August 25, 1981

bcc: O. Rothberg

Repo 9/1

Docket No. 50-255
LS05-81- 08-045

RECEIVED SEP 03 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. David P. Hoffman
Nuclear Licensing Administrator
Consumers Power Company
1945 W Parnall Road
Jackson, Michigan 49201

Dear Mr. Hoffman:

SUBJECT: SYSTEMATIC EVALUATION PROGRAM TOPIC III-7.A., INSERVICE INSPECTION INCLUDING PRESTRESSED CONCRETE CONTAINMENTS WITH EITHER GROUTED OR UNGROUTED TENDONS - PALISADES

Enclosed is a copy of our draft evaluation of Systematic Evaluation Program Topic III-7.A.

The evaluation identifies deficiencies in the technical specifications which currently govern the tendon surveillance program at Palisades.

You are requested to examine the facts upon which the staff has based its evaluation and respond either by confirming that the facts are correct, or by identifying errors and supplying the corrected information. We encourage you to supply any other material that might affect the staff's evaluation of these topics or be significant in the integrated assessment of your facility.

Your response is requested within 30 days of receipt of this letter. If no response is received within that time, we will assume that you have no comments or corrections.

Sincerely,

Add: Ted Michaels

SE04
S/1

DSU USE EX(04)

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

Enclosure:
As stated

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PDR ADOCK 05000255
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cc w/enclosure:
See next page

*See previous yellow for additional concurrences.

OFFICE					ORB#5:DL	AD:SA:DL	
SURNAME					DCrutchfield	GLainas	
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OFFICE	SEPB:DL	SEPB:DL	SEPB:DL	MSEB:RBS	SEB:DE	SEPB:DL	ORB#5:DL:PM
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DATE	7/13/81	7/20/81	7/27/81	7/29/81	7/5/81	8/11/81	8/20/81

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7/ /81

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DATE	7/13/81	7/20/81	7/ /81	7/ /81	7/ /81	7/ /81	7/ /81

UNITED STATES
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WASHINGTON, D. C. 20555
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Operating Reactors Branch No. 5
Division of Licensing

Enclosure:
As stated

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PALISADES
SYSTEMATIC EVALUATION PROGRAM BRANCH
TOPIC III-7.A

TOPIC III-7.A INSERVICE INSPECTION INCLUDING PRESTRESSED CONCRETE CONTAINMENTS WITH EITHER GROUTED OR UNGROUTED TENDONS

I. Introduction

This topic reviews the inservice inspection program of all Category I structures including steel, reinforced concrete and prestressed concrete containments. The objective is to assure that the licensees inspection program will detect any structurally significant deterioration of Category I structures in order that the structures will be capable of performing their necessary functions.

II. Review Criteria

Review criteria for this topic is Regulatory Guide 1.35, Revision 2, "Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment Structures," as interpreted in the Standard Technical Specifications dated August 15, 1979. Also, ISI requirements are described in 10 CFR, Part 50, Appendix J, Part V.A.

III. Related Safety Topics

1. Topic III-7.C, "Delamination of Prestressed Concrete Containment Structures."
2. Topic III-7.D, "Containment Structural Integrity Test."

IV. Review Guidelines

With the exception of Containment, there currently exists no inservice inspection (ISI) requirements for safety-related structures. 10 CFR, Part 50, Appendix J, Section V.A, requires a general inspection of accessible interior and exterior surfaces of containment structures for any structural deterioration prior to performing Type A leak tests. No other guidelines are given. 10 CFR, Part 50, Appendix J is currently being rewritten in TAP A-23 to clarify ISI requirements. ASME Section XI is currently considering ISI requirements for steel and concrete containments. The extent to which this section of the code will be implemented on existing nuclear power plants will be determined when the code is issued and receives NRC endorsement. Therefore, the only applicable portion of this topic is that part dealing with ISI requirements of tendons in prestressed concrete containments with current criteria defined in Regulatory Guide 1.35, Revision 2.

Since there has been much discussion, disagreement and interpretation regarding Regulatory Guide 1.35, Revision 2 by licensees and architect-engineers, the NRC has recently contracted with Oak Ridge National Laboratory (ORNL) to conduct a study and make recommendations concerning ISI requirements for prestressed containments. The purpose is to use ORNLs results to assist the NRC in issuing a revised Regulatory Guide 1.35. The ORNL report is expected to be completed by the end of 1981 and the revised Regulatory Guide 1.35 is expected to be issued by mid to late 1982. Implementation of the revised Regulatory Guide 1.35 on existing plants will be determined after the revised guide is issued.

V. Evaluation

Regulatory Guide 1.35, Revision 2 provides guidance on tendon surveillance in the areas of sample selection, visual inspection, prestress monitoring, material tests and inspections and acceptance criteria.

The approximate time frame followed by the licensee concerning the containment at Palisades is shown below:

Initial Prestressing	May-September	1969
Structural Integrity Test	March	1970
1st Tendon ISI (1 year test)	April	1971
2nd Tendon ISI (3 year test)	February	1974
3rd Tendon ISI (5 year test)	September-December	1975

The 10 year ISI will be performed later this year. The time intervals between inspections conform with current criteria. The licensee, after reviewing the results of the 1, 3, and 5 year tests, concluded that the tendons at Palisades are experiencing no abnormal degradation and are continuing to perform their required function.

A. Current Criteria

For the 1, 3, and 5 year inspections, current criteria requires the inspection and liftoff testing of 6 dome tendons (2 from each 60° group), 5 vertical tendons randomly and representativaely distributed and 10 hoop tendons randomly and representatively distributed. If these results indicate no problems in the tendons, sample size for the 10 year and subsequent inspections is decreased to 3 dome tendons, 3 vertical tendons and 3 hoop tendons. Visual inspection of tendon anchorage assembly hardware and surrounding concrete is required. The concrete around the anchorage should be checked during the integrated leak testing while the containment is at maximum pressure. Liftoff testing requires measurement of jacking force and elongation and comparison of these to predetermined allowables. Tendon detensioning is required to identify broken or damaged wires.

Wires from one tendon of each type (dome, hoop, vertical) should be removed for examination for corrosion and tensile testing. Three tensile tests are required from each wire. Sheathing filler grease must be inspected for grease coverage of the anchorage system , influence of temperature variations, voids in the trumpet, and requirements imposed by grease specifications.

Acceptance criteria are that the prestress force for each tendon should be "within the limits predicted for the time of the test." There should be no more than one tendon value outside of these limits. If one tendon is found outside these limits, one tendon on each side should be tested. If both of these are found acceptable, the low reading tendon is considered unique and not indicative of a problem;

however, if either of these adjacent tendons also reads low or more than one tendon in the entire group of similar (dome, hoop, vertical) tendons reads below set limits, it is considered unacceptable. All tensile test values should be greater than or equal to the guaranteed ultimate strength of the material.

B. Testing Requirements at Palisades

The technical specifications at Palisades were originally written before the issuance of Regulatory Guide 1.35. After the three year test, the specifications were changed to conform with Regulatory Guide 1.35 and were used during the five year test.

During the one year inspection by the licensee, three hoop tendons, 20 vertical tendons (three initially, two additional to account for one low reading, and 15 chosen at random), and three dome tendons (spaced 120 apart) were tested for liftoff and wire continuity. End anchorage assemblies were inspected. Wire inspection and mechanical tests were performed on one wire from 11 tendons. Sheathing filler was laboratory tested for deleterious material. The three year inspection by the licensee consisted of liftoff testing 16 vertical tendons, three hoop tendons and three dome tendons. Eleven of these tendons were the same ones tested during the one year test. Wire inspection and mechanical tests were again performed on wires from the original 11 tendons. End anchorage assemblies and sheathing filler grease was inspected as before.

In the 5 year inspection, the number and location of tendons tested for liftoff and wire continuity conformed with current criteria. None of the tendons selected had been tested previously. Wire inspection and mechanical testing was performed in accordance withe Regulatory Guide 1.35, Revision 2. Tendon anchorage hardware and surrounding concrete was inspected. Sheathing filler was laboratory tested for contamination.

C. Discussion

The tendon surveillance program now in effect at Palisades is in substantial conformance with current criteria defined in Regulatory Guide 1.35, Revision 2; however, there are deviations, some of which are not acceptable and discussed below.

For all three tests, acceptable liftoff test limits were the minimum effective design prestress as the lower limit and $.73f_s$ as the upper. The upper limit is required as it is an indication of an abnormality if tendon prestress force is too high and also some concrete degradation may occur if tendon prestress is too high. The lower limit is the force relied on to resist design loads. Regulatory Guide 1.35, Revision 2 requires that the prestress force measured for each tendon be within limits "predicted for the time of the test." Regulatory Guide 1.35, Revision 3 and 1.35.1 that were issued for comment clarify the intent of the present Regulatory Guide 1.35. The intent of Regulatory Guide, Revision 2 is that the limits for each tendon vary with time so that one can identify trends in the rate of prestress loss. Measured tendon forces for each tendon should be within these limits and not average tendon force.

The objective is to track prestress force loss with time so that rates of prestress loss can be determined and compared to these assumed in design, thus identifying potential problems before they actually occur. Results of the one year and three year liftoff tests were plotted showing normalized force per wire versus time; however, acceptance criteria remained constant with time. The normalized liftoff force is the measured liftoff force which has been modified to account for elastic stress loss during initial installation and for liftoff force deviation from the base value. By normalizing the measured liftoff force, a common base is established for comparisons.

The results of the five year liftoff tests were presented in a bar graph, thus losing the time dimension completely. For future tests, plant technical specifications do not require acceptance limits which vary with time.

For Palisades, the minimum effective design prestress value and the predicted prestress value converge as time progresses. Therefore, the range between the expected loss curves and the minimum effective design prestress curves decreases as time approaches 40 years. As a result, it is expected that more tendons will exhibit values below the minimum effective design prestress value in the future. This may require that future inspections of tendons be conducted at more frequent intervals than currently required. In addition, remedial action may be required if the actual losses were not appropriately enveloped by those considered in the containment design.

As stated, the liftoff test results for the one and three year tests are presented on a graph whose axes are normalized force per wire versus time. Presentation of results in this manner does not show problems associated with wire breakage. It is possible to show an acceptable wire force in a tendon that has an unacceptable tendon force by dividing the unacceptable tendon force by the number of effective wires when there is excessive wire breakage. Therefore, liftoff test results should be shown as tendon force versus time. Even with wire breakage, wire stress must still be maintained below an upper acceptable limit during any retensioning.

The one and three year inspections deviated by liftoff testing a smaller sample size of dome and hoop tendons and by testing the same tendons in both tests. The sample size was in agreement with current criteria for the five year test.

Current criteria requires visual inspection of the concrete surrounding the tendon anchorages. The visual inspection is to take place during the integrated leak test while the containment is at maximum test pressure. The technical specifications at Palisades (section 4.5.5.b) do not require this inspection during the integrated leak test.

VI. Conclusions

The containment tendon surveillance program at Palisades largely conforms with current criteria but has some unacceptable deficiencies.

A method of checking prestress loss with time and a graphical presentation of the results is necessary. Force at the time of the test for each tendon should be compared to that assumed for that particular tendon in the design.

Palisades' Technical Specifications, Section 4.5, Page 4-36, state that force-time records will be established and maintained for each tendon group (i.e., dome, hoop, vertical). This was totally disregarded in the five year test.

The results of the one, three, five year and any future inspections should be included on these graphs. The graphs should show tendon force not wire force versus time for reasons given in the evaluation. The staff has done this from some of the values and shown them in the attached Figures 5-1, 5-2, 5-3. A normalization factor of 0.97 was assumed for the five year test data by averaging previously given normalization factors for other tendons which had never been liftoff tested. Also, the three year values for vertical tendon which were concluded to be questionable due to method of testing were not included.

The graphs to be prepared by the licensee should use actual calculated normalization factors excluding the term to account for missing wires.

Acceptance criteria should be established which vary with time. An acceptable method for future inspections would be to specify upper and lower acceptance limits for tendon forces which vary with time, envelope the expected loss curve, and maintain the lower limit above the minimum effective design prestress. Current plant technical specifications should be changed to reflect this.

Since the expected loss curves approach the minimum effective design prestress at 40 years, more frequent inspections may be necessary in the future than now required. This should be determined after reviewing the results of each future inspection.

The one and three year inspections liftoff tested smaller samples than currently required, but this deviation is not judged to be significant since all five year test values were higher than the minimum effective design prestress values. Also, one and three year prestress values would have a larger margin between expected and minimum effect design values. The one and three year test results should be viewed with some caution because the method of determining liftoff was changed from detecting changes in sound when striking shims with a hammer to actually knocking one shim loose. Additional one and three year data would have been useful to establish trends in prestress loss, but had additional tests been performed the results would have to be viewed with caution also and would be marginally useful since they would have been tested using the original method. To establish reliable trends, the method of testing must remain constant. Therefore, using smaller one and three year samples is not judged to be significant.

Concrete surrounding the end anchorage of prestressing tendons liftoff tested during the previous tendon inspection should be visually inspected during the integrated leak rate tests while the containment is at maximum test pressure. The surrounding concrete should be viewed for any unusual cracking. Cracks larger than .01 inch as described in ASME Section III, Division 2, Subsection CC-6000 should be noted and evaluated. Any changes should be noted and evaluated during subsequent inspections.

In addition to the random tendons required to be inspected during the ten year test per Regulatory Guide 1.35, Revision 2, tendons BF-65, DL-38 and one additional dome tendon selected at random should be tested for liftoff. BF-65 and Dl-38 appear to be losing prestress at a substantially faster rate than expected. Even viewing one and three year dome tendon results with caution, it appears that dome tendons may be losing prestress faster than predicted. This would be even more likely if the one and three year results were actually higher than shown as they very likely would be had the 5 year testing method been used. Testing these additional dome tendons would increase the data base to determine if this is really the case.

The above changes should be implemented but they may be changed when Regulatory Guide 1.35, Revision 3 is issued and decisions on implementing this revised Regulatory Guide on existing plants are made.

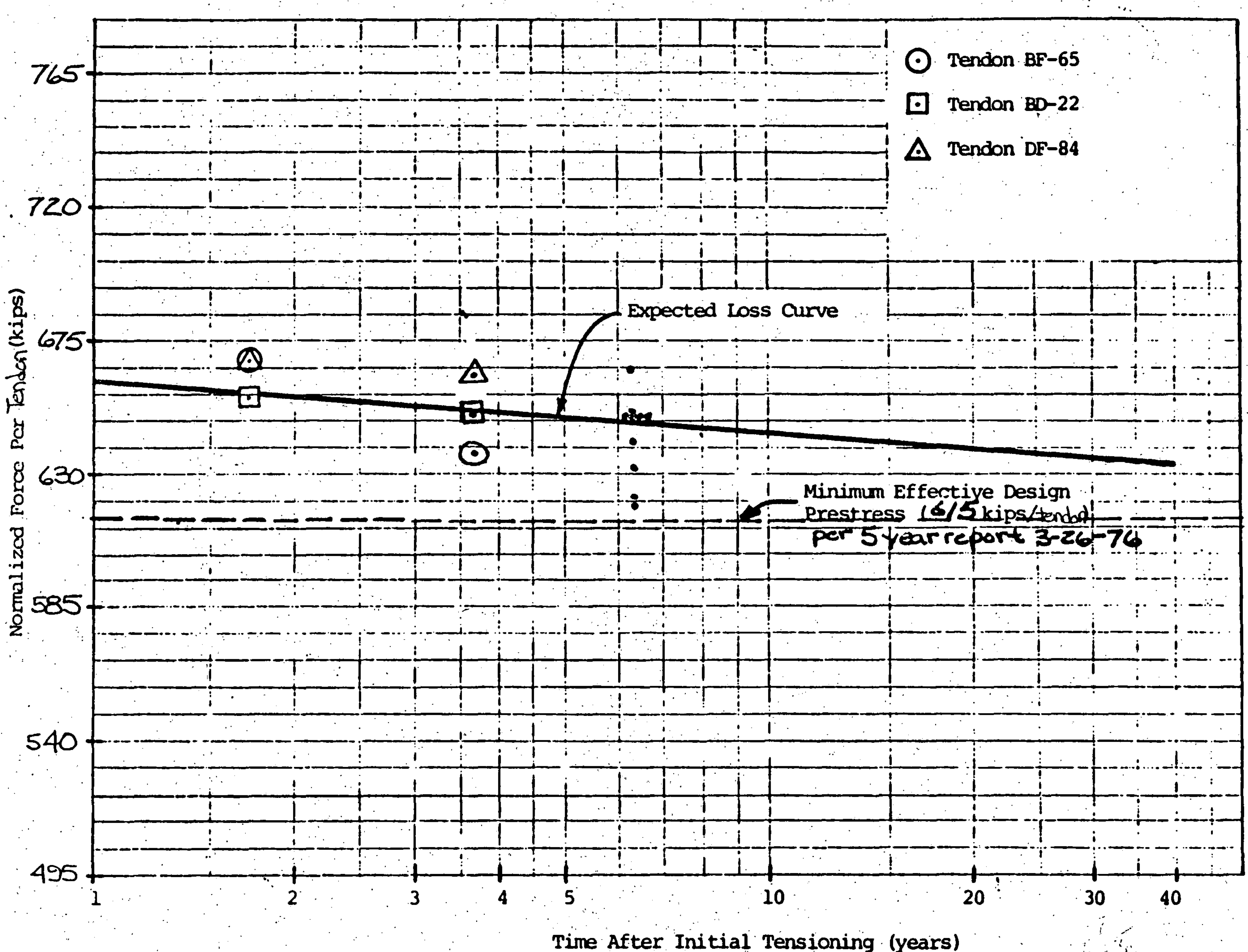

FIGURE 5-1 Average Normalized Tendon Force vs. Time - Hoop Tendons

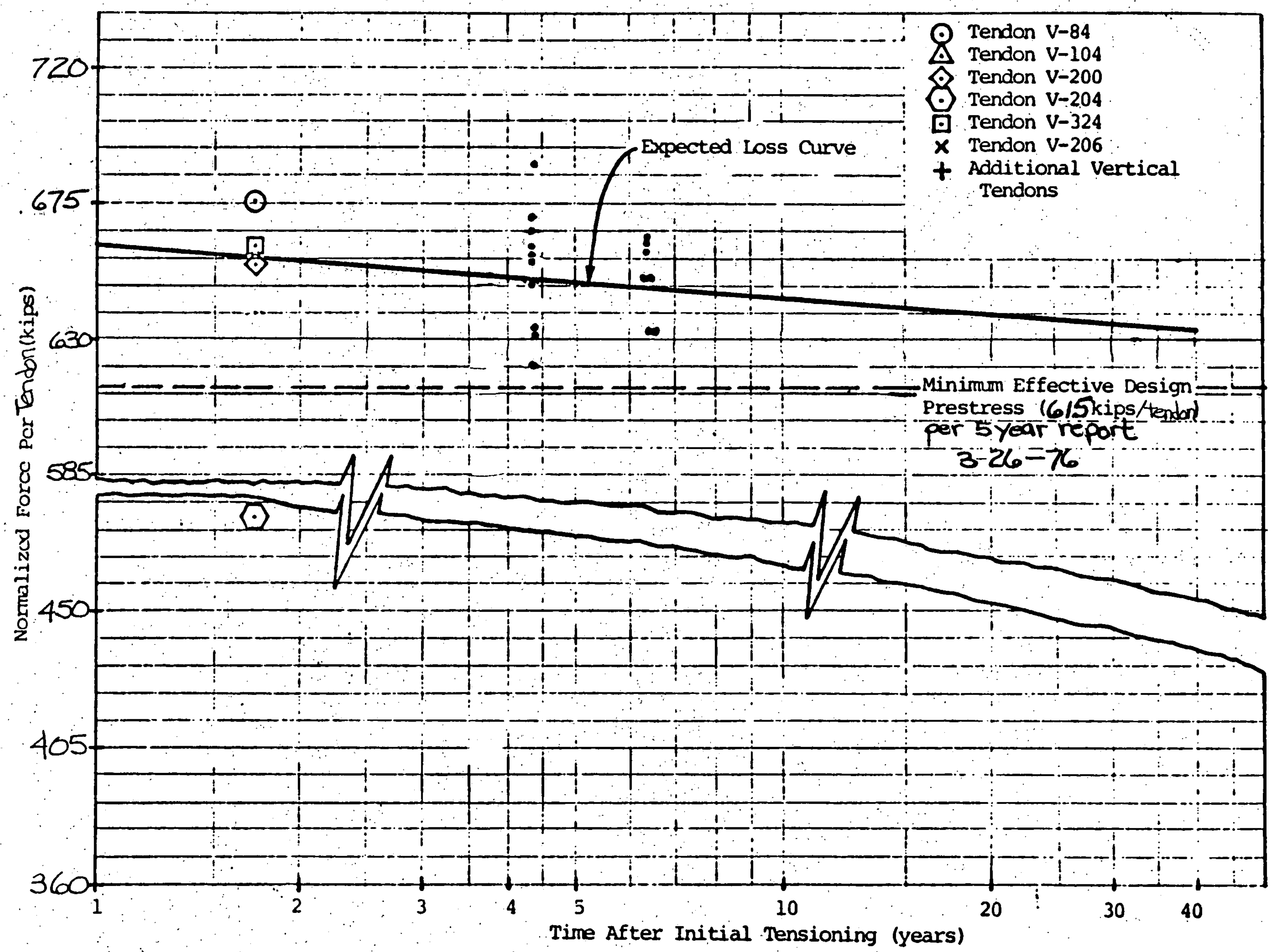

FIGURE 5-2 Normalized Tendon Force vs. Time - Vertical Tendons

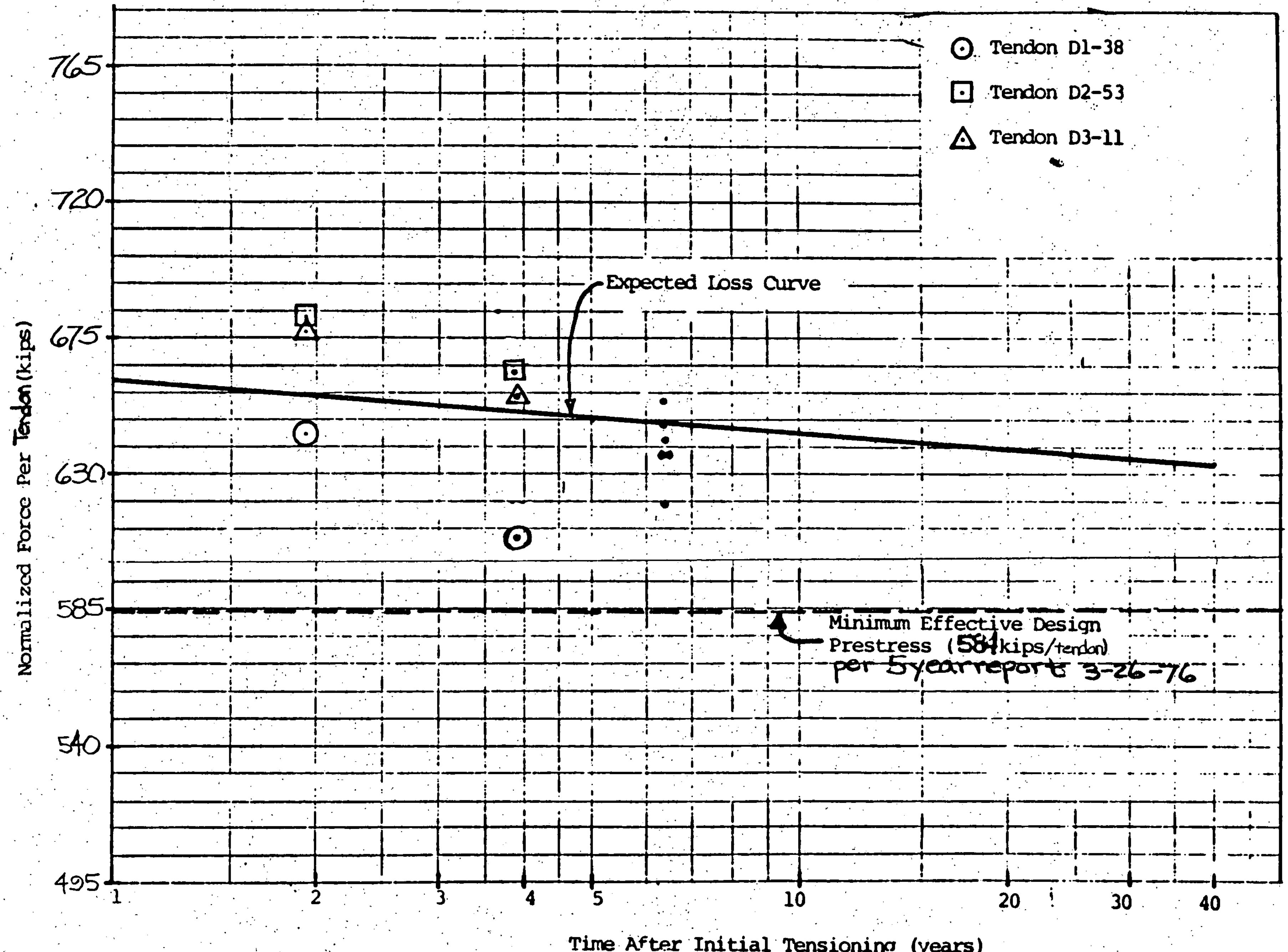

FIGURE 5-3 Average Normalized Tendon Force vs. Time - Dome Tendons