above indicate deterioration of the sample wire.

   To date, the event described by Item (1) above has never occurred on a load-cell tendon; therefore, Action Items (2), (3) and (4) above have never been mandated.

Even if the intent of the above event/actions were applied to non-load-cell tendons which have been subjected to liftoff testing, no tendon to date would require detensioning for further examination. This is true since no liftoff to date has shown a tendon load below the respective load cell alarm low setpoint for the type of tendon under test which could indicate possible severe corrosive degradation of that tendon and the need for further inspection.

As indicated in the March 18, 1985, Tendon Surveillance Report (P-85084), Section 2.4.1.2, several tendons were detensioned and inspected following discovery of the tendon corrosion problems in 1984. This action was not required by the FSAR.

Comprehensive examination of a tendon is not possible through detensioning. The detensioned tendon can only be pulled out approximately six to seven feet from one end only. Therefore, this allows inspection of only a short length of tendon relative to the full tendon length (approximately 58 feet, 103 feet and 106 feet, typical, for crosshead, circumferential and longitudinal tendons, respectively).