

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
TENDON SURVEILLANCE PROGRAM

ENGINEERING EVALUATION REPORT
FOR THE
FIFTH TENDON SURVEILLANCE
INSPECTION PERIOD

Originated By: Michael Marcellus

Reviewed By: Dale D. Krause

Report Date: 20 JUNE 1994

Gilbert/Commonwealth
Reading, Pa.

9408220231 940812
PDR ADOCK 05000302
Q PDR

 TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
—	TABLE OF CONTENTS	2
1.0	INTRODUCTION	4
2.0	REGULATORY ISSUES AND LICENSING POSITIONS	4
3.0	TENDON SELECTION	6
4.0	TENDON PHYSICAL CONDITION TESTS	8
4.1	ANCHORAGE ASSEMBLY INSPECTION	8
4.2	PHYSICAL CONDITION TESTS	11
5.0	INDIVIDUAL TENDONS	
	LIFT OFF FORCE EVALUATION	13
5.1	EVALUATION FOR COMPLIANCE WITH APPROVED TECHNICAL SPECIFICATION CRITERIA	14
5.2	EVALUATION FOR COMPLIANCE WITH REG. GUIDE 1.35	14
6.0	TENDON GROUPS AVERAGE FORCE AND TREND EVALUATION	19
6.1	DOMT TENDONS LIFTOFF FORCE EVALUATION & TRENDS	20
6.2	HOOP TENDONS LIFTOFF FORCE EVALUATION & TRENDS	20
6.3	VERTICAL TENDONS LIFTOFF FORCE EVALUATION & TRENDS	21
6.4	LIFTOFF FORCES OVERALL EVALUATION & TRENDS	22
7.0	TENDON ELONGATION	31
8.0	TENDON RELATED CONCRETE INSPECTION	31
9.0	CORROSION PROTECTION SYSTEM	32
10.0	EVALUATION OF OTHER NONCONFORMANCES	35
11.0	CONCLUSIONS	36
12.0	REFERENCES	39

<u>TABLES</u>	<u>TITLE</u>	<u>PAGE</u>
TABLE 5.0	FIFTH SURVEILLANCE RESULTS	17
TABLE 5.2	FORCE DEVIATIONS AT TENDON ENDS	18
TABLE 6.0	GENERAL TENDON HISTORICAL DATA	23
TABLE 6.1	SUMMARY OF DOME TENDON FORCES	24
TABLE 6.2	SUMMARY OF HOOP TENDON FORCES	26
TABLE 6.3	SUMMARY OF VERTICAL TENDON FORCES	29

FIGURES

FIGURE 6.1	DOME GROUP TREND OF LOSSES	25
FIGURE 6.2	HOOP GROUP TREND OF LOSSES	28
FIGURE 6.3	VERTICAL GROUP TREND OF LOSSES	30

APPENDICES

APPENDIX A	PREDICTED FORCE VS TIME CURVES (39 Pages)
APPENDIX B	AVERAGE NORMALIZED LIFTOFF FORCES AND NORMALIZATION FACTORS (3 Pages)
APPENDIX C	TENDON WIRE SUMMARIES FOR DOME, HOOP AND VERTICAL TENDON GROUPS (7 Pages)
APPENDIX D	EVALUATION OF REPLACED BULK FILLER (3 Pages)
APPENDIX E	PLOTS OF INSPECTED HOOP TENDONS UP TO AND INCLUDING THE FIFTH SURVEILLANCE (8 Pages)

**FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
TENDON SURVEILLANCE PROGRAM
ENGINEERING REPORT**

1.0 INTRODUCTION

The fifth tendon surveillance for the Crystal River Unit 3 Reactor Building post tensioning system was performed during the period from November 1, 1993 to January 4, 1994. This particular surveillance occurred during the seventeenth year after the CR3 structural integrity test, which took place in November, 1976. All work for the entire length of the surveillance period was completed while the plant was at full power operation.

The surveillance contractor, VSL Corp., performed the actual inspection activities at the CR3 site. Florida Power Corporation (FPC) controlled and monitored all activities. Gilbert/Commonwealth, Inc. (G/C) provided engineering support before, during, and after the surveillance period. The VSL Report, identified as Reference 1 herein, presents the results of the various inspection activities performed during the surveillance period.

Work was performed according to the requirements of FPC Surveillance Procedure SP-182. Laboratory tests of material samples, including tendon wires and bulk filler grease, were performed and these results are also included in the VSL report.

The purpose of this report is to evaluate and summarize the results of the surveillance with respect to the requirements for the CR3 Tendon Surveillance Program. Various nonconformances are summarized in the VSL Report, Appendix 5. Results found to be outside established acceptance criteria and not previously accepted, are reviewed and dispositioned in their respective sections within this report.

All work performed for this surveillance is evaluated based on the acceptance criteria as presented in US NRC Regulatory Guide 1.35, (RG) Revision 3, issued in July 1990, and incorporated into Surveillance Procedure, SP-182. (RG implementation date for CR3 is January 2, 1994.)

2.0 REGULATORY ISSUES AND LICENSING POSITIONS

Since the completion of the fourth tendon surveillance for CR3, the two Regulatory Guides applicable to tendon surveillance were formally issued in July, 1990. These include the following:

US NRC Regulatory Guide 1.35, Revision 3

Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containments.

US NRC Regulatory Guide 1.35.1, Revision 0

Determining Prestressing Forces for Inspection of Prestressed Concrete Containments.

In addition to the above two regulatory guides, the ASME document related to the tendon surveillance of concrete containments was also issued.

ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWL

Rules for Inservice Inspection of Nuclear Power Plant Components, issued in 1989 and updated in 1992.

Engineering preparation work for this surveillance included the completion of two engineering studies for review and evaluation of the CR3 tendon surveillance program against the requirements and acceptance criteria of the above Regulatory Guides and ASME document. Refer to References 6 and 7 for additional information. These studies were performed so that positions and acceptance criteria could be developed for use in the CR3 surveillance procedure and in other tendon related documentation.

Establishing the acceptance criteria for this particular surveillance was also complicated by the concurrent evolution of the FPC Technical Specification Improvement Program (TSIP), as well as the positioning of the FPC Tendon Surveillance Program with respect to the new Regulatory Guide and ASME requirements. Revision 10 of the surveillance procedure SP-182 was used for an interim period pending the approval of the TSIP by the NRC.

At the start of the surveillance, Technical Specification (TS) positions, Sections 3.6.1.6/4.6.1.6, Amendment 29 were applicable and remained applicable until 1/2/94. Final Implementation of the revised Technical Specification position came on 1/2/94 after most of the surveillance activity was complete.

Under the new TSIP Program, the revised TS Sections applicable to the tendon surveillance program are Sections SR 3.6.1.2, 5.6.2.7 and 5.7.2, Amendment 149. These positions all reflect the FPC commitment to NRC Reg. Guide 1.35, Rev 3. Final acceptance criteria was built into Revision 11 of SP-182 to meet the requirements of both the original TS, and the acceptance criteria as presented in the new Revision 3 of RG 1.35.

This engineering report evaluates the results of the surveillance against the requirements of the original TS at the time of the surveillance (up to 1/2/94), as well as the requirements of RG 1.35, Revision 3 and the final approved TS.

3.0 TENDON SELECTION

Consistent with the requirements of Regulatory Guide 1.35, Revision 3, eleven tendons were selected for inspection and testing during this surveillance period. This group of tendons represents 2% of the total tendon population as required by RG 1.35. The original Technical Specification Section 4.6.1.6.1 also requires the same sample size of eleven tendons, including 3 dome, 3 vertical and 5 hoop. The selection process involved the consideration of the following criteria:

- A. Tendons were selected to be random but representative of the entire tendon population. Samples were picked to represent the areas of containment that were not previously surveyed and that were accessible.
- B. Representative samples were selected to represent the respective groupings of tendons, including D100 series, D200 series, etc.
- C. Control tendons previously selected were retained.
- D. Except for the control tendons, tendons were selected which were not previously tested.
- E. Tendons in the range from 0 degrees to 120 degrees are in the proximity of the plant main steam vents. With the plant operating at power, work in this area would be too dangerous and would pose a significant safety hazard to workers on scaffold in the immediate and adjacent areas. Therefore, this area was excluded from the scope of this surveillance. Note however that most of the CR3 surveillances were performed during outages and that the exclusion of this zone for this surveillance did not bias the representative sample of the overall tendon population.
- F. Documentation was researched and inquiries made of FPC personnel to determine if there were any leaking or problem tendons which should be included in the scope of this surveillance. None were found necessary for inclusion.
- G. Tendon historical data sheets were reviewed and the number of effective wires reviewed and considered. A tendon with the minimal number of effective wires was not selected for detensioning or as a control tendon.
- H. The reduced force dome tendons are not in the selected population since their prestress forces are significantly less than all other tendons.
- I. Accessibility for the surveillance equipment was considered in walkdowns by FPC and bidders.

As the surveillance was performed during normal plant operation, there was no heavy load consideration required for tendons over the fuel pool area, as is necessary during a surveillance performed in a refueling outage.

The tendons selected for this fifth surveillance include the following:

<u>DOME</u>	<u>HOOP</u>	<u>VERTICAL</u>
D138	35H1	34V6 C
D215 C	42H1	56V15 D
D224 A	46H29 C	61V14
D231 D	46H47 D	34V23 A
	62H8	
	46H3 A	

C = Control Tendon

D = Detensioned Tendon

A = Alternate Tendon

At the start of the surveillance, the alternate dome tendon, D224, was substituted in place of the selected tendon, D138. This was necessary as the removal of the upper section of the plant vent stack would have been required to access D138. A substantial effort involving the use of another crane would have been required and at a significant cost.

During the actual inspection period, it was determined necessary to add three more hoop tendons to the inspection and testing process due to low prestress forces in hoop tendons. These tendons include the following:

HOOP
46H28
46H30
46H21

Tendons 46H28 and 46H30 were added to the scope of the surveillance since they are the adjacent tendons of 46H29, which had an average liftoff force less than 90% of the base acceptance criteria (RG 1.35, Rev. 3) for that tendon. Tendon 46H21 was selected to investigate the extent of the low prestress condition of hoop tendons in the vicinity of 46H29. The tendon is representative of mid height of the containment and had not been previously retensioned. It was also selected as a replacement control tendon, since it was decided to detension the original control tendon, 46H29, for further evaluation. Tendon 46H21 was inspected in the first surveillance and therefore, has some documented performance history for use as a new control tendon.

Predicted tendon prestress force curves were prepared for all of the selected tendons, an alternate tendon from each tendon group, and for adjacent tendons on each side of the selected tendons. These curves were included in the latest revision of Surveillance Procedure, SP-182.

4.0 TENDON PHYSICAL INSPECTION

4.1 Anchorage Assembly Inspection

Tendon anchorage assembly components, including stressing washers (anchorheads), buttonheads, bearing plates, and shims were all inspected by VSL during the surveillance. Table 3 of the VSL Report summarizes the results of the inspection for corrosion at each of the tendon ends. These results are based on the Enclosure 14, 15 and 16 documents for each tendon, included in the VSL Report.

Inspections found a few instances of corrosion levels exceeding the established acceptable levels. These conditions are discussed below.

Stressing Washers (Anchorheads)

Corrosion on the stressing washer is of particular concern as it may indicate the presence of moisture and oxidation within the sealed end cap. Corrosion levels of 3 or less are acceptable without additional justification per SP-182. Inspection results tabulated in the VSL Report, Table 3, indicate a total of five instances where corrosion levels of 4 or 5 were observed on stressing washers on the following tendons:

D231, field end
35H1, field end
46H21, field end.

56V15, field and shop end
42H1, field and shop end

A pitting condition existed on localized areas of the above stressing washers, with no signs of active oxidation or buildup of crust or rust. This condition was typically observed and noted on the documentation for all the above stressing washers. The condition was similar to surface casting voids and not due to corrosion. No free moisture was observed within the sealed end caps of any tendon. The bulk filler grease covered all tendon stressing washers except for the shop (top) end of vertical tendon 56V15. As this tendon was fully detensioned, it was later refilled and topped with replacement grease.

It is suspected that the indicated conditions on the stressing washers have existed since original installation. This is supported by the fact that the anchorheads were well covered with bulk grease and that current grease testing confirmed the grease met the acceptance criteria. The observed conditions do not indicate abnormal degradation and will not affect the function and integrity of the stressing washers.

Buttonheads

Corrosion levels of 2 or less are acceptable for buttonheads in accordance with SP-182. Inspection results tabulated in the VSL Report, Table 3 indicate one tendon, 42H1 field end, where a corrosion level of 4 was observed on six buttonheads. The buttonheads were cleaned and additional field inspection by FPC concluded the buttonheads are still effective and acceptable.

A number of buttonheads are noted as misformed and recorded by VSL on the SP-182 Enclosure forms. The noted observations were further discussed with VSL and FPC. The results of the inspections and the recording of data by VSL on misformed buttonheads was intended for historical record purposes. The discrepancies as noted were not gross deficiencies outside the acceptance criteria for buttonheads as specified in SP-182, Enclosure 6. Results do not suggest the wires are to be considered ineffective. It was concluded that the observed buttonhead conditions have existed since the original tendon installation and are acceptable. Those wires determined by VSL to be ineffective wires, are summarized on Table 4 of the VSL Report.

Bearing Plates

Bearing plate corrosion levels greater than 3 are unacceptable without rework or justification per SP-182. Inspection results as tabulated in the VSL Report, Table 3 indicate that six tendons had corrosion levels of 4 or 5 on their bearing plates. These tendons and ends are:

D224, field and shop end
56V15, shop end (Top)
46H21, field end

D231, field and shop end
61V14, shop end
46H47, field and shop end

In all cases, the corrosion was found to be outside the sealed area of the tendon end caps. Epoxy repairs as specified in SP-182 were completed on four of the above bearing plates. This repair procedure provides a smooth surface to allow proper sealing of the new O Ring to the plate. The bearing plate for tendon D231 was cleaned and accepted. Tendon 46H21 bearing plate was cleaned and repainted per SP-182.

The bearing plate corrosion conditions were all exterior to the O ring seals. No corrosion had progressed to the point of allowing environmental conditions and moisture to breach the integrity of the O ring and affect tendon anchorage components.

The design function of the bearing plates is to transmit the tendon force into the concrete containment. The corrosion conditions found did not degrade the bearing plates from performing this design function. While the corrosion condition required cleanup and resurfacing with epoxy, the effect on the required thickness of the bearing plate is insignificant. Therefore, the existing conditions and repairs made to the bearing plates are found acceptable. The protection of anchorage components is assured, and the function and integrity of the bearing plates is maintained.

Shims

Shim corrosion levels of 3 or less are acceptable without additional justification per SP-182. Table 3 of the VSL Report shows that there were no shims with corrosion levels greater than 2. It should be noted however, that some shims were found to have a heavy film coating on them apparently from the time of original installation. In some cases, it was necessary to avoid shim locations with this coating when inserting the feeler gauge, since it could affect the accuracy of the determined liftoff force.

End Caps and Studs

Tendon end caps and hold down studs are not considered an anchorage assembly component. However, they provide environmental protection from the elements for the tendon anchorage assembly. End caps typically were corroded indicative of their age and environment. This corrosion level however, did not affect their design function of protecting the anchorage assembly.

After removal from the tendon anchorage, tendon end caps were taken to the CR3 shop where they were cleaned and repainted.

Studs and exterior nuts used to secure the end caps were replaced and repainted as necessary.

4.2 Physical Condition Tests

Sample wires were removed from the three tendons selected for detensioning, D231, 46H47, and 56V15. In addition, another ineffective wire was removed from 56V15 and one random wire was removed from the detensioned 46H29. Three broken wires were found at the field end of 46H29 and were removed for sample selection and testing.

All samples were tested in accordance with ASTM A421-76 for Uncoated Stress Relieved Wire for Prestressed Concrete. The minimum acceptance values for ultimate strength, yield strength and elongation are 240 Ksi, 204 Ksi and 4% respectively.

Table 7 of the VSL report tabulates the laboratory test results for the wire samples. All the tested samples exceeded the required minimum values for yield strength and elongation. All samples but one exceeded the required minimum ultimate strength. A very minor error in the measurement of the wire diameter could contribute to this condition. The center wire sample from tendon D231 had a reported 239 ksi value for ultimate strength. The other two samples at the ends were 243 ksi and 244 ksi, resulting in an average tensile value of 242 ksi for the three samples from the same wire. Review of previous tendon surveillance reports concluded that this is the only occurrence of an ultimate strength value less than the required minimum of 240 ksi. Therefore, the anomaly is accepted as a unique occurrence and is not considered significant.

In addition to the standard wire testing performed and discussed above, additional tests were requested for closer examination of the three broken wires found at the field end of tendon 46H29 during the surveillance. As a result of the field performing various alternative liftoff techniques, it is suspected that these wires were inadvertently broken during the surveillance work.

A visual inspection of the wire breaks at the site concluded that the fracture occurred as a result of mechanical damage to the stressed wire. The fact that each of the broken wires was the same length supported this position. The mechanical damage appeared to have caused an indentation on the wires resulting in failure of the stressed wire. Shims were removed and inspected for any markings made by a wire rubbing against the shim. Evidence was found on the bottom of the shims of such an occurrence, and the length of wire stub corresponded to the location of the shim markings.

To confirm the above, the wires were sent to a testing facility for examination with a scanning electron microscope. The laboratory conclusion confirmed that the wires failed as a result of tensile shear overload caused by mechanical deformation and indentation of the wires on one side. There was no evidence of stress corrosion cracking. Results from the electron microscope scanning, including photos of the fracture structure from 15X to 1390X, are presented in a separate report in Appendix 2 of the VSL report.

Tendon wires, and specifically ineffective tendon wires, are tabulated in Appendix C for comparison with the acceptance criteria as specified in Enclosure 5 of SP-182. This acceptance criteria is summarized as follows:

- A. Broken and ineffective wires shall not exceed 8 wires per individual tendon.
- B. Broken and ineffective wires shall not exceed 2% of the total number of wires in that group. Groups are defined in the following manner:

Vertical Tendons; One stressing sequence quadrant of 36 tendons.
Dome Tendons; One layer series of 41 tendons, i.e. D100, D200 & D300 groups.
Hoop tendons; One side of a buttress, 47 tendons.
- C. Broken and ineffective wires shall not exceed 3% in any ten consecutive tendons in a group.

This acceptance criteria is not required for Technical Specification or current Regulatory Guide compliance, but is maintained from the original design basis of the post tensioning system. It provides a flag for potential deficiencies in the tendon system and as such, was continued for this surveillance.

The cumulative results of these wire summaries, as tabulated for all surveillances, has indicated that there are no deviations from the SP-182 Enclosure 5 acceptance criteria. (Note that there are two individual tendons having greater than 8 ineffective wires. This anomaly is not considered a deficiency and is discussed in Appendix C.)

The results of the tendon wire summaries provide additional assurance that the tendon wires are performing their intended function and that no local problem areas exist in the tendon post tensioning system.

5.0 INDIVIDUAL TENDONS LIFT OFF FORCE EVALUATION

Evaluation of the individual tendon liftoff forces for the fifth surveillance will consider both the existing Technical Specification positions and the latest revision of Regulatory Guide 1.35 criteria.

Measured liftoff forces are the average of both ends, except for the vertical tendons where liftoff is measured from the top only. Refer to Enclosure 20 data presented in the VSL report. Liftoff forces for all 14 tendons in the scope of this surveillance, along with comparisons to TS and Reg. Guide acceptance criteria are presented in Table 5.0. Tendon liftoff results for a tendon fall into one of five acceptance categories.

These categories are described in the following designations:

<u>CATEGORY</u>	<u>DESCRIPTION</u>
A. Greater than 1721 Kips	Greater than Technical Specification upper limit.
B. Greater than or equal to 95% Base and less than 1721 Kips	Equal to or above RG 95% limit and less than TS upper limit.
C. Less than 95% Base and greater than or equal to 90% Base	Less than RG 95% limit and greater than or equal to the RG 90% limit.
D. Less than 90% Base and greater than 1249 Kips	Less than RG 90% limit and greater than TS lower limit.
E. Less than 1249 Kips	Below Technical Specification lower limit.

5.1 Evaluation for Compliance with Approved TS Criteria (Up to 1/2/94)

The Technical Specification acceptance criteria, which existed for the last several surveillances and for most of this surveillance, states that each tendon shall have a measured liftoff between 1249 kips and 1721 kips. All tendons had liftoffs that were within the acceptance criteria of the TS. The lowest average liftoff force of all the tendons is 1300 kips for tendon 46H29, or 4.08% above the TS lower limit. The highest force recorded is 1590 kips for tendon 34V6, which is 92.3% of the TS upper limit.

5.2 Evaluation for Compliance with Regulatory Guide 1.35 Criteria

The predicted prestress force vs. time curves are presented for each tendon in the VSL report and in Appendix A herein. Minor corrections were recorded on the attached copy. The force curves have been prepared using the procedure for the development of these force curves as presented in Regulatory Guide 1.35.1 (Reference 5). Predicted base prestress forces have been calculated accounting for prestress losses due to elastic shortening of the tendon, stress relaxation of the wire, concrete shrinkage and concrete creep.

The 95% base line is 95% of the predicted base force curve and is the lower limit for acceptance of a tendon liftoff force according to the requirements of RG 1.35. Tendons with measured liftoff values less than 95% but greater than or equal to 90% base are to have their adjacent tendons lifted off. Tendons with measured liftoff values less than the 90% base line are considered defective according to the Reg. Guide. Measured liftoff forces for all 14 tendons in the scope of this surveillance, along with comparisons to the Reg. Guide base and 95% base lower limits are presented in Table 5.0. A summary of these liftoffs with respect to their resulting acceptance category is presented below.

Measured liftoff forces above their predicted base.

D215	34V6	35H1
D224	56V15	42H1
D231	61V14	46H47

Measured liftoff forces at or above 95% Base

46H21	62H8	46H30
-------	------	-------

Measured liftoff forces at or above 90% Base and below 95% Base

46H28

Measured liftoff forces below 90% Base

46H29

Of the eleven selected tendons in the scope of this surveillance, all tendons but one met the RG acceptance criteria for liftoff. Hoop tendon 46H29, the control tendon, was the only tendon, at 88.1% of the predicted base, found to be below the 90% Base limit. Actions were taken to address this low prestress condition and the liftoffs of adjacent tendons 46H28 and 46H30, were performed.

For tendon 46H30, a large deviation occurred between the liftoff force at the field end and the liftoff force at the shop end. Note that some of these differences were over 200 kips. An initial force at the shop end of 1138 kips was cause for concern as it would fall below both RG and TS lower limits. Numerous other liftoff readings were taken on both 46H30 and 46H29 to gather data and evaluate the problem. Also, the equipment used for measuring liftoff forces was evaluated. Based upon additional data and field observations, it was determined that a recession existed in the area between the two mated shims where the feeler gauge was used. This allowed the feeler gauge to pull out prior to actual liftoff. Closer inspection of the removed shims also confirmed that shim surface conditions and tolerances were an obvious contributor. In addition, some shims were found to have a coating that was not of consistent thickness over the entire shim surface.

To further evaluate the large deviation of forces between ends, engineering requested the field to detension 46H29 and perform a push/pull drag test to determine if there was any obstruction or cause for the large disparity. The detensioned tendon moved in both directions with resulting forces found to be about equal (7.2 kips vs 7.4 kips). No obstruction or other cause was determined from the push/pull test. The tendon was then inspected and treated as another detensioned tendon. A new control tendon was selected.

Table 5.2 was prepared to tabulate the results of the additional liftoff data for tendons 46H30 and 46H29 and for use in selecting which liftoff is considered valid and applicable. Based on the tabulated data, liftoff values were selected and indicated in the Table.

For 46H29, the 1300 kip value was judged to be the appropriate liftoff value. This was the first liftoff recorded and had the smallest deviation between the field and shop end results. Broken wires found at the field end of tendon 46H29 during the surveillance do not affect the selected liftoff figure, as it was determined that the three broken wires occurred after this liftoff was completed. The selected liftoff force for 46H29 is 88.1% of base.

For tendon 46H30, the 1382 kip value was judged to be the valid liftoff. Two of the three shop end liftoff forces had a large deviation of over 200+ kips. The forces at the field end are all very consistent, therefore, the shop end of 1395 is the best representation with the lowest deviation between the two ends. The liftoff of 1382 kips is 95.3% of the predicted base and therefore the tendon is considered acceptable, being above the lower limit of 95% base.

The liftoff force of tendon 46H28, the other adjacent tendon to 46H29, is 90.4% of the predicted base. Therefore, the liftoff results of the adjacent tendons of tendon 46H29, at 95.3% and 90.4% of their respective base values, provided mixed results as to the extent of the low hoop prestress condition of 46H29.

Tendon 46H21 was then selected as an additional tendon to be checked for liftoff. Tendon 46H21 is representative of the mid section of the hoop area in the same meridian sector as tendons 46H28 and 46H29. It was also selected as the new control tendon since the original control tendon, 46H29, was detensioned and is no longer a valid control tendon. The liftoff force for hoop tendon 46H21 was found to be acceptable with a measured force at 97.9% of base.

With the additional tendons selected for liftoff measurement and detensioning, as well as the additional inspections and tests performed on wires and grease samples, it was determined that sufficient information had been gathered to conclude that the extent of the low prestress condition was limited to 46H29 and 46H28. However, it was decided that some further evaluation and possible courses of action be made concerning the low prestress force condition for these hoop tendons. A preliminary evaluation was made with considerations and recommendations documented separately in the Reference 19 Report.

The results from the various inspections and from the wire and grease laboratory tests for the two problem tendons 46H28 and 46H29, have determined that there is no evidence of wire failure or problems with the corrosion protection system. Based upon all the available data, it is concluded that the two hoop tendons are still performing their intended function, but have experienced somewhat greater losses than predicted.

The overall effect of these additional losses will be considered in the performance evaluation and trending analysis as presented in Section 6.0 of this report for the hoop group of tendons.

TABLE 5.0
TENDON SURVEILLANCE PROGRAM
FIFTH SURVEILLANCE RESULTS

20-Jun-94
09:54:39 AM

Tendon Number	Predicted Base Value at 5th Surveillance (Kips)	Measured Tendon Force for 5th Surveillance (Kips)	% of Base (3 / 2) X 100%	Lower Limit 95% Base per Reg Guide 1.35 for 5th Surveillance (Kips)	Lower Limit per Tech. Spec. (Kips)	Measured vs. Predicted Base (3-2/2) X 100%	Measured vs. Lower Limit RG 1.35 (3-5/5) X 100%	Measured vs. Lower Limit Tech. Spec. (3-6/6) X 100%	Acceptance Category
1	2	3	4	5	6	7	8	9	10
D215	1311	1518	115.8%	1246	1249	15.8%	21.8%	21.5%	B
D224	1320	1425	108.0%	1254	1249	8.0%	13.6%	14.1%	B
D231	1299	1335	102.8%	1234	1249	2.8%	8.2%	6.9%	B
Dome Avg.			108.8%			8.8%	14.6%	14.2%	
34V6	1513	1590	105.0%	1439	1249	5.0%	10.5%	27.3%	B
56V15	1510	1541	102.1%	1434	1249	2.1%	7.5%	23.4%	B
61V14	1549	1587	102.5%	1471	1249	2.5%	7.9%	27.1%	B
Vert. Avg.			103.2%			3.2%	8.6%	25.9%	
35H1	1424	1572	110.4%	1352	1249	10.4%	16.3%	25.9%	B
42H1	1431	1560	109.0%	1360	1249	9.0%	14.7%	24.9%	B
46H21 +	1455	1425	97.9%	1383	1249	-2.1%	3.0%	14.1%	B
46H28 +	1521	1375	90.4%	1445	1249	-9.6%	-4.8%	10.1%	C
46H29	1476	1300 *	88.1%	1402	1249	-11.9%	-7.3%	4.1%	D
46H30 +	1450	1382 *	95.3%	1378	1249	-4.7%	0.3%	10.6%	B
46H47	1445	1468	101.6%	1373	1249	1.6%	6.9%	17.5%	B
62H8	1464	1435	98.0%	1391	1249	-2.0%	3.2%	14.9%	B
Hoop Avg.			98.8%			6.4%	7.1%	15.3%	
Overall Average			103.6%			6.1%	10.1%	18.4%	

- Notes:
- 1) Average's are computed using absolute values of tabulated data.
 - 2) Acceptance categories are as follows:
 - A - Liftoff force greater than 1721K (T.S. upper limit applicable at time of inspection).
 - B - Liftoff force greater than or equal to 95% Base and less than 1721K.
 - C - Liftoff force less than 95% Base; greater than 90% Base (Reg. Guide 1.35).
 - D - Liftoff force less than 90% Base and greater than 1249K.
 - E - Liftoff force less than 1249K (T.S. lower limit applicable at time of inspection).
 - 3) * Values selected for use in final analysis from the results of several liftoff tests performed.
 - 4) Sources for the tabulated data are noted as follows:
 - Column 3, measured liftoff force VSL Summary Report, Enclosure 20.
 - Column 2 and 5, Base and 95% values, from Tendon Force Curves.
 - Column 6, Tech Spec lower limit, SP-182, Rev. 10, Section 3.6.4.
 - 5) + Indicates additional tendons added during the surveillance.

File: SURVEIL5.WK3

TABLE 5.2
LIFTOFF DATA
FIFTH SURVEILLANCE RESULTS
FORCE DEVIATIONS AT TENDON ENDS

23-May-94
11:49:14 AM

Tendon Number	Average Liftoff (Kips)	Field End		Shop End		Date	Difference at Ends 3-4 (Kips)	% Difference Of Average (3-4) / 2
		Force (Kips)	Ram No.	Force (Kips)	Ram No.			
1	2	3		4		5	6	7
D215	1518	1579		1458		11/09/93	121	8.0%
D224	1425	1412		1438		11/17/93	26	1.8%
D231	1335	1332		1337		12/01/93	5	0.4%
35H1	1572	1568		1577		01/03/94	9	0.6%
42H1	1560	1507		1613		01/03/94	106	6.8%
46H21	1425	1427		1423		12/07/93	4	0.3%
46H28	1375	1374		1376		11/22/93	2	0.1%
46H29	1300 *	1280	12-3	1321	12-3	11/19/93	41	3.2%
	1335	1256	6529	1414	12-3	12/08/93	158	11.8%
	1262	1172	6529	1352	12-3	12/08/93	180	14.3%
	1347	1275	6529	1420	12-3	12/08/93	145	10.8%
	1323	1256	6529	1391	12-3	12/08/93	135	10.2%
46H30	1254	1371	6529	1138	12-3	11/22/93	233	18.6%
	1382 *	1368	6529	1395	12-3	12/07/93	27	2.0%
	1238	1368	6529	1109	12-3	12/07/93	259	20.9%
46H47	1465	1472		1464		12/04/93	8	0.5%
62H8	1435	1462		1407		12/29/93	55	3.8%
						Average	89	6.7%

* Indicates the selected choice for the tendon.

Note: N/A to Vertical Tendons since Liftoff is measured from upper end only.

6.0 TENDON GROUP AVERAGE FORCE AND TREND EVALUATION

In addition to the review of the individual tendon forces, the average normalized tendon force for each tendon group is to be reviewed based on the results of the liftoffs determined during this surveillance. The calculation for these averages is contained within Enclosure 41 of SP-182, Revision 11. Enclosures 41 & 42 of SP-182 are attached in Appendix B and show normalization factors and the average normalized forces for each of the three tendon groupings. Each group average is compared to the minimum required design prestress force for each tendon group. These values are design bases values for the containment design and are noted as follows:

<u>Tendon Group</u>	<u>Required Minimum Design Prestress Force Average</u>
Dome	1215 Kips
Hoop	1252 Kips
Vertical	1149 Kips

Table 6.0 provides a complete listing of the tendons inspected in the first through the fifth surveillances. Tables 6.1, 6.2 and 6.3 present an overall summary of data for the dome, hoop and vertical tendons respectively. These summaries present measured liftoff values and other data for each tendon in each of the five surveillances. Both the 95% base RG limit and the TS lower limit are presented, and a comparison made with the measured liftoff values for each tendon. The normalized average force calculations are also included for each group and for each surveillance.

Note that prior to the fourth surveillance, the Regulatory Guide "lower limit" was defined differently than the current RG 95% base limit. For comparison purposes, tendon data presented in Tables 6.1, 6.2 and 6.3, for surveillances one through three was reworked to develop the equivalent 95% base lower limit as defined in the current Reg. Guide, Revision 3. Column 5 presents these revised values. Measured liftoffs are compared to these values as well as the TS lower limit.

The tabulated data provides the basis for establishing the overall trend of losses for each tendon group. Curves were plotted to represent the best fit (regression analysis) of the data points from each of the surveillances. These curves represent the overall trend of losses for the dome, hoop, and vertical tendon groups for CR3. These curves are attached as Figures 6.1, 6.2 and 6.3 respectively.

Results of the average normalized force calculation, and the trend of losses for each group of tendons are discussed in the following sections.

6.1 Dome Tendons Lift-Off Force Evaluation

Table 6.1 indicates that the average normalized liftoff force for the dome group of tendons for this surveillance period is 1454 kips. This exceeds the minimum required prestress of 1215 kips by almost 20%.

Figure 6.1 shows the plot of the regression line representing the overall trend of losses for the dome tendons since the first surveillance period. Data points are reasonably correlated and the projected trend line at the end of the forty year life of the plant is well above the minimum required prestress level of 1215 kips.

The data in Table 6.1 reflects an overall positive condition of the dome tendon group. Columns 7 and 8 compare measured liftoffs versus RG and applicable TS lower limits. The calculated percentages are all positive numbers indicating that measured liftoffs were above their RG and TS lower limits. Therefore, in addition to the minimum required average prestress value for the dome group being met, individual dome tendons were found to meet current Technical Specification and RG 1.35 acceptance criteria.

6.2 Hoop Tendons Lift-Off Force Evaluation

Table 6.2 indicates that the average normalized liftoff force for the hoop group of tendons was calculated as 1424 kips. This exceeds the minimum required prestress of 1252 kips by almost 14%.

Figure 6.2 shows the plot of the regression line representing the overall trend of losses for the hoop tendons since the first surveillance. The data points have good correlation and the projected trend line at the end of the forty year plant life is above the minimum required prestress level of 1252 kips. The low prestress condition of two hoop tendons is reflected in the average for the current surveillance, and is therefore accounted for in this projection.

Data in Table 6.2 reflects an overall positive condition of the hoop tendon group. A review of the measured liftoffs versus the TS lower limit shows that all hoop tendons have exceeded the Technical Specification lower limit. In fact, tendon 46H29 from this surveillance is the lowest hoop tendon shown with a 4.1% margin over the TS limit.

A review of the measured liftoffs versus the Reg. Guide 95% base lower limit shows some negative values for some hoop tendons (See columns 7 & 8). This indicates that some hoop tendon liftoffs do not meet the current Reg Guide acceptance criteria. Five hoop tendons of a total of 43 inspected to date do not meet the Reg. Guide 95% base value. These tendons are listed as follows:

<u>Tendon</u>	<u>Surveillance</u>	<u>% below</u>
35H28	2	-1.7
51H26	3	-2.9
51H26	4	-2.1
46H28	5	-4.8
46H29	5	-7.3

While these results indicate a few individual tendons have not met the acceptance criteria of the current Reg. Guide, the required minimum prestress levels for the overall hoop group has still been met with ample margin. Furthermore, the overall positive results from the various wire and grease tests support the conclusion that the integrity of the hoop tendons, and the structural integrity of the containment have been maintained.

6.3 Vertical Tendons Lift-Off Force Evaluation

The average normalized liftoff force for the vertical group of tendons was calculated as 1571 kips. This exceeds the minimum required prestress of 1149 kips by almost 37%.

Figure 6.3 shows the plot of the regression line representing the overall trend of losses for the vertical tendons since the first surveillance. Results indicate the trend of losses for the vertical group is well above the required minimum prestress force of 1149 kips. The data points are less correlated than the other groups but the projected trend line at the end of the forty year life of the plant is still well above the required minimum prestress level.

Data in Table 6.3 reflects an overall positive condition of the vertical tendon group. Measured liftoffs, when compared to the lower limit of the TS, show that all values are positive (Columns 7 and 8). This indicates that the none were below the TS limit. When the same comparison is made against the lower limit of the Reg. Guide, only one tendon shows as negative. This tendon was 12V1, as inspected in the third surveillance period. A closer examination of the data indicates that the same tendon was inspected again in the fourth surveillance with results indicating that the same tendon was 5.6% above the 95% Base limit. The G/C fourth surveillance report (Reference 7.) reported this as an error from the third surveillance. Therefore, it can be concluded that all vertical tendons meet the current Reg. Guide acceptance criteria.

6.4 Lift-Off Forces Overall Evaluation

Computed overall averages of tendons measured forces vs. the RG 1.35 and TS lower limits for all three tendon groups are shown at the bottom of Columns 7 & 8, Tables 6.1, 6.2 & 6.3 and are summarized below. (Note that these computed averages for measured liftoff vs. RG 1.35 values are based on the adjusted lower limit values for surveillances one through three, as explained in Section 6.0. and noted on the Tables.)

<u>Group</u>	<u>Above RG</u> <u>95% Base</u> <u>Lower Limit</u>	<u>Above</u> <u>Tech. Spec.</u> <u>Lower limit</u>
Dome	13.5%	20.2
Hoop	6.6	19.4
Vertical	10.3	29.2

These results indicate margins above the applicable lower limits. As the TS lower limits are typically below that of RG 1.35, greater margin is available when comparing with the TS lower limit.

Average tendon force margins, with respect to the Reg. Guide, show the hoop group with the lowest margin of 6.6%. These results are a positive indication of the overall condition and performance of the prestressing system.

***** CR3 TENDON SURVEILLANCE HISTORICAL RECORD *****

TABLE 6.0

20MAY94

SURVEILLANCE PERIOD	1ST SURVEILLANCE 11/27/77 TO 2/9/78	2ND SURVEILLANCE 3/5/80 TO 5/9/80	3RD SURVEILLANCE 9/28/81 TO 12/7/81	4TH SURVEILLANCE 9/15/87 TO 11/17/87	5TH SURVEILLANCE 11/93 TO 1/94	
YEARS AFTER SIT SIT 11/76	1 YEAR	3.5 YEARS	5 YEARS	11 YEARS	17 YEARS	SUMMARY DATA
REQUIRED TO INSPECT	21 TOT-10H,6V,5D	21 TOT-10H,6V,5D	21 TOT-10H,6V,5D	11 TOT-5H,3V,3D	11 TOT-5H,3V,3D	85 TOT-40H,24V,21D
ACTUALLY INSPECTED	23 TOT-10H,7V,6D	22 TOT-10H,7V,5D	21 TOT-10H,6V,5D	11 TOT-5H,3V,3D	14 TOT-8H,3V,3D	91 TOT-43H,26V,22D
SP 182 BASIS G/C REPORT	REV -- 3/78	REV -- 5/80	REV 4 5/19/82	REV 7 3/10/88	REV 10 & 11 5/94	
DOME TENDONS	D139	D122	D123	D105 D	D215 R,C	22 DOME TENDONS
123 TOTAL	D215	D140	D215 R	D212 R	D231 D	INSPECTED TO DATE
3 GROUPS OF 41	D221 D	D208 D	D212	D328	D224 A	
D100'S, D200'S, D300'S	D228	D323	D322 D			
	D234	D331	D329			
	D340					
VERTICAL TENDONS	12V19	12V12	12V1	12V1 R	34V6 R,C	26 VERTICAL TENDON
144 TOTAL	12V20	12V20 R	34V6 R	34V4	56V15 D	INSPECTED TO DATE
6 GROUPS OF 24	12V21	23V5	34V19 D	56V2 D	61V14	
12, 34, 56, 23, 45, 61	23V15	34V1	45V16			
	34V6	45V6	56V11			
	45V3 D	56V20	61V5			
	56V1	56V1 D,R				
HORIZONTAL TENDONS	13H10	13H22	13H19 R	13H20	35H1	43 HOOP TENDONS
282 TOTAL	13H19	13H32 D	13H46	13H40 D	42H1	INSPECTED TO DATE
6 GROUPS @ 47 HIGH	13H37	13H43	42H20	51H26 R	46H21 C(New)	
13, 24, 35, 46, 51, 62	13H47	51H10	42H40	51H41	46H28 ADJ.	
3 TENDONS PER HOOP	51H11	51H23	51H26	46H19	46H29 R,C,D	
	62H9	51H37	51H45		46H30 ADJ.	
	46H21	53H24	53H35		46H47 D	
	46H29	53H28	53H40		62H8	
	46H37 D	53H44	62H34			
	46H46	46H42	46H10 D			
TOTAL TENDONS = 549						
TOTAL INSPECTED	23	22	21	11	14	91 TOTAL INSPECTED
LEGEND -	A, ALTERNATE	C, CONTROL	D, DETENSIONED	R, REPEATED	ADJ., ADJACENT	FILE-CR3RSTSP.WK1

TABLE 6.1
SUMMARY OF DOME TENDON FORCES THROUGH FIFTH SURVEILLANCE
SORTED BY SURVEILLANCE NO. / TENDON NO.

20-Jun-94

11:03:00 AM

Tendon Number	Original Lock-Off Force (Kips)	Measured Lift-Off Force (Kips)	Surveillance Number	Lower Limit * 95% Base per Reg. Guide 1.35 (Kips)	Lower Limit per Tech. Spec. (Kips)	Measured vs. Reg. Guide (3-5)/5 X 100%	Measured vs. Tech. Spec. (3-6)/6 X 100%	Normalizing Factor NF (Kips)	Normalized Force (3+9) (Kips)	Minimum Required Avg. Force (Kips)
1	2	3	4	5	6	7	8	9	10	11
D139	1686	1590	1	1351	1249	17.7	27.3	-18	1572	1215
D215	1667	1644	1	1307	1249	25.8	31.6	28	1672	1215
D221	1670	1511	1	1463	1249	3.3	21.0	-141	1370	1215
D228	1667	1524	1	1378	1249	10.6	22.0	-46	1478	1215
D234	1643	1513	1	1415	1249	6.9	21.1	-86	1427	1215
D340	1634	1562	1	1401	1249	11.5	25.1	-68	1494	1215
								Average	1502	
D122	1664	1647	2	1356	1249	21.5	31.9	-53	1594	1215
D140	1669	1587	2	1410	1249	12.6	27.1	-102	1485	1215
D208	1648	1594	2	1392	1249	14.5	27.6	-81	1513	1215
D323	1671	1526	2	1299	1249	17.5	22.2	19	1545	1215
D331	1636	1461	2	1259	1249	16.0	17.0	59	1520	1215
								Average	1531	
D123	1611	1304	3	1231	1249	5.9	4.4	75	1379	1215
D212	1600	1338	3	1292	1249	3.6	7.1	16	1354	1215
D215	1667	1594	3	1278	1249	24.7	27.6	28	1622	1215
D322	1628	1494	3	1315	1249	13.6	19.6	-8	1486	1215
D329	1645	1506	3	1295	1249	16.3	20.6	-12	1494	1215
								Average	1467	
D105	1646	1452	4	1297	1249	12.0	16.3	-11	1441	1215
D212	1600	1275	4	1250	1249	2.0	2.1	16	1291	1215
D328	1670	1618	4	1375	1249	17.7	29.5	-112	1506	1215
								Average	1413	
D215	1666	1518	5	1246	1249	21.8	21.5	27	1545	1215
D224	1598	1425	5	1254	1249	13.6	14.1	17	1442	1215
D231	1651	1335	5	1234	1249	8.2	6.9	39	1374	1215
								Average	1454	
Average	1647	1501				13.5	20.2			

* Lower limit values for Surveillance 1 through 3 were revised to represent 95% Base value currently specified by R.G. 1.35, Revision 3. (Previous lower limits were at approximately 97% Base.)

FPC - Crystal River Unit #3
Tendon Surveillance Program
Dome Group Trend of Losses

FIGURE 6.1

***** Avg. All Forces in Surveillance
oooo Min. Required Avg. Force

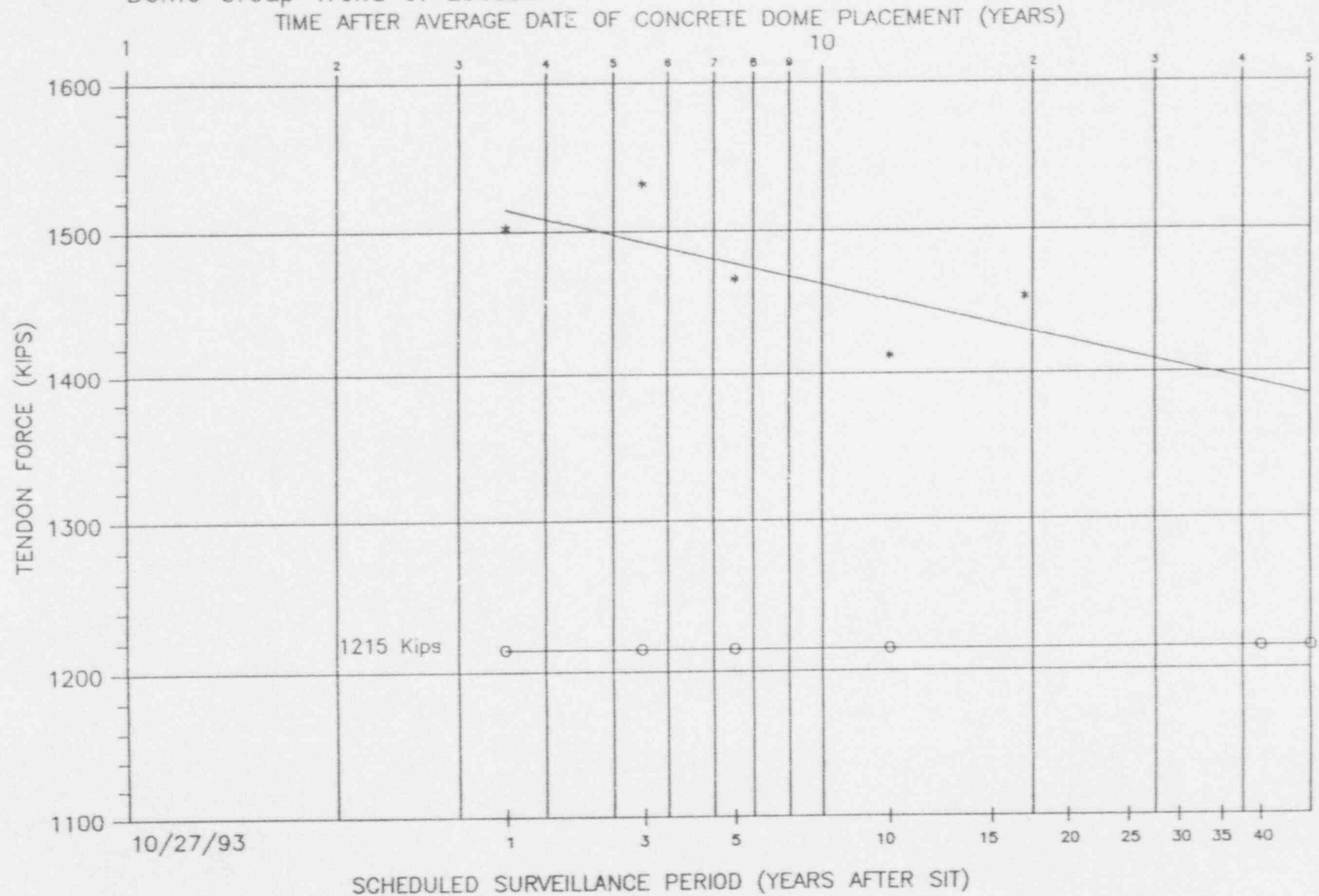


TABLE 6.2
SUMMARY OF HOOP TENDON FORCES THROUGH FIFTH SURVEILLANCE
SORTED BY SURVEILLANCE NO. / TENDON NO.

20-Jun-94
11:04:01 AM

Tendon Number	Original Lock-Off Force (Kips)	Measured Lift-Off Force (Kips)	Surveillance Number	Lower Limit * 95% Base per Reg. Guide 1.35 (Kips)	Lower Limit per Tech. Spec. (Kips)	Measured vs. Reg. Guide (3-5)/5 X 100%	Measured vs. Tech. Spec. (3-6)/6 X 100%	Normalizing Factor NF (Kips)	Normalized Force (3+9) (Kips)	Minimum Required Avg. Force (Kips)
1	2	3	4	5	6	7	8	9	10	11
13H10	1604	1524	1	1432	1249	6.4	22.0	-17	1507	1252
13H19	1625	1485	1	1372	1249	8.2	18.9	50	1535	1252
13H37	1629	1606	1	1354	1249	18.6	28.6	66	1672	1252
13H47	1623	1606	1	1341	1249	19.8	28.6	81	1687	1252
46H21	1653	1502	1	1422	1249	5.6	20.3	-6	1496	1252
46H29	1667	1463	1	1444	1249	1.3	17.1	-26	1437	1252
46H37	1617	1457	1	1402	1249	3.9	16.7	15	1472	1252
46H46	1644	1464	1	1435	1249	2.9	17.2	-20	1444	1252
51H11	1615	1474	1	1363	1249	6.1	18.0	58	1532	1252
62H19	1639	1574	1	1400	1249	12.4	26.0	19	1593	1252
								Average	1538	
13H22	1652	1572	2	1470	1249	6.9	25.9	-59	1513	1252
13H32	1653	1611	2	1465	1249	10.0	29.0	-53	1558	1252
13H43	1641	1583	2	1359	1249	16.5	26.7	59	1642	1252
35H24	1621	1533	2	1447	1249	5.9	22.7	-36	1497	1252
35H28	1626	1430	2	1454	1249	-1.7	14.5	-40	1390	1252
35H44	1653	1622	2	1463	1249	10.9	29.9	-53	1569	1252
46H42	1599	1548	2	1391	1249	11.3	23.9	24	1572	1252
51H10	1674	1572	2	1503	1249	4.6	25.9	-94	1478	1252
51H23	1609	1528	2	1349	1249	13.3	22.3	70	1598	1252
51H37	1606	1567	2	1335	1249	17.4	25.5	86	1653	1252
								Average	1547	
13H19	1625	1424	3	1354	1249	5.2	14.0	50	1474	1252
13H46	1623	1546	3	1418	1249	9.0	23.8	-20	1526	1252
35H35	1604	1328	3	1322	1249	0.5	6.3	86	1414	1252
35H40	1660	1458	3	1458	1249	0.0	16.7	-62	1396	1252
42H20	1662	1544	3	1444	1249	6.9	23.6	70	1614	1252
42H40	1651	1466	3	1429	1249	2.6	17.4	152	1618	1252
46H10	1646	1478	3	1437	1249	2.9	18.3	-40	1438	1252
51H26	1661	1424	3	1466	1249	-2.9	14.0	-70	1354	1252
51H45	1581	1492	3	1294	1249	15.3	19.5	118	1610	1252
62H34	1626	1546	3	1400	1249	10.4	23.8	70	1616	1252
								Average	1506	

TABLE 6.2
SUMMARY OF HOOP TENDON FORCES THROUGH FIFTH SURVEILLANCE
SORTED BY SURVEILLANCE NO. / TENDON NO.

20-Jun-94
11:04:01 AM

Tendon Number	Original Lock-Off Force (Kips)	Measured Lift-Off Force (Kips)	Surveillance Number	Lower Limit * 95% Base per Reg. Guide 1.35 (Kips)	Lower Limit per Tech. Spec. (Kips)	Measured vs. Reg. Guide (3-5)/5 X 100%	Measured vs. Tech. Spec. (3-6)/6 X 100%	Normalizing Factor NF (Kips)	Normalized Force (3+9) (Kips)	Minimum Required Avg. Force (Kips)
1	2	3	4	5	6	7	8	9	10	11
13H20	1604	1456	4	1390	1249	4.7	16.6	-15	1441	1252
13H40	1623	1470	4	1407	1249	4.5	17.7	-27	1443	1252
46H19	1617	1470	4	1357	1249	8.3	17.7	25	1495	1252
51H26	1661	1411	4	1442	1249	-2.1	13.0	-70	1341	1252
51H41	1631	1362	4	1315	1249	3.6	9.0	64	1426	1252
								Average	1429	
35H1	1640	1572	5	1352	1249	16.3	25.9	19	1591	1252
42H1	1645	1560	5	1360	1249	14.7	24.9	12	1572	1252
46H21	1653	1425	5	1383	1249	3.0	14.1	-12	1413	1252
46H28	1690	1375	5	1445	1249	-4.8	10.1	-77	1298	1252
46H29	1667	1300	5	1402	1249	-7.3	4.1	-32	1268	1252
46H30	1642	1382	5	1378	1249	0.3	10.6	-7	1375	1252
46H47	1623	1468	5	1373	1249	6.9	17.5	-3	1465	1252
62H8	1624	1435	5	1391	1249	3.2	14.9	-22	1413	1252
								Average	1424	
Average	1635	1491				6.6	19.4			

* Lower limit values for Surveillance 1 through 3 were revised to represent 95% Base value currently specified by R.G. 1.35, Revision 3. (Previous lower limits were at approximately 97% Base.)

FPC - Crystal River Unit #3
Tendon Surveillance Program
Hoop Group Trend of Losses

FIGURE 6.2

***** Avg. All Forces in Surveillance
oooo Min. Required Avg. Force

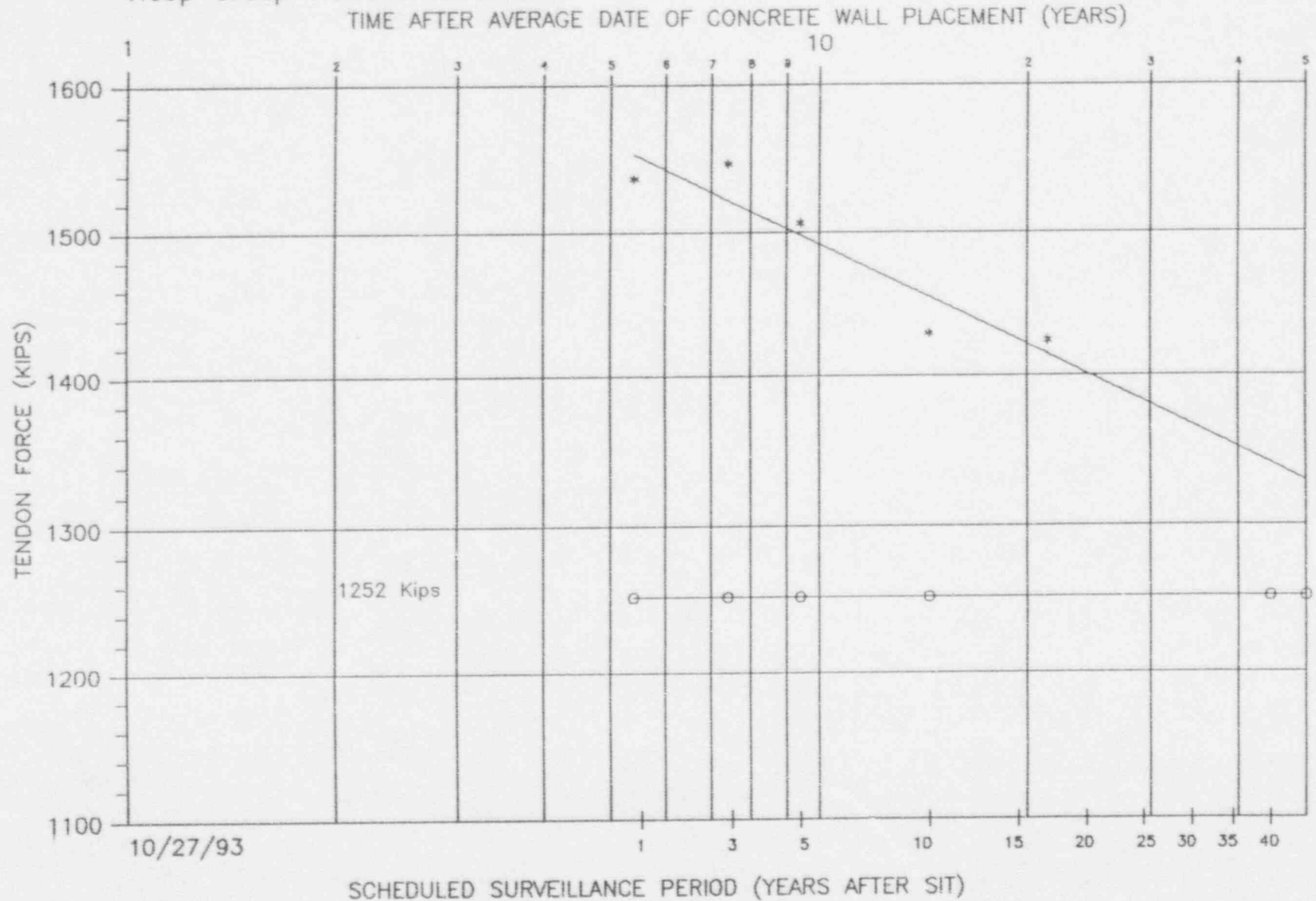


TABLE 6.3
SUMMARY OF VERTICAL TENDON FORCES THROUGH FIFTH SURVEILLANCE
SORTED BY SURVEILLANCE NO. / TENDON NO.

20-Jun-94

11:04:58 AM

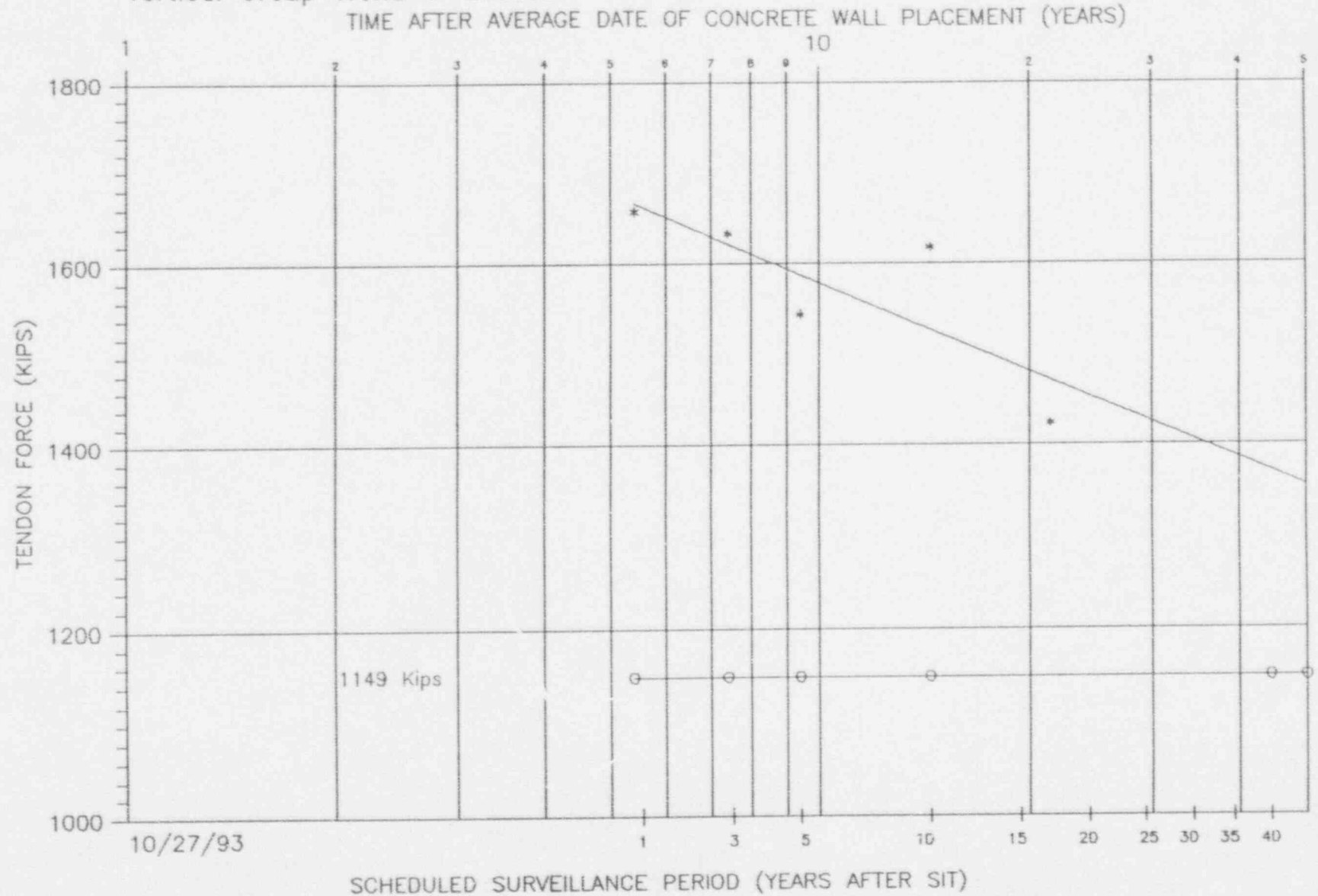
Tendon Number	Original Lock-Off Force (Kips)	Measured Lift-Off Force (Kips)	Surveillance Number	Lower Limit * 95% Base per Reg. Guide 1.35 (Kips)	Lower Limit per Tech. Spec. (Kips)	Measured vs. Reg. Guide (3-5)/5 X 100%	Measured vs. Tech. Spec. (3-6)/6 X 100%	Normalizing Factor NF (Kips)	Normalized Force (3+9) (Kips)	Minimum Required Avg. Force (Kips)
1	2	3	4	5	6	7	8	9	10	11
12V19	1654	1590	1	1448	1249	9.8	27.3	22	1612	1149
12V20	1598	1785	1	1458	1249	22.4	42.9	8	1793	1149
12V21	1638	1633	1	1436	1249	13.7	30.7	35	1668	1149
23V15	1615	1590	1	1436	1249	10.7	27.3	35	1625	1149
34V6	1609	1590	1	1460	1249	8.9	27.3	9	1599	1149
45V3	1639	1678	1	1465	1249	14.5	34.3	4	1682	1149
56V1	1784	1719	1	1563	1249	10.0	37.6	-102	1617	1149
								Average	1657	
12V12	1670	1718	2	1516	1249	13.3	37.6	-54	1664	1149
12V20	1598	1740	2	1457	1249	19.4	39.3	8	1748	1149
23V5	1711	1580	2	1497	1249	5.5	26.5	-33	1547	1149
34V1	1651	1569	2	1447	1249	8.4	25.6	20	1589	1149
45V6	1614	1685	2	1444	1249	16.7	34.9	21	1706	1149
56V1	1784	1707	2	1561	1249	9.4	36.7	-102	1605	1149
56V20	1687	1630	2	1524	1249	7.0	30.5	-62	1568	1149
								Average	1632	
12V1	1675	1315	3	1469	1249	-10.5	5.3	-10	1305	1149
34V19	1573	1640	3	1397	1249	17.4	31.3	65	1705	1149
34V6	1609	1600	3	1451	1249	10.3	28.1	9	1609	1149
45V16	1661	1575	3	1485	1249	6.1	26.1	-27	1548	1149
56V11	1658	1565	3	1463	1249	7.0	25.3	-5	1560	1149
61V5	1643	1519	3	1437	1249	5.7	21.6	23	1542	1149
								Average	1545	
12V1	1675	1535	4	1454	1249	5.6	22.9	-10	1525	1149
34V4	1585	1623	4	1412	1249	14.9	29.9	41	1664	1149
56V2	1603	1648	4	1434	1249	14.9	31.9	13	1661	1149
								Average	1617	
34V6	1609	1590	5	1439	1249	10.5	27.3	7	1597	1149
56V15	1638	1541	5	1434	1249	7.5	23.4	13	1554	1149
61V14	1646	1587	5	1471	1249	7.9	27.1	-26	1561	1149
								Average	1571	
Average	1647	1614				10.3	29.2			

* Lower limit values for Surveillance 1 through 3 were revised to represent 95% Base values currently specified by R.G. 1.35, Revision 3. (Previous lower limits were at approximately 97% Base.)

FPC - Crystal River Unit #3
Tendon Surveillance Program
Vertical Group Trend of Losses

FIGURE 6.3

***** Avg. All Forces in Surveillance
oooo Min. Required Avg. Force



7.0 TENDON ELONGATION

Information on tendon elongation was taken for all detensioned tendons during the retensioning process. RG acceptance criteria states that the percent difference of tendon elongation measured during the surveillance be compared to the elongation at original installation. A difference exceeding plus or minus ten percent shall be investigated to determine if the difference is related to wire failure or wire slipping at anchorages.

Measured elongation values from this surveillance are presented in the VSL Report, Table 2, and in the Enclosure 29 data attached in the VSL Report for each tendon. These elongation differences are summarized as follows:

<u>Tendon</u>	<u>Elongation</u>
56V15	-16.3%
D231	- 8.7%
46H29	+ 1.2%
46H47	-14.0%

The above results show that 56V15 and 46H47 do not meet the acceptance criteria. However, the negative values indicate that less elongation was measured in the current surveillance than at the time of original stressing. This condition also occurred in prior surveillances. Therefore, these differences are not considered to be an indication of wire failure or slippage.

Each tendon had one or more wires removed for inspection and testing. These wires were visually inspected and found to be in very good condition. Tensile and yield strength tests were performed on the wire samples, and results demonstrated that all wires met the guaranteed minimum ultimate tensile and yield strengths for the material.

Based on the above, the deviation of measured tendon elongation with the acceptance criteria is not the result of wire failure or slippage. There is no adverse or detrimental effect on the integrity of the post tensioning system.

8.0 TENDON RELATED CONCRETE INSPECTION

As part of the surveillance, visual inspections were performed to evaluate the condition of the concrete immediately adjacent to each tendon area. In addition, a general inspection was performed to evaluate the concrete condition of the exterior of the containment. These inspections were performed as required by the Reg. Guide. Results are documented in the VSL Report in Enclosures 22 through 24, for the local tendon area inspections and in Enclosure 48 for the general containment inspection.

The surveillance procedure requires that concrete cracks greater than 0.010 inches in width be evaluated. Cracks in excess of 0.040 inches shall be investigated for cause and effect on the structural integrity of the containment. Of the fourteen tendon areas inspected as part of this surveillance, six tendons had concrete cracks ranging in sizes from 0.010" to 0.025". These tendon areas are D215, D231, 46H21, 46H28, 46H30 and 46H47. Cracks were evaluated and accepted as shrinkage or surface cracks and were all found to have no impact on the ability of the structure to perform its design function. There were no cracks observed to be greater than the 0.040 inch threshold.

The results of the general containment exterior inspection found concrete spalling and cracking on the outside corners of Buttress 1 and Buttress 2. The condition at Buttress 2 was previously reviewed by FPC Engineering, where it was determined that the condition is cosmetic and not structurally significant. FPC has initiated a Request for Engineering Assistance to evaluate the condition at Buttress 1, and will disposition the condition within that process.

Exterior walls were all found to be in good condition. There was no evidence of leaking grease or other abnormal concrete degradation. The dome area was also inspected and there was no indication of any major cracks or abnormal conditions. A small concrete spill on the dome was recorded and accepted by FPC engineering as cosmetic.

Based on the results of the tendon adjacent area concrete inspections and the general exterior containment inspection, no significant concrete problems were found which would affect the integrity of the post tensioning system or the concrete containment structure.

9.0 CORROSION PROTECTION SYSTEM INSPECTION

Specification SP-5959, dated 3/29/71 was found to be used for the original installation and bulk filling of the prestressing system. Section 3.07.3 of the specification specifies that the type of grease used in the original bulk filling of the tendon conduit was 2090-P2 as manufactured by Viscosity Oil Company.

The bulk grease specified for use in Revision 10 of SP-182 is Visconorust 2090-P2 or latest compatible formulation. It was determined that Visconorust 2090-P4 was the current formulation available for use by VSL during this surveillance and that the 2090-P4 grease was also used in prior surveillances. Certificates of Conformance were found in contractor test reports for the third and fourth surveillances. Mr. Charles Novak of Viscosity Oil Company was contacted and the use of the P-4 grease was discussed with him. It was determined that the 2090-P4 grease was previously found compatible and acceptable for use at CR3 and is still acceptable.

Visual examinations of the grease were performed by VSL with results of each tendon presented in the VSL report, Enclosure 16. There were no adverse findings as a result of the visual inspections. It was noted that the P-4 grease is lighter in color and thicker than the older P-2 grease. This difference was taken into account in the acceptance criteria for visual grease inspection.

Samples of bulk filler grease were removed from each end of the tendons and sent for laboratory testing. Tests were performed for the following conditions:

	<u>Acceptance Criteria</u>
Chlorides	10 ppm maximum
Nitrates	10 ppm maximum
Sulfides	10 ppm maximum
Moisture content	10% Maximum
Reserve Alkalinity (Base)	Greater than 50% of the installed value, or greater than 0 when the installed value was less than 5.

All samples of filler grease met the required acceptance criteria for chlorides, nitrates, sulfides and moisture content. The criteria for Reserve Alkalinity (R.A.) warrants further discussion.

The evaluation of the results for reserve alkalinity are presented in the VSL Report, Table 6. The vast majority of tendon samples resulted in neutralization numbers between values of 30 to 60. This is indicative of 2090-P4 grease since it is specified by Viscosity Oil as having a minimum R.A. of 35. Only two exceptions are noted in Table 6 of the VSL Report with alkalinity values less than 30. These include tendon D224 field end with a reserve alkalinity of 14.43 and tendon 62H8 field end with an R.A. of 1.25.

Additional discussions with Mr. C. Novak of Viscosity Oil determined that the reserve alkalinity of 2090-P4 was 35, and the reserve alkalinity for 2090-P2 grease was 3. Applying acceptance criteria for reserve alkalinity as noted above would result in the following acceptance values for both types of grease:

<u>Grease Type</u>	<u>Minimum Installed R.A. Value</u>	<u>Acceptable R.A. Value</u>
2090-P2	3 minimum	> 0
2090-P4	35 minimum	> 18.5

Since CR3 has used both types of grease, it is believed that the low R.A. values for tendons D224 and 62H8 are representative of a sample of 2090-P2 grease. The grease testing laboratory was contacted and it was confirmed that two separate tests were performed to confirm the 1.25 R.A. value for 62H8. Additional samples of the grease available on site were visually inspected. It was determined that the 62H8 field end sample was a noticeably darker grease of thinner consistency than the shop end. Therefore, it is concluded that the low reserve alkalinity level from the 62H8 field end sample is a sample of Visconorust 2090-P2. The test value of 1.25 is acceptable since it meets the above acceptance criteria and is greater than zero.

A review of previous surveillance summary reports indicates that sample testing of the bulk filler grease was performed successfully in the past and met the required acceptance criteria.

Note that the above acceptance criteria values are only representative of old grease. New grease supplied by Viscosity Oil has more stringent acceptance criteria per SP-182, Section 4.1.4.9. Certificates of Conformance for the newly purchased grease were provided by Viscosity Oil. Copies of the Certificates of Conformance are included in the VSL report.

Based on the visual inspections performed during the surveillance and the results of sample testing of the bulk filler material, it can be concluded that the corrosion protection system is performing its protective function with no abnormal degradation.

Grease replacement quantities for individual tendons were monitored as required by the Reg. Guide. The specified acceptance criteria is that the amount of grease replaced shall not exceed 5% of the net duct volume. Prior criteria used on CR3 was a 4 gallon maximum. This threshold was maintained in Revision 11 of SP-182 as the 4 gallon value is close to but conservatively lower than the 5% volume criteria.

VSL tabulated the replaced grease data in Table 5 of their report. All tendons failed to meet the acceptance criteria. A review of prior surveillance reports indicates that CR3 has not been able to meet this acceptance criteria in the past. This exceedance has typically been in the range of 10 to 23 gallons over that removed. This condition has been evaluated in depth in the past and the evaluation is still applicable at this time. This evaluation has been updated for the current grease replacement data and is presented in Appendix D.

Inspections of the Reactor Building have not located any grease seepage or tendon leakage problems. The inspection of bottom end caps of all the vertical tendons as required by the current revision of the Reg. Guide, was performed with no leaks found. The overall condition of the tendon wires remains good and successful wire tests performed for all five surveillances support the conclusion that the corrosion protection system is performing well and maintaining the integrity of the tendons.

During the preparation of the surveillance procedure for this surveillance, two discrepancies occurred with the required procedures for grease testing as required by Reg. Guide 1.35, Revision 3. Reg. Guide 1.35, Section 6, specifies APHA 428 for the testing of sulfides. VSL's testing lab determined that the APHA 428 test was a test for sulfites and requested direction on which test to perform. After some research and review, it was determined that the Reg. Guide was in error and that the proper test for sulfides is APHA 427.

The Reg. Guide also specifies ASTM D3867 (formerly ASTM D992) as the test method for nitrates/nitrites. The VSL testing facility questioned the use of this test method since it would be very expensive and involved the use of some hazardous materials. The method could not be performed by that facility and no other facility was known to be familiar with or capable of performing the test. After additional review, the ASTM D992 test was determined to be acceptable for use. The disposition of both of these discrepancies involved contacts and concurrence with the NRC.

10.0 EVALUATION OF OTHER NONCONFORMANCES

Shim material used for this surveillance was purchased by FPC and is ASTM A633 material. This was accepted and documented as meeting the specifications of the original Armco material.

11.0 CONCLUSIONS

The results of the surveillance have demonstrated that the structural integrity of the CR3 containment has been maintained at a level consistent with the requirements of the original Technical Specification and the intent of Revision 3 of Regulatory Guide 1.35.

Conclusions based upon the various inspections and tests performed during this surveillance are summarized below.

Individual Tendon Forces

All tendons met the Technical Specification acceptance criteria for individual prestress forces. Two tendons, 46H28 and 46H29, failed to meet the Reg. Guide 95% base lower limit for measured liftoff forces. The liftoff of 46H28 was 90.4% of its predicted base, and the liftoff for 46H29 was 88.1% of its predicted base. This is a reportable position according to the Reg. Guide.

As a result of the above condition, corrective action was taken. Tendon 46H29 was detensioned and inspected, and additional tendon inspections were performed. Both tendons were retensioned to bring their prestress forces up to the required levels.

The extent and cause of this condition was thoroughly investigated. At this time, the extent of the condition appears to be limited to these two hoop tendons. The tendons have experienced somewhat greater losses than predicted and the causes of the condition are not fully defined at this time. A preliminary review of potential causes, and recommendations for future review efforts was initiated and will provide future reference information. See Reference 19. No other action items are required at this time to address this issue.

Average Group Tendon Forces

The average prestress condition for each of the three groups of tendons is currently projected to exceed the required minimum levels at the end of the expected 40 year plant life. The projected trend of prestress forces for each of the three tendon groups shows adequate margin available at the projected end of the forty year plant life.

Anchorage and Assembly Hardware

Tendon anchorage hardware was inspected and found to be in good condition. There were instances of corrosion that were found, such as on bearing plates outside of the O ring end cap seal. These corrosion instances are typical of that expected for a plant in service almost twenty years. Cases of minor pitting were observed on the stressing washers and buttonheads. This condition is suspected as being present at installation. This same observation was also made in the Fourth Surveillance Engineering Report (Reference 8, Section 8.1) for a corrosion condition on a stressing washer.

Wires

Tendon wires were found to be in good condition. No corrosion was found on the tendon wires removed from the detensioned tendons. Material tests on the tendon wires showed that all wires, except one, met the minimum guaranteed ultimate tensile strength. The one exception was accepted as an anomaly since the other tests on the same wire were found to be above the minimum required values.

Corrosion Protection System

Grease samples as tested were all found to meet the required acceptance criteria for the various conditions of impurity. The corrosion protection system was found to be performing its protective function with no indications of abnormal degradation.

Concrete

A few minor cracks and spalls found during the inspection were typical for a facility of this age. No concrete problems were observed that impacted the design function or integrity of the concrete containment.

Recommendations

Based on the results from the surveillance and the engineering evaluations performed herein, recommendations are provided as follows:

FPC should pursue a preventative maintenance program to mitigate the effects of corrosion problems on bearing plates, end caps and studs. Similarly, concrete spalling and cracking problems should be repaired before they propagate and deteriorate concrete and reinforcement.

The contractor selected for the next surveillance should be appraised of field conditions at Crystal River which may affect liftoff results. The method and determination of liftoff should also be discussed in conjunction with the specific equipment to be used by the contractor. This should eliminate the potential of breaking tendon wires during the liftoff process.

12.0 REFERENCES

1. 17th Year In -Service Tendon Surveillance Test Report, Revision 0, March 1994, by VSL Corporation (For Fifth surveillance).
2. FPC Surveillance Procedure, SP-182, Tendon Surveillance Program, Revision 10.
3. FFC Surveillance Procedure, SP-182, Tendon Surveillance Program, Revision 11.
4. US NRC Regulatory Guide 1.35, Revision 3, Inservice Inspection of UngROUTED Tendons in Prestressed Concrete Containments.
5. Proposed US NRC Regulatory Guide 1.35.1, Determining Prestressing Forces for Inspection of Prestressed Concrete Containments, April 1979.
6. Engineering Study of Regulatory Issues for the Tendon Surveillance Program, March 5, 1993, issued by FCS-13670.
7. Engineering Review of ASME Section XI, Subsection IWL for the Tendon Surveillance Program, May 28, 1993, issued by FCS-13892, 6/2/93.
8. Fourth Tendon Surveillance Engineering Evaluation, Surveillance report by G/C Inc., March 10, 1988.
9. Third Tendon Surveillance Liftoff Force Evaluation, Surveillance Report by G/C Inc., May 19, 1982.
10. Second Tendon Surveillance Liftoff Force Evaluation, Surveillance Report by G/C Inc., May 1980.
11. First Tendon Surveillance Liftoff Force Evaluation, Surveillance Report by G/C, Revision 1, April 1980.
12. Fourth Tendon Surveillance Test Report
Containment Structure Post Tensioning System Surveillance, Ten Year Surveillance, by VSL Corp., November, 1987.
13. Third Tendon Surveillance Test of the Reactor Containment Building Five Years after Structural Integrity Test, by VSL Corp., December 1981.
14. Second Tendon Surveillance Test of the Reactor Containment Building Three Years after Structural Integrity Test, by VSL Corp., May 1980.
15. First Tendon Surveillance Test of the Reactor Containment Building One Year after Structural Integrity Test, by VSL Corp., March 1978.

16. Tendon History Sheets for the Dome, Hoop and Vertical tendons, updated to the fifth surveillance.
17. G/C Design Input Record DI-5520-152.0 SE, Revision 2, November, 1993.
18. NRC inspection/Violation Report 50-302/93-27, December 10, 1993.
19. Meeting Minutes and Report on CR3 Tendons and Containment Restoration, Low Hoop Prestress Condition, G/C Letter to FPC, FCS-14237, December 14, 1993.

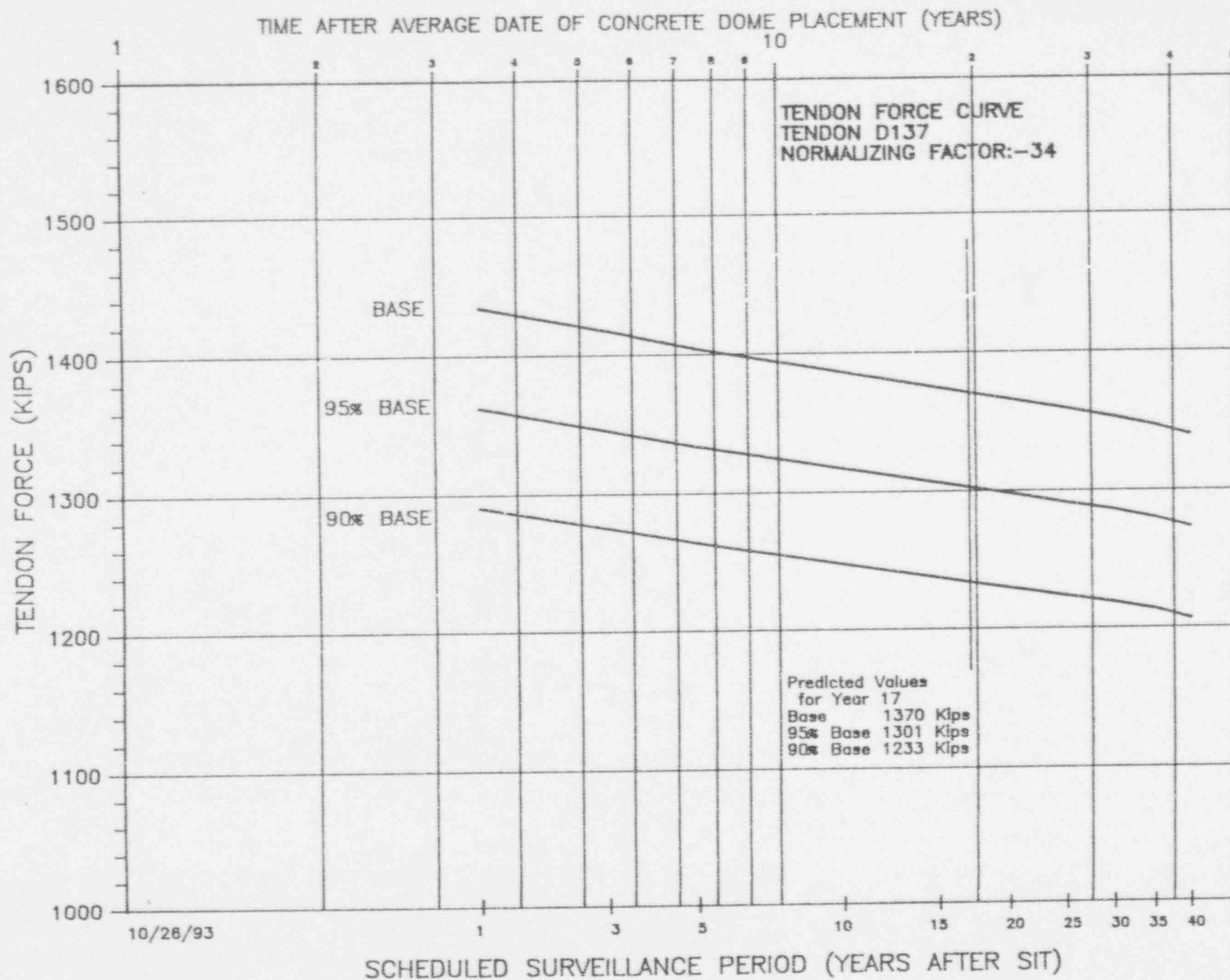
APPENDIX A

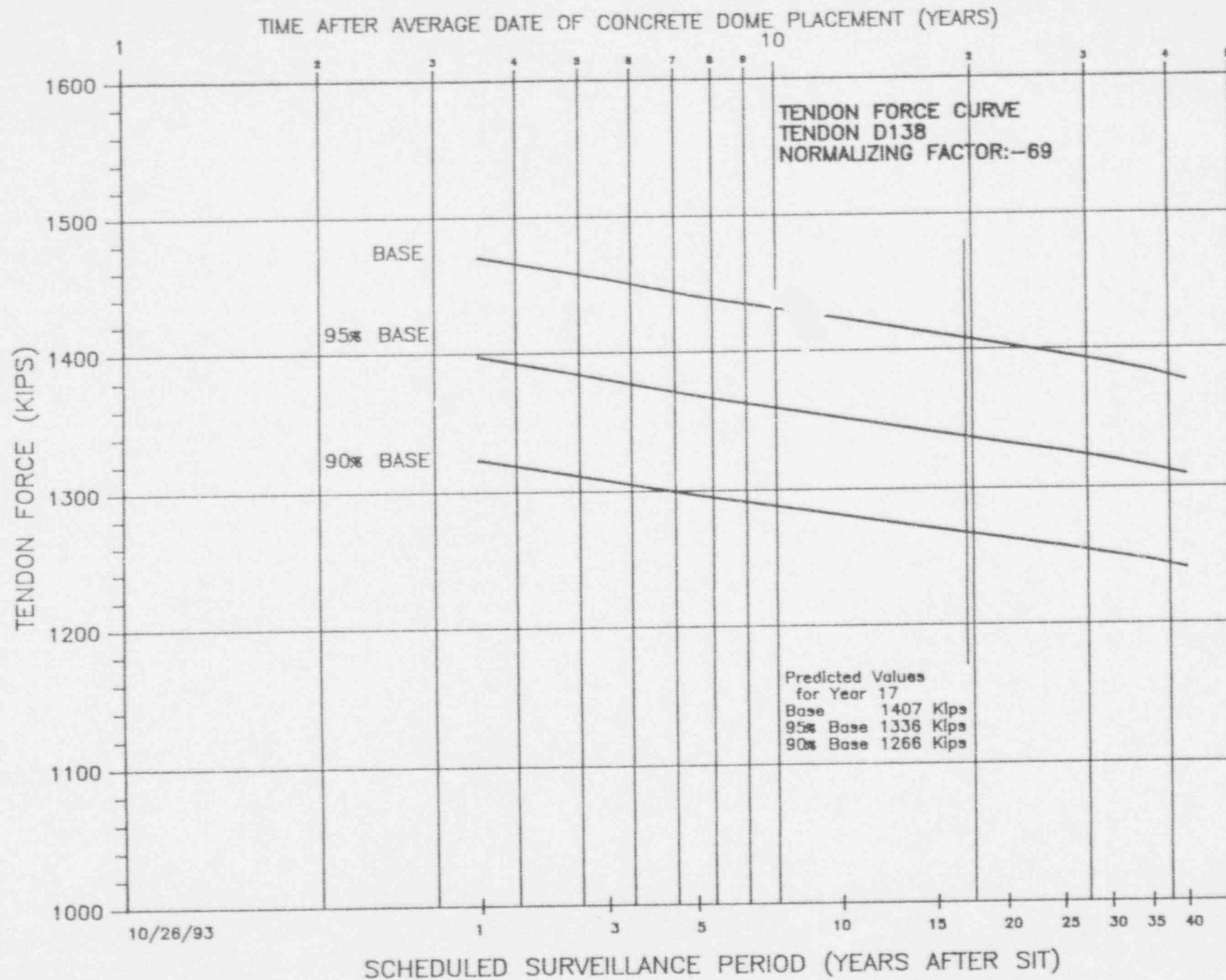
PREDICTED FORCE VS TIME CURVES

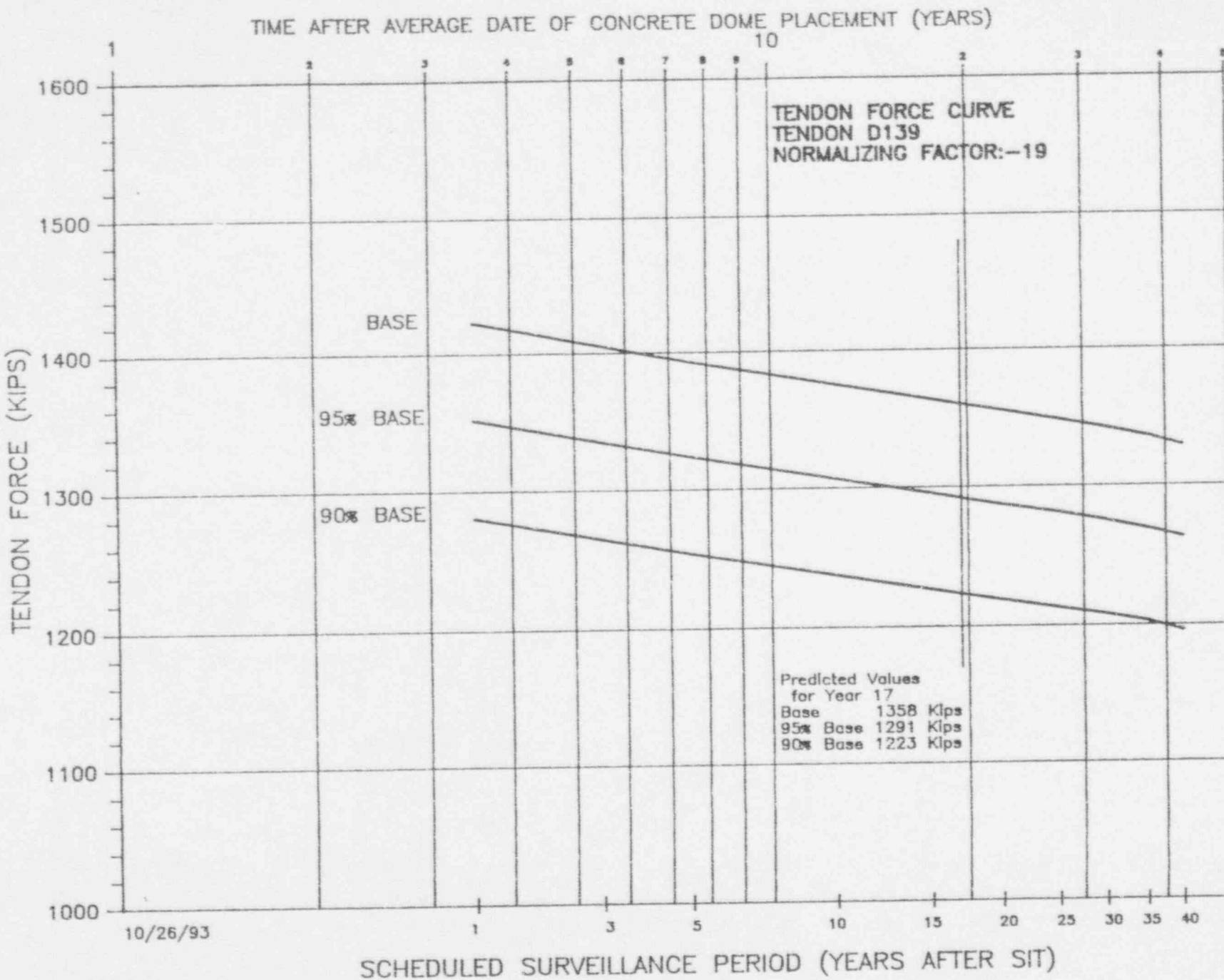
FOR THE FIFTH TENDON SURVEILLANCE

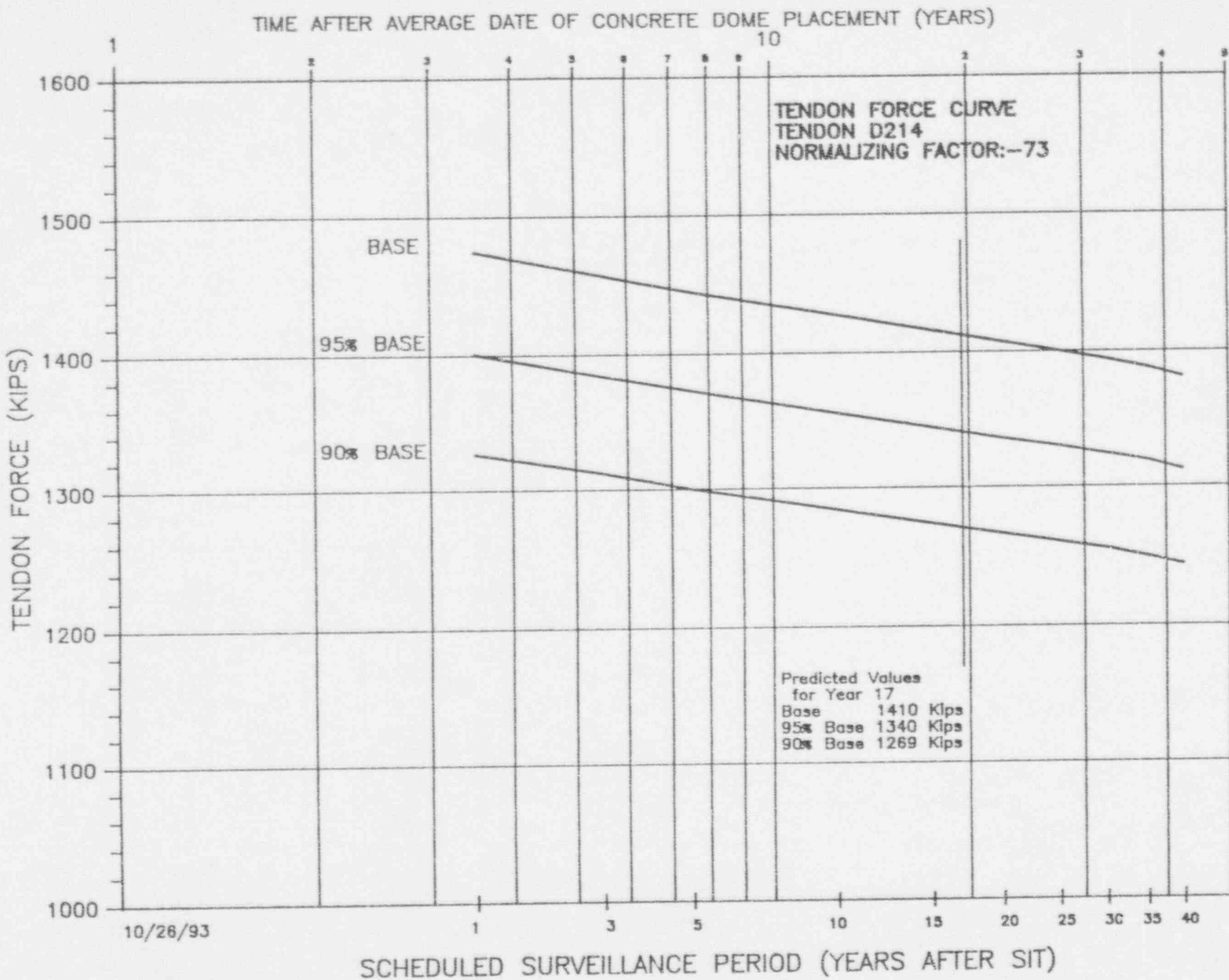
Notes -

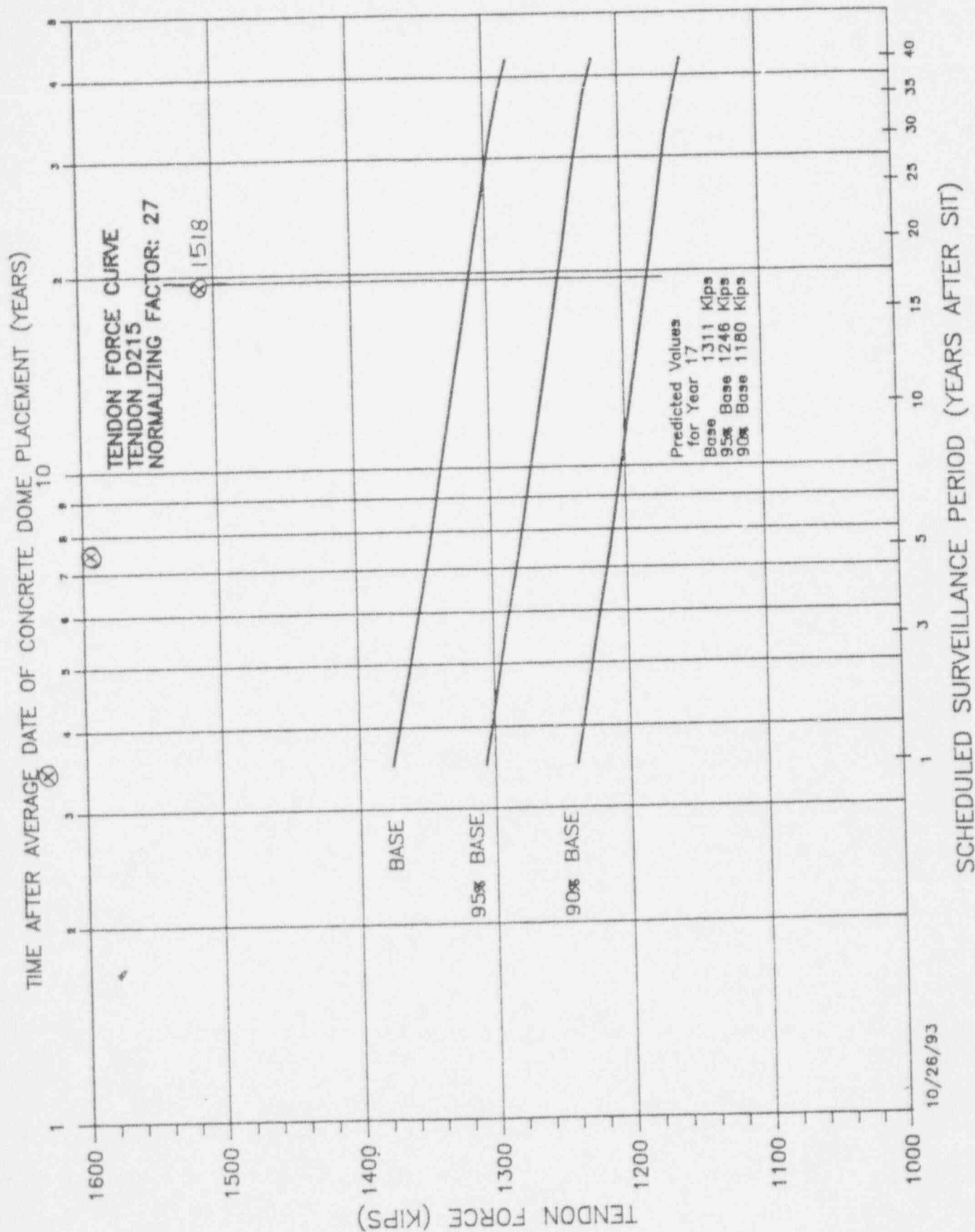
1. Normalization factors on two of the original prepared force curves were in error with the wrong number presented in Revision 11 of SP-182 and in the current VSL Report. Corrections were made in the following curves and in a corrected version of Enclosure 41 contained in Appendix B. Curves affected include 42H1, 62H7 and 62H8.
2. Tendon 46H21 was added to the scope of tendons to be inspected during this fifth surveillance. The force curve was not included in SP-182 but was prepared separately and is attached in this Appendix.
3. A second force curve for tendon 46H29 was prepared and is attached. The original curve represented a full 163 wire tendon. The second curve was prepared and represents a 159 wire tendon, since one wire was removed and three wires were broken.

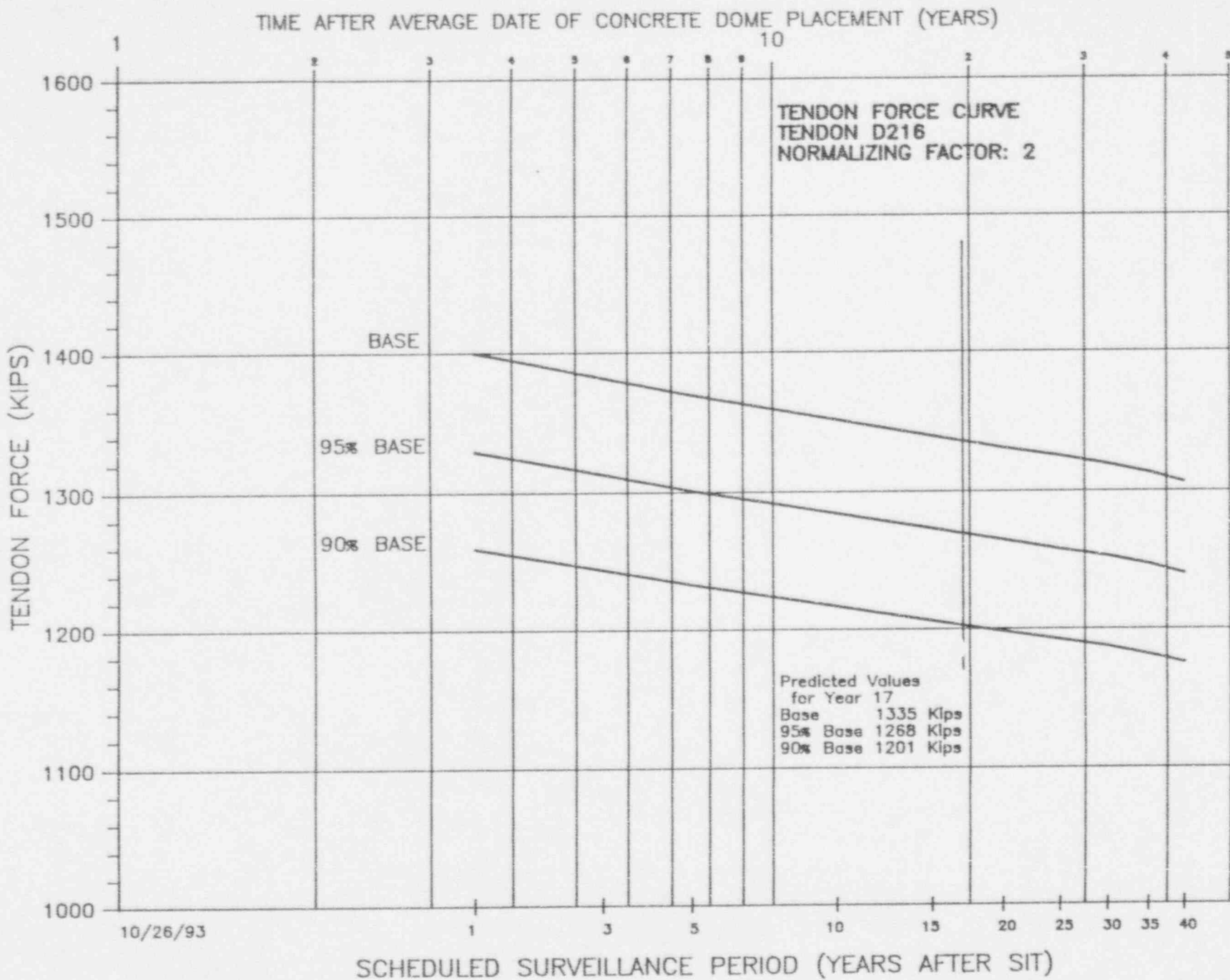


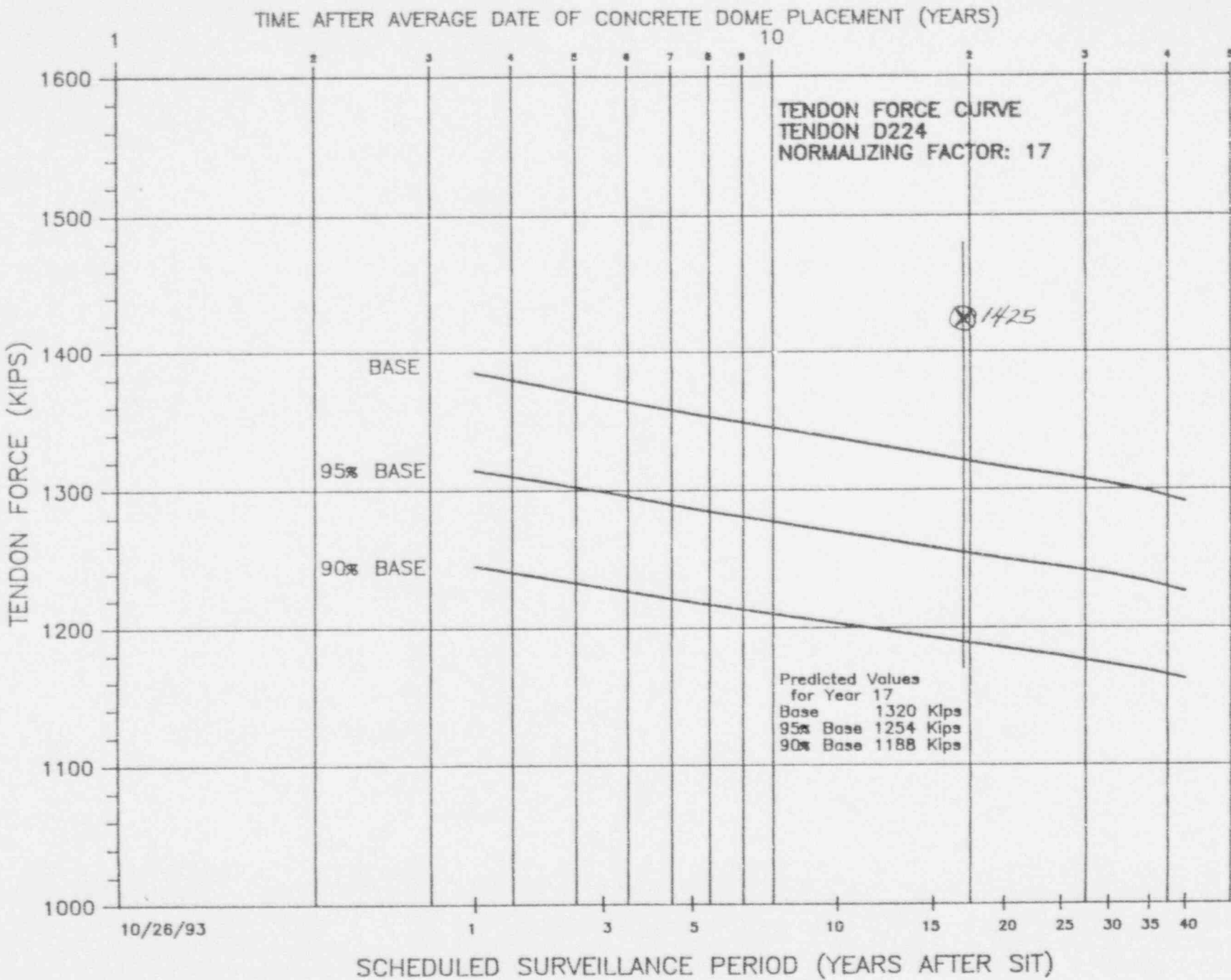


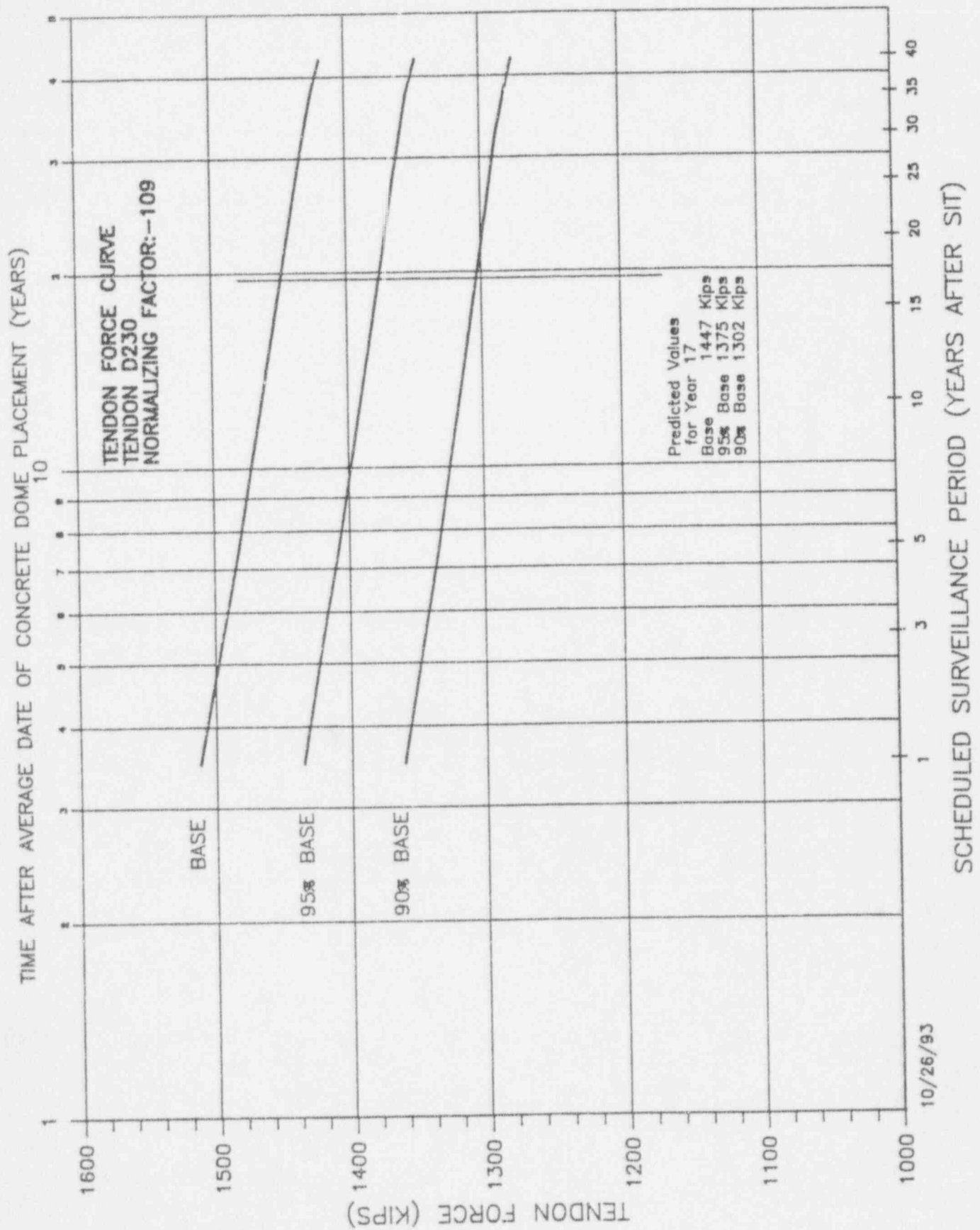


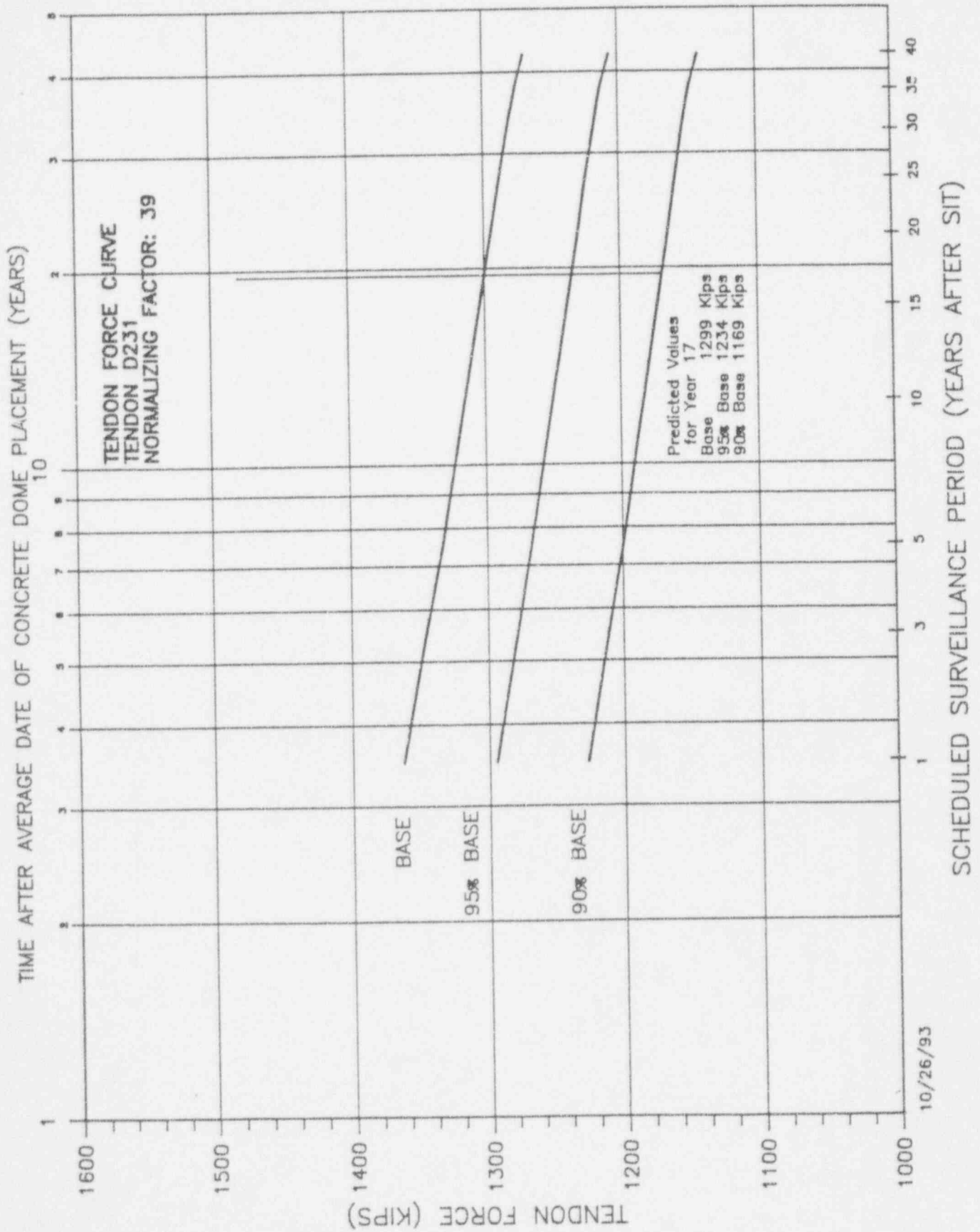


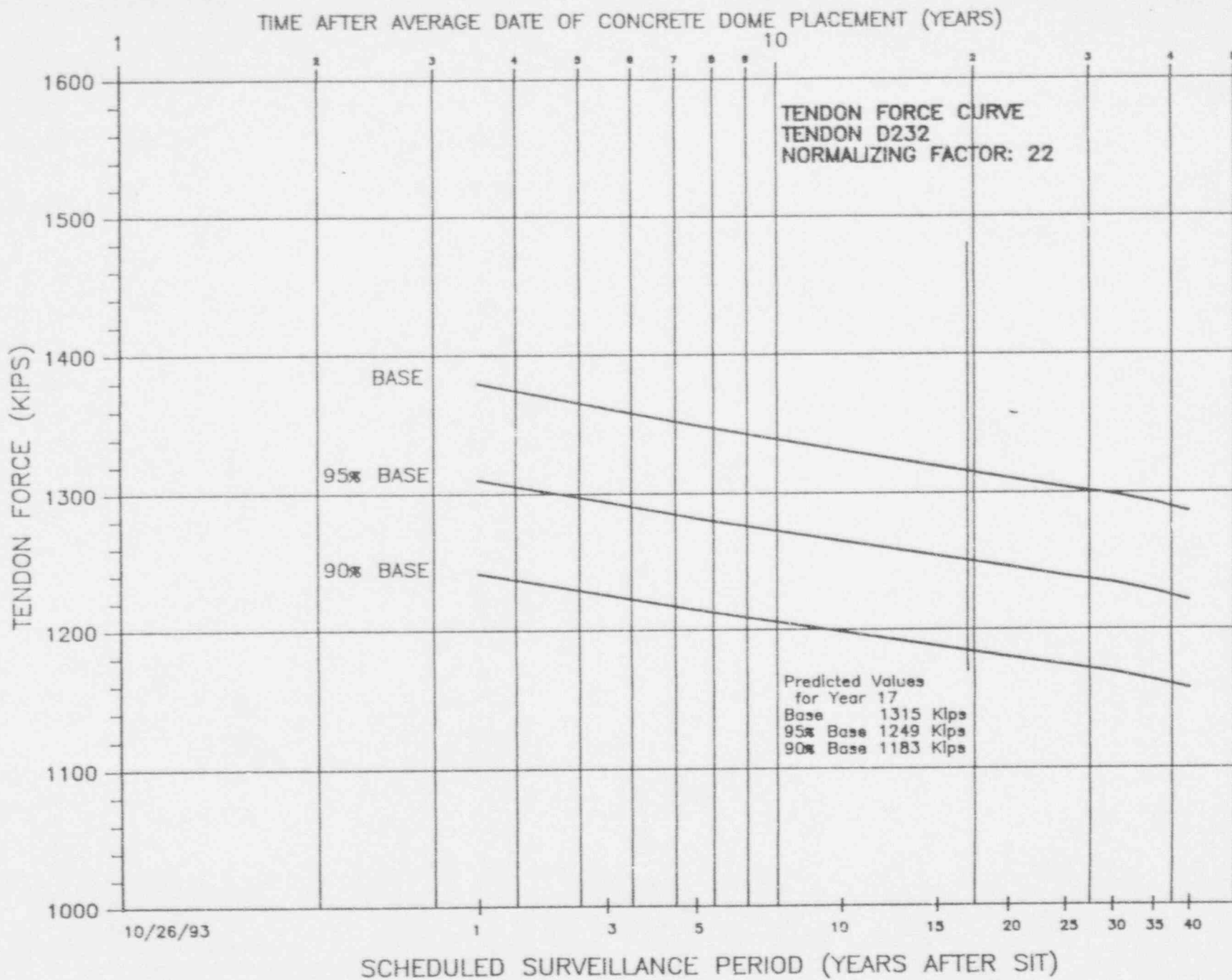


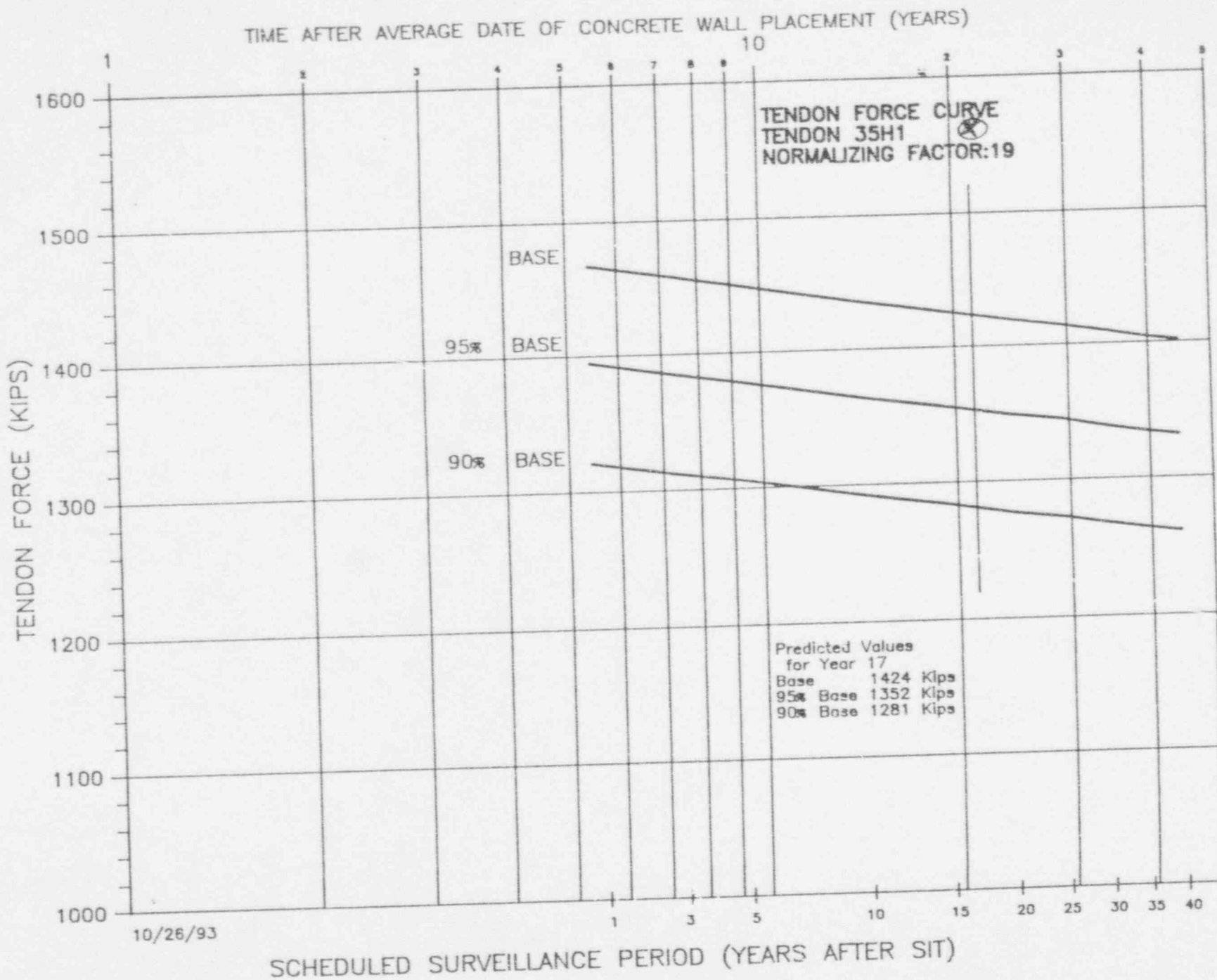


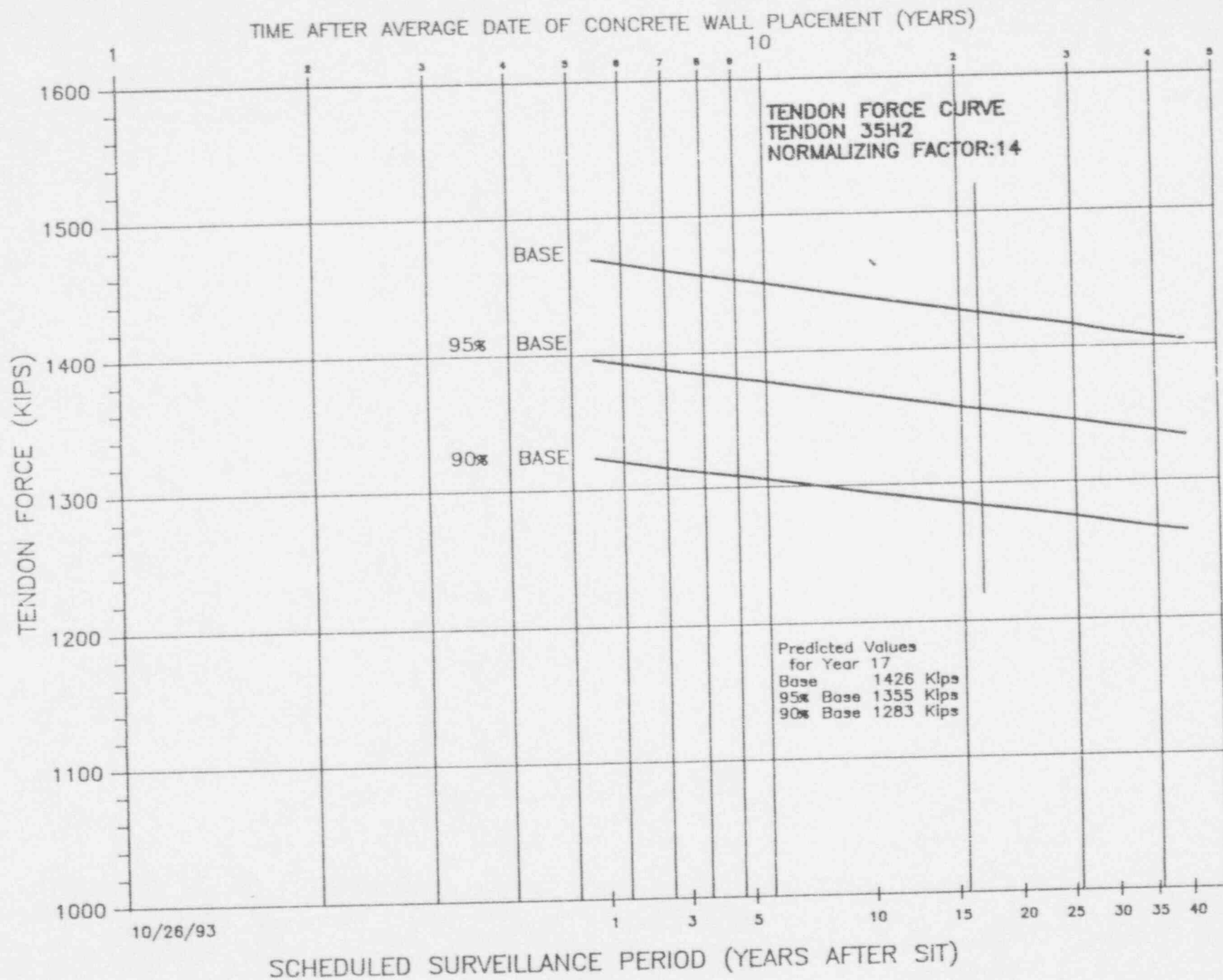


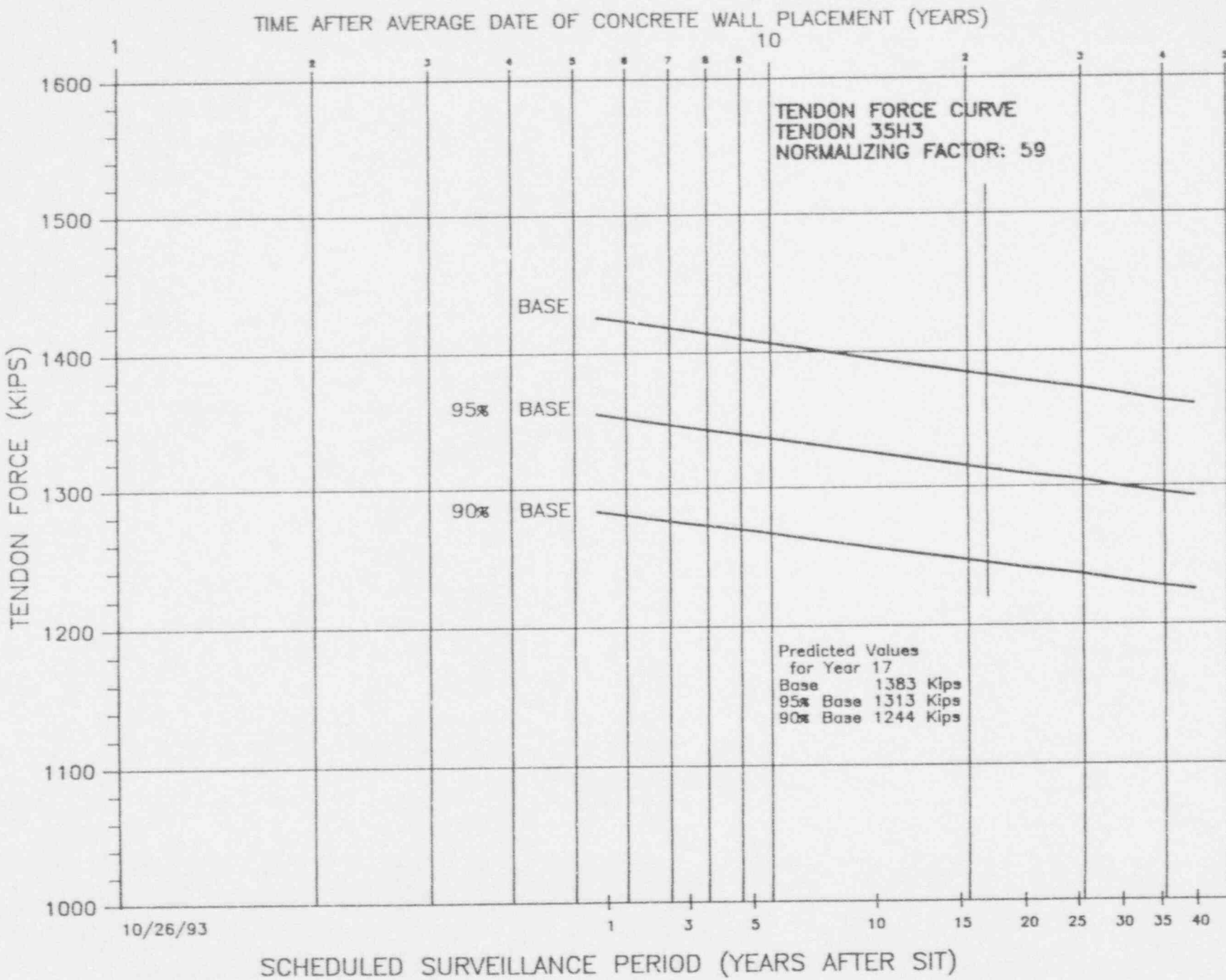


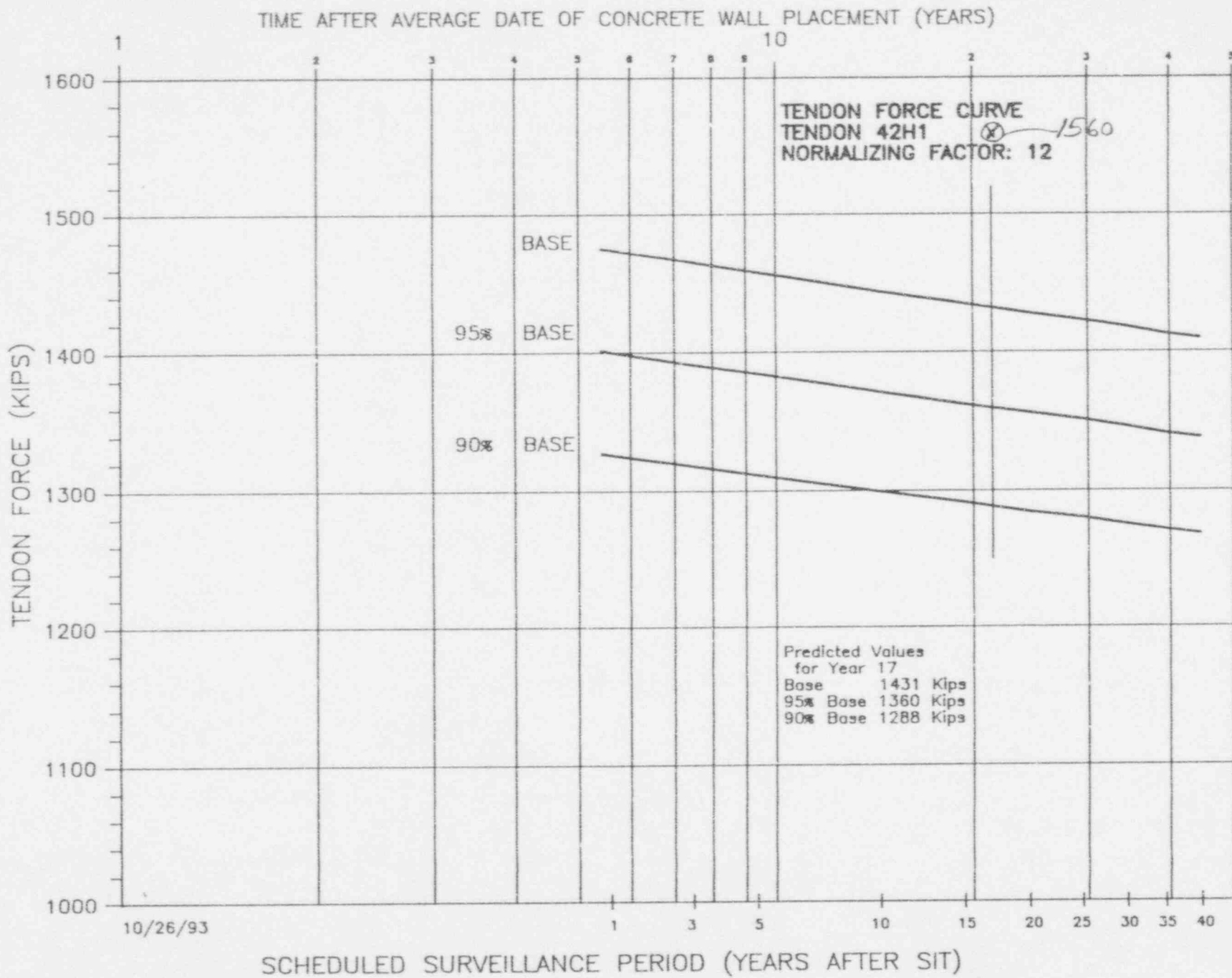


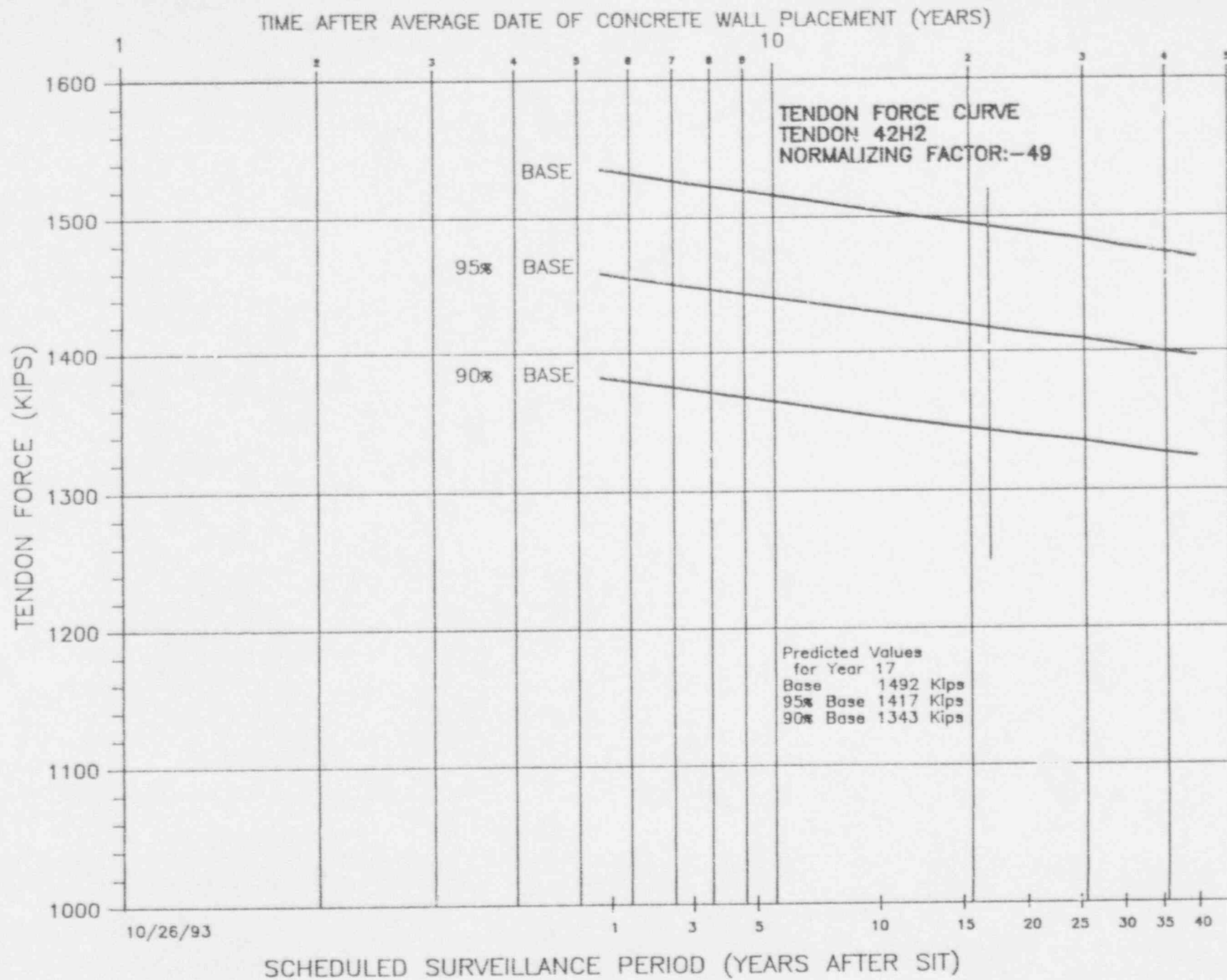


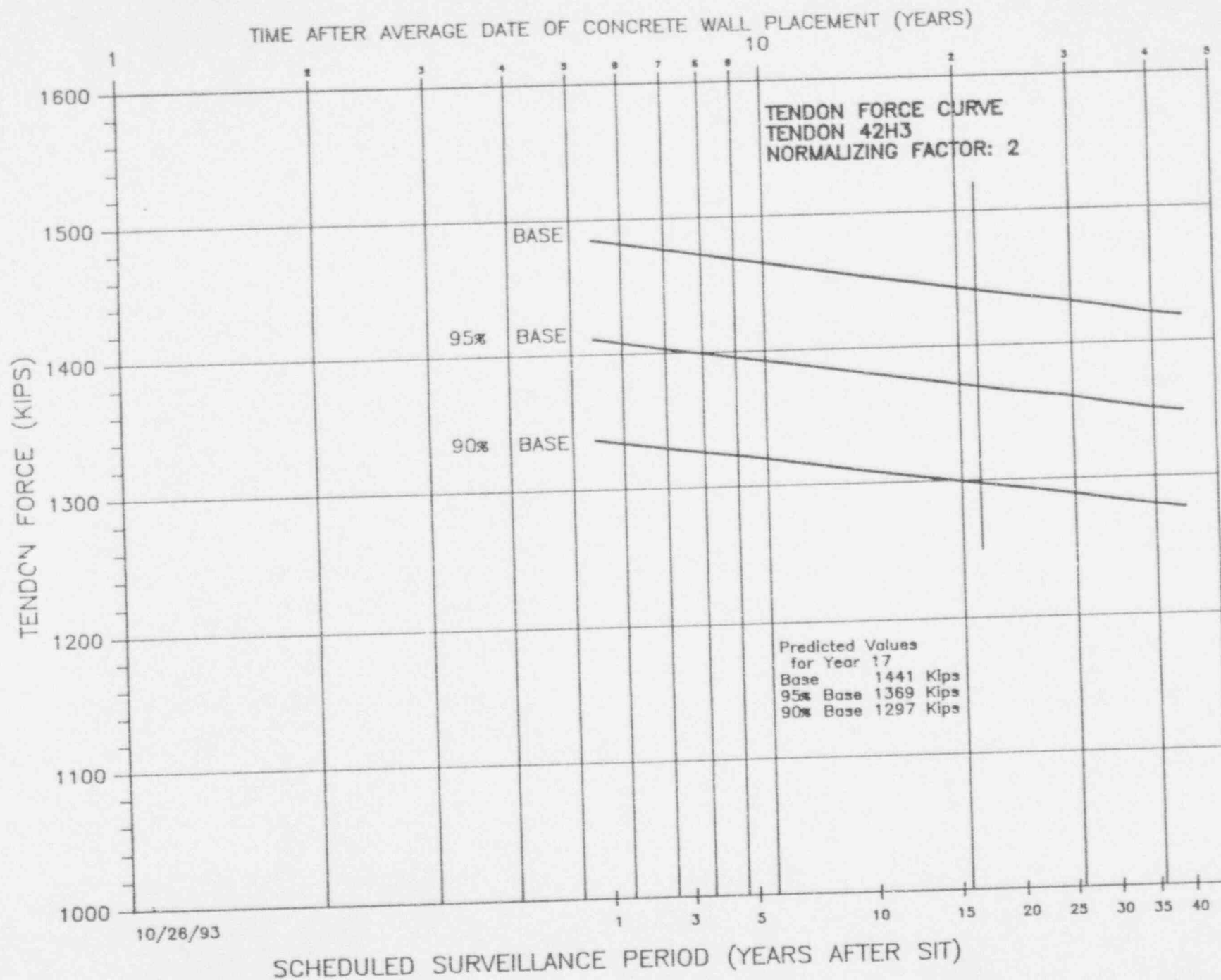


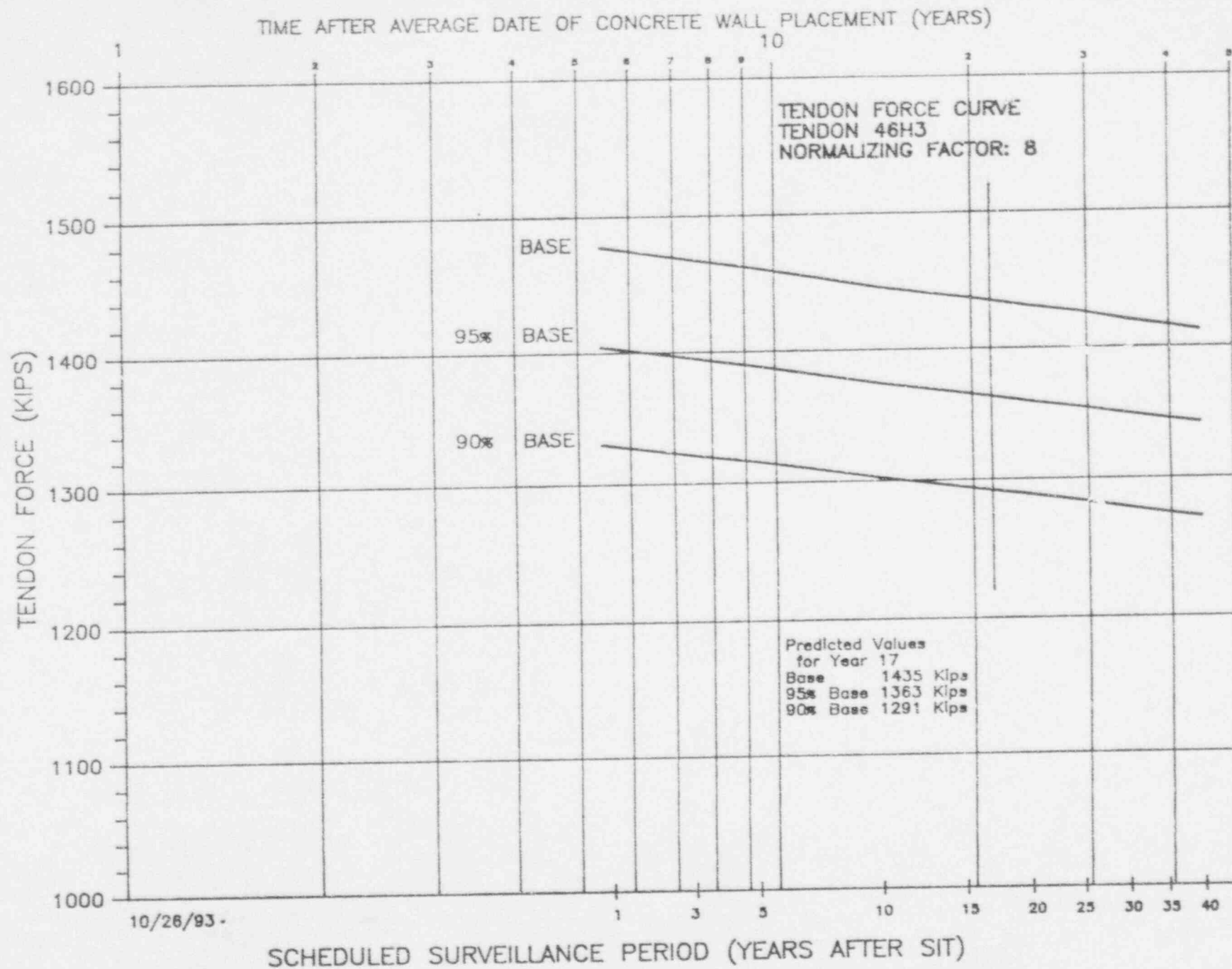


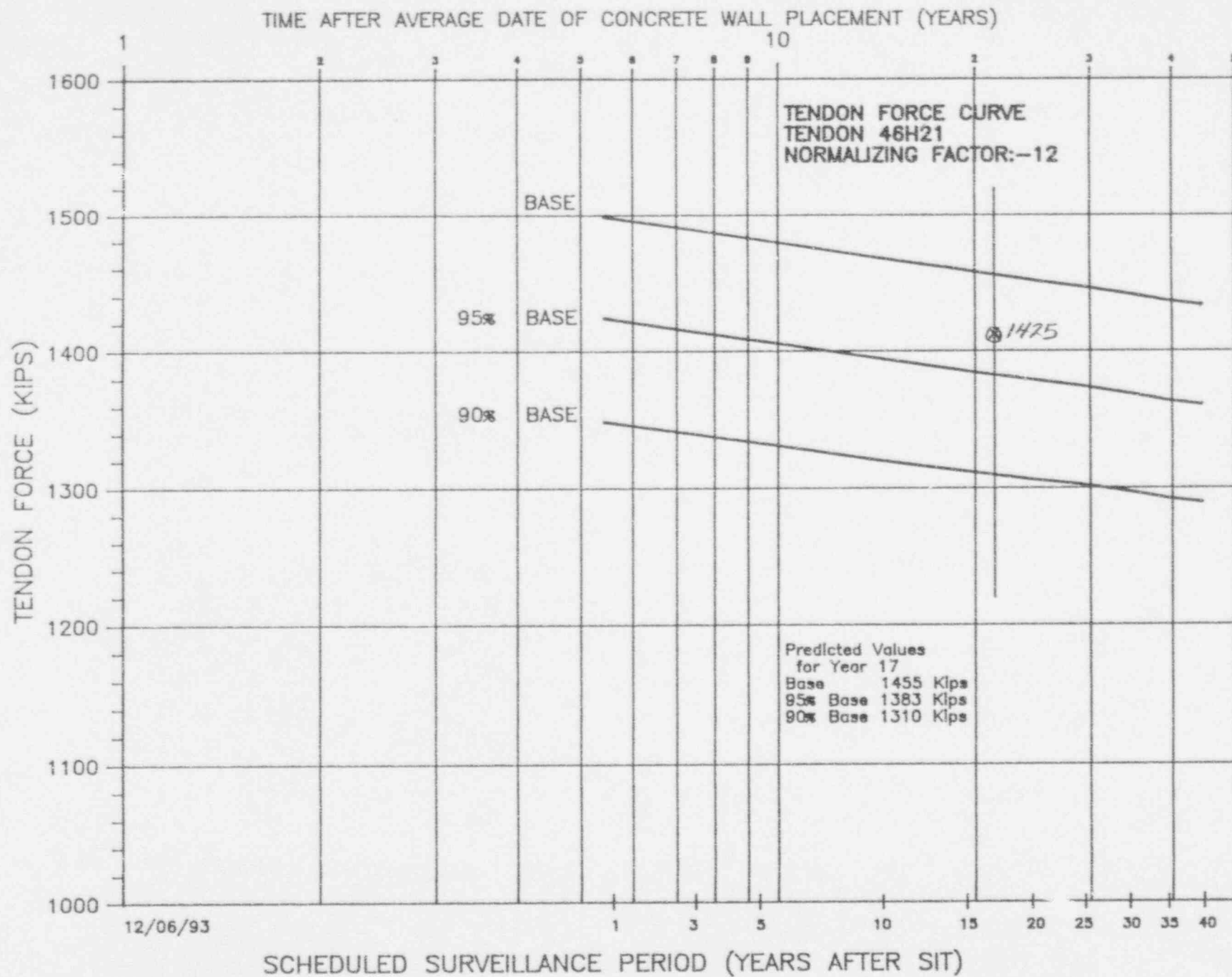


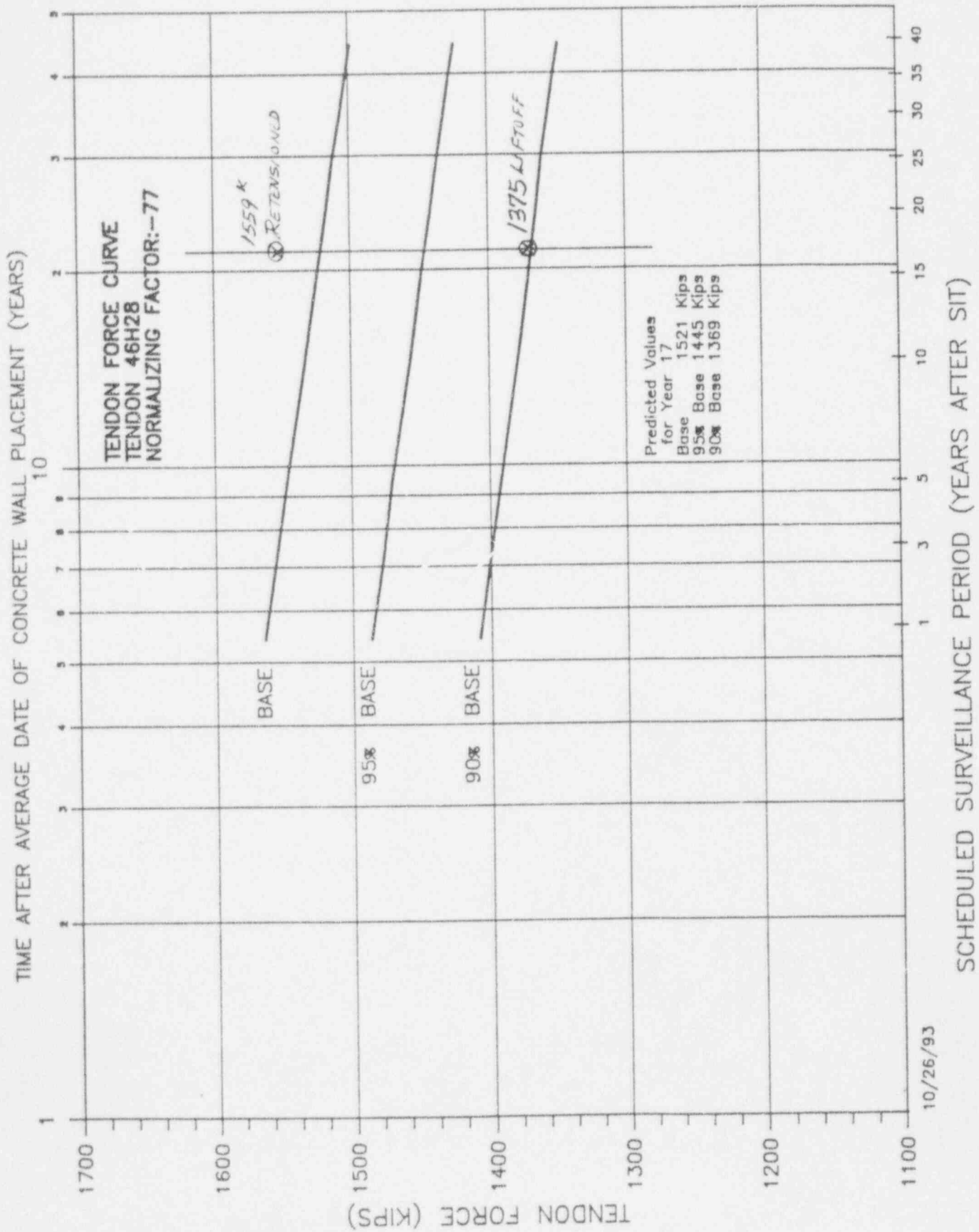


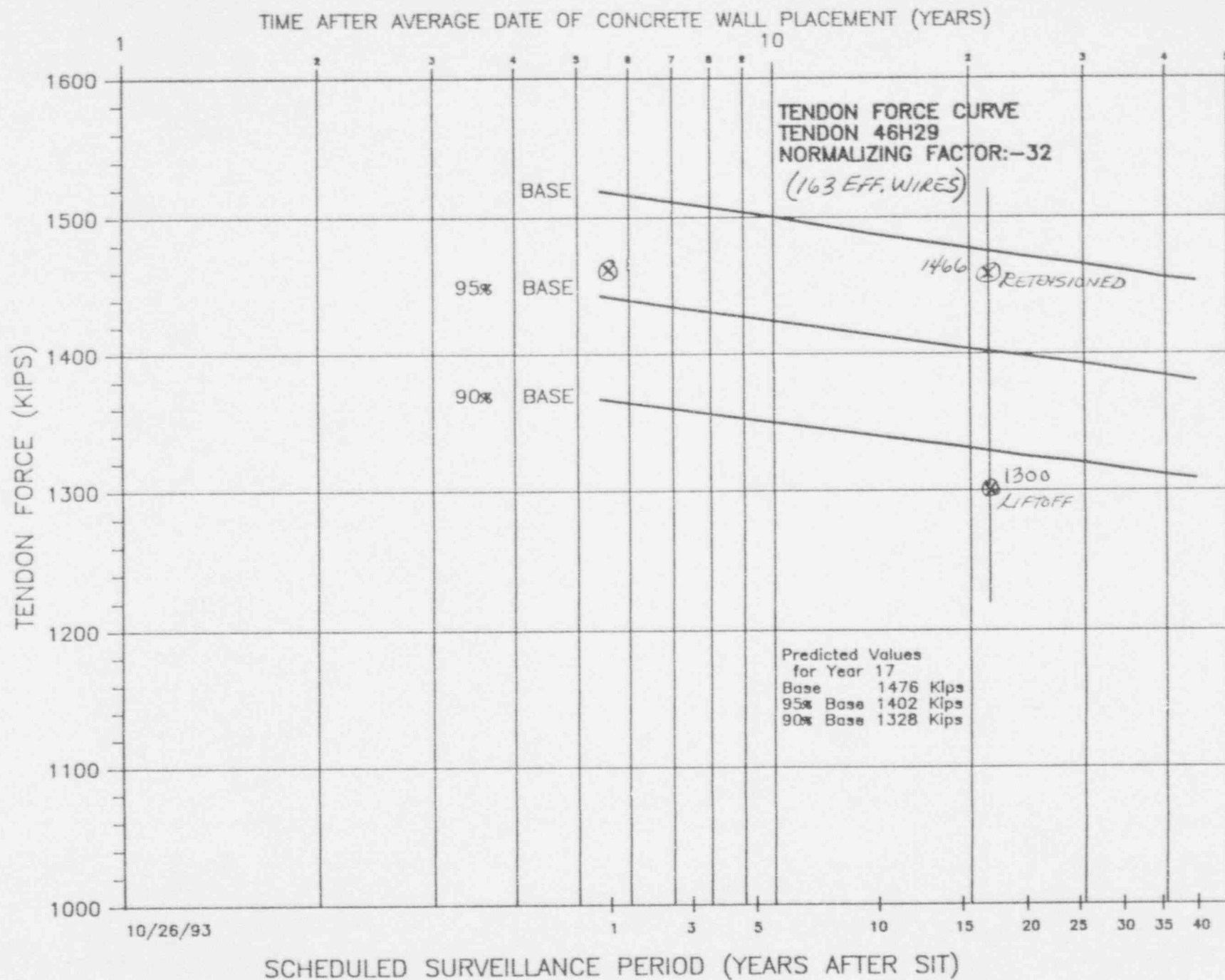


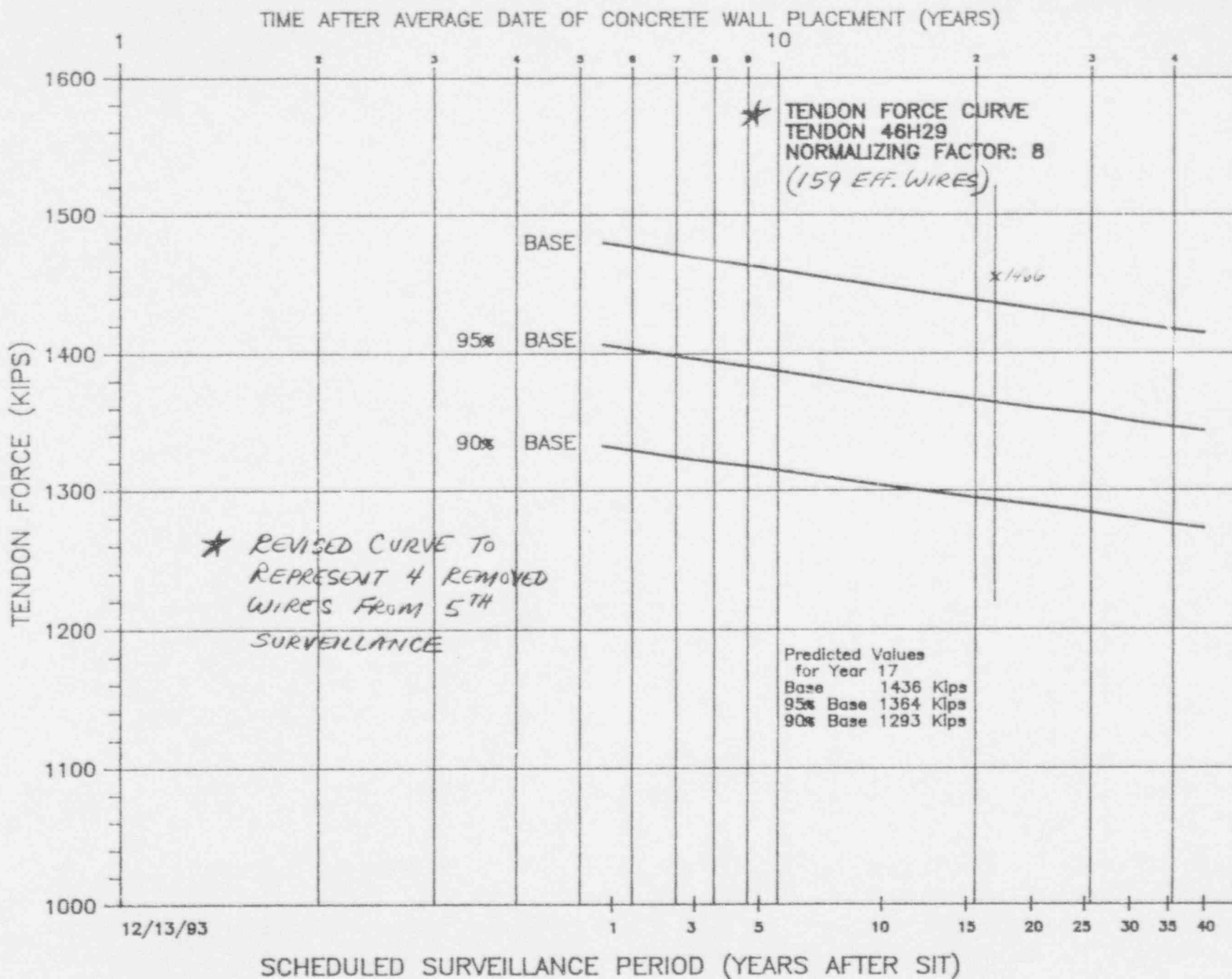


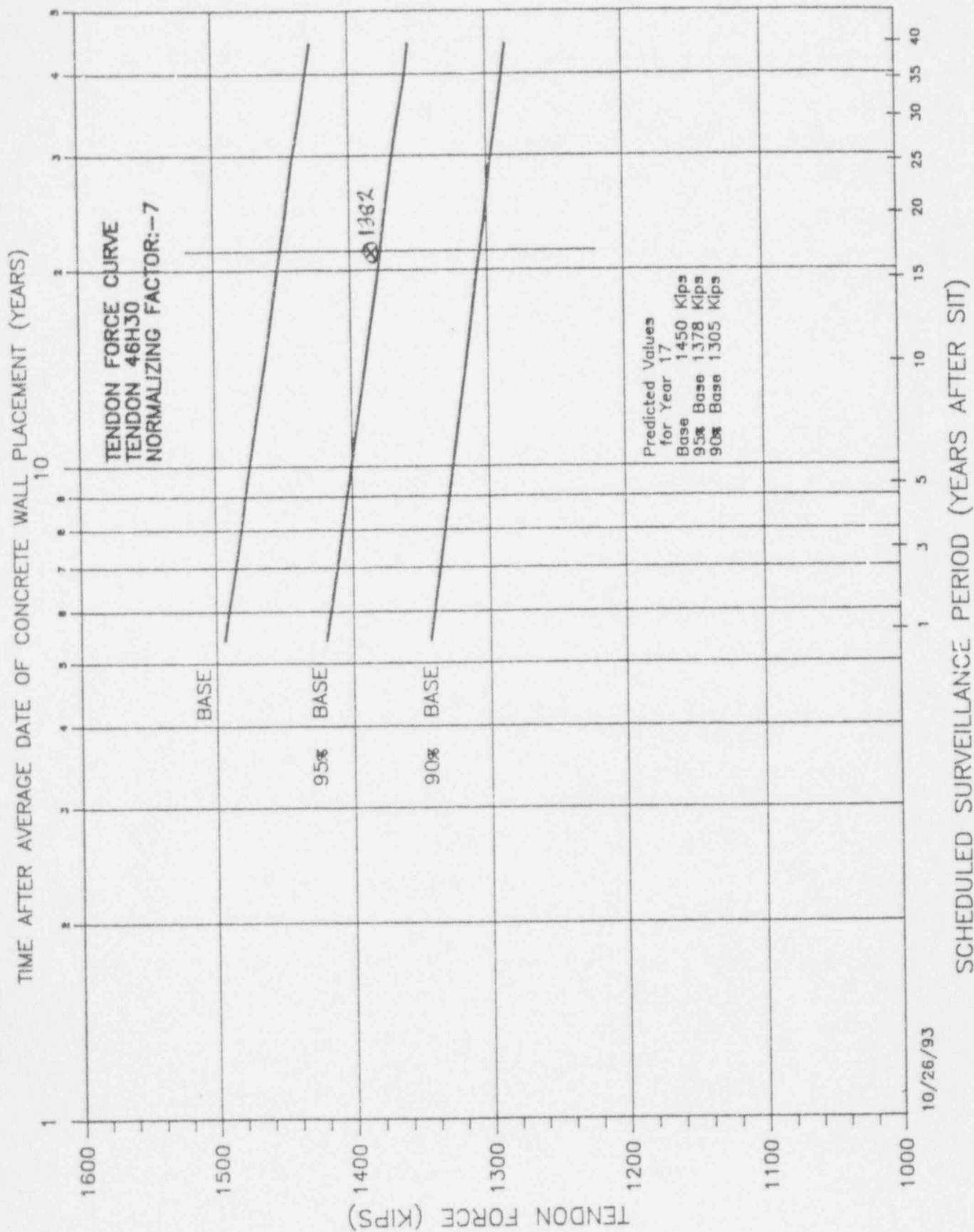


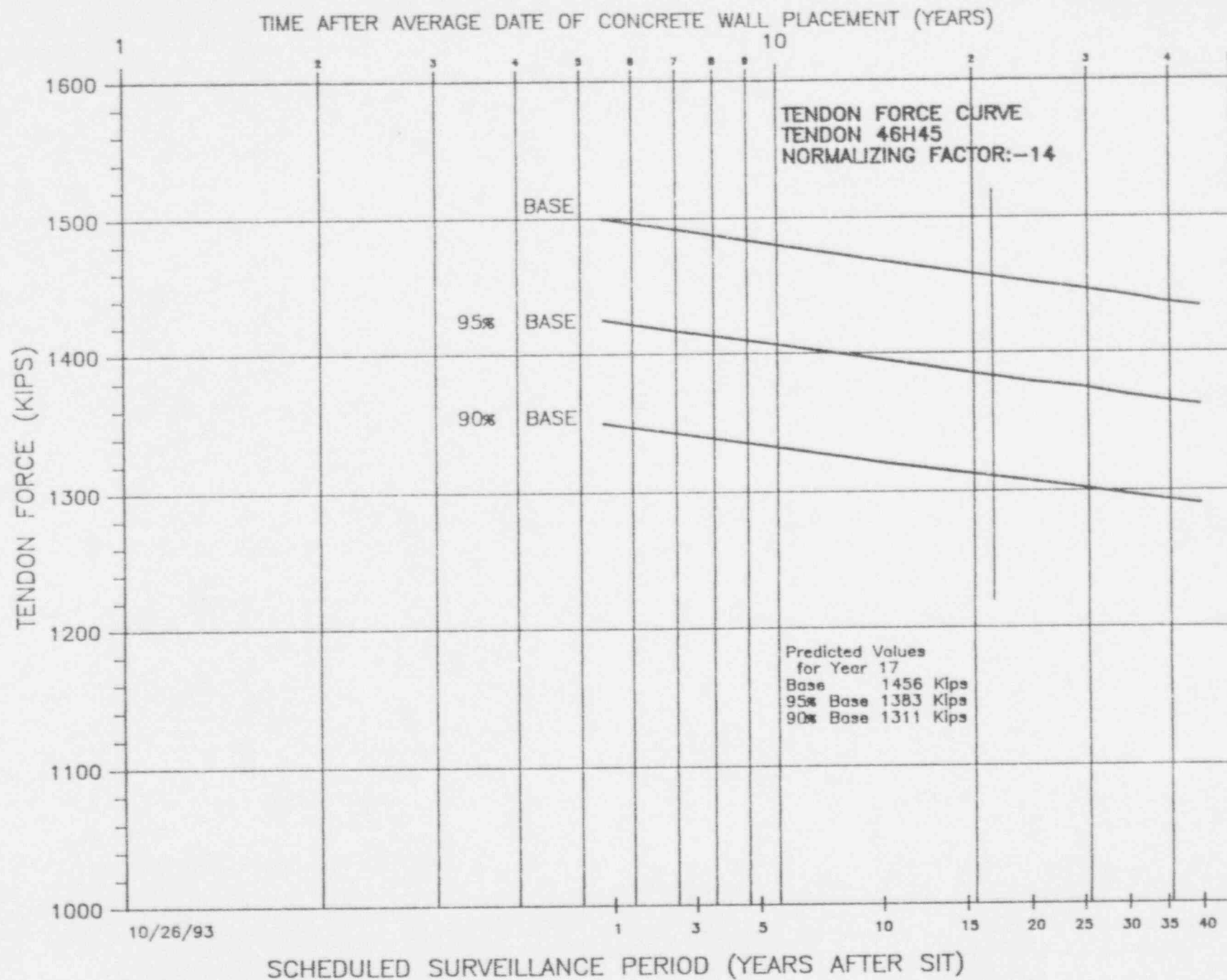


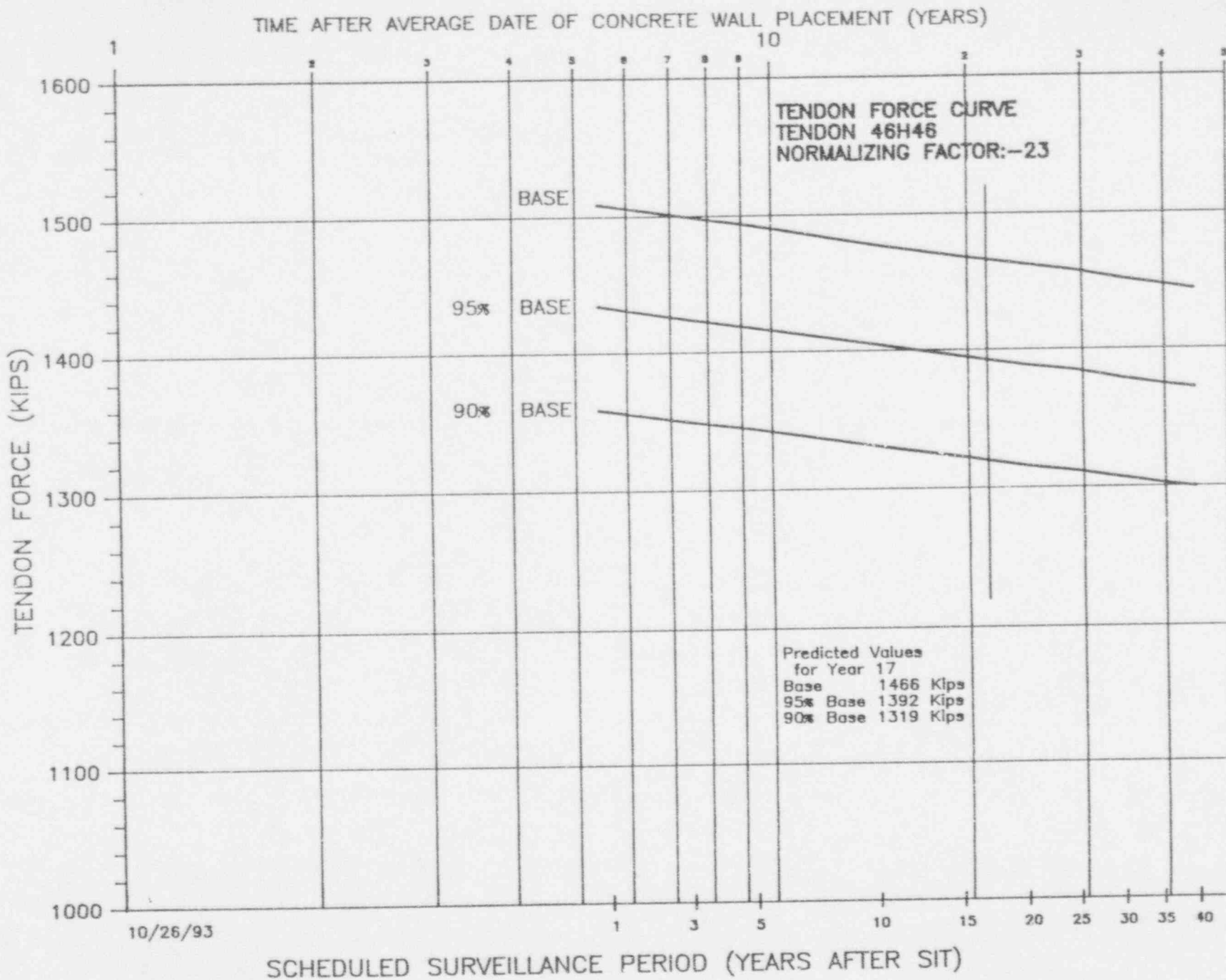


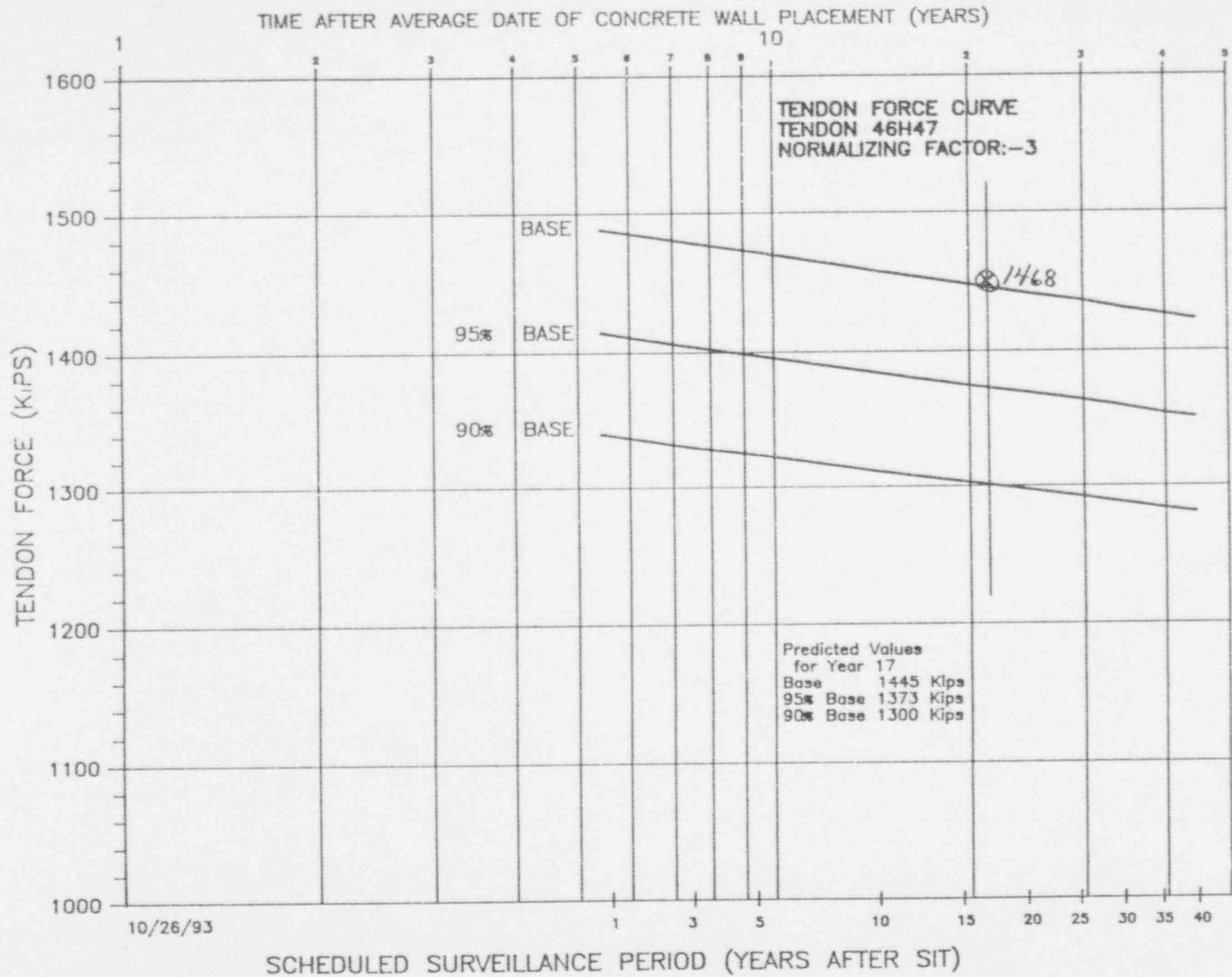


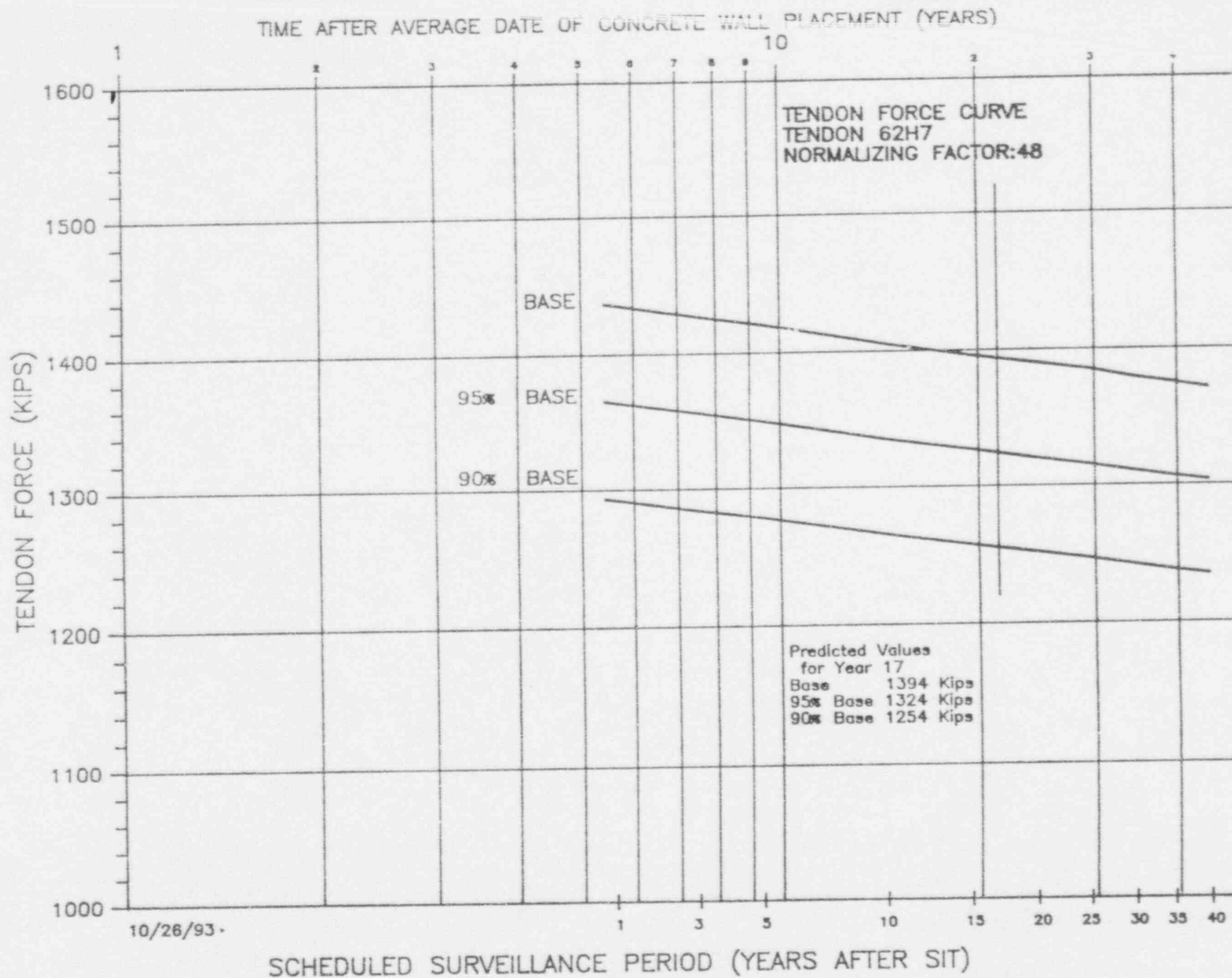


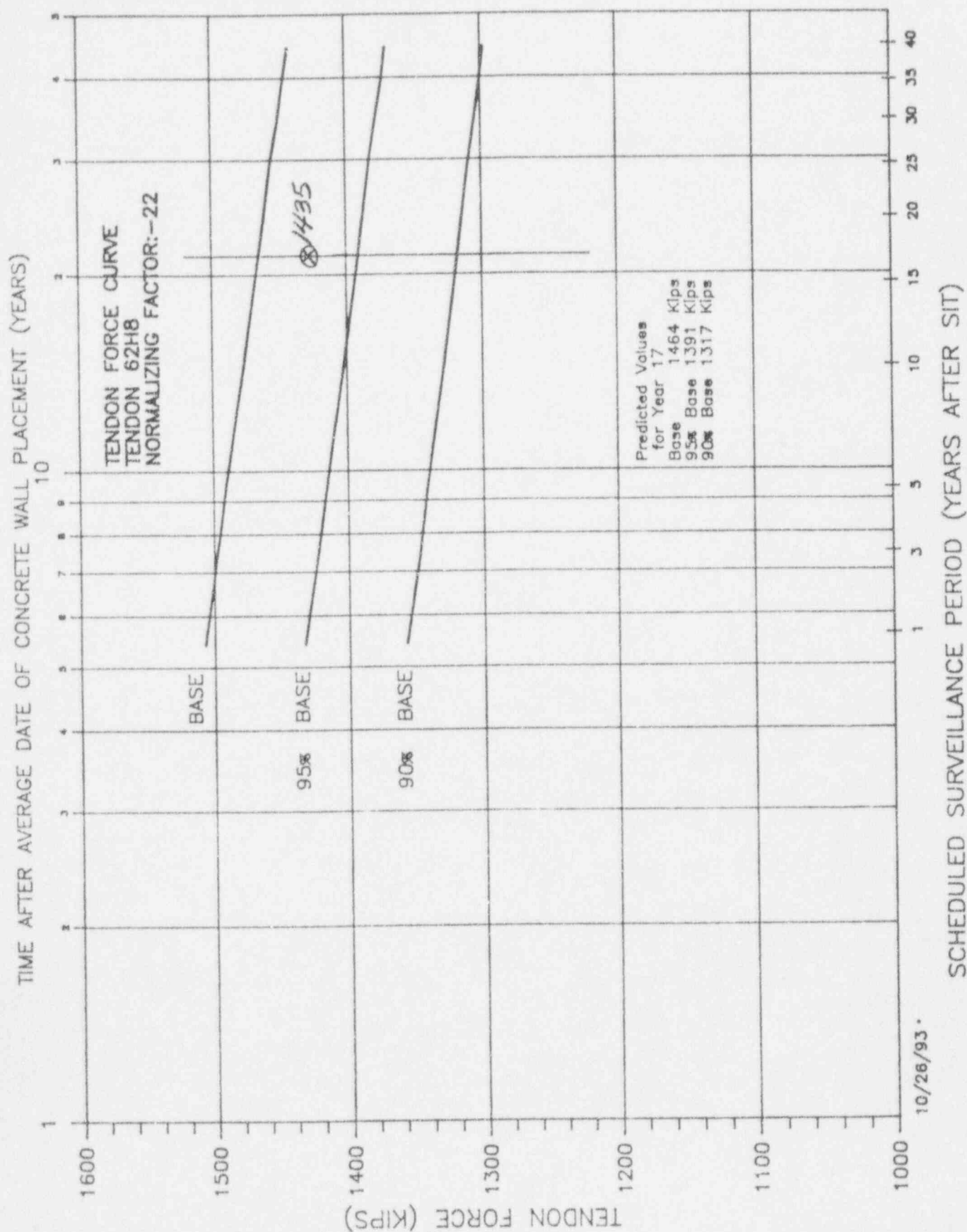


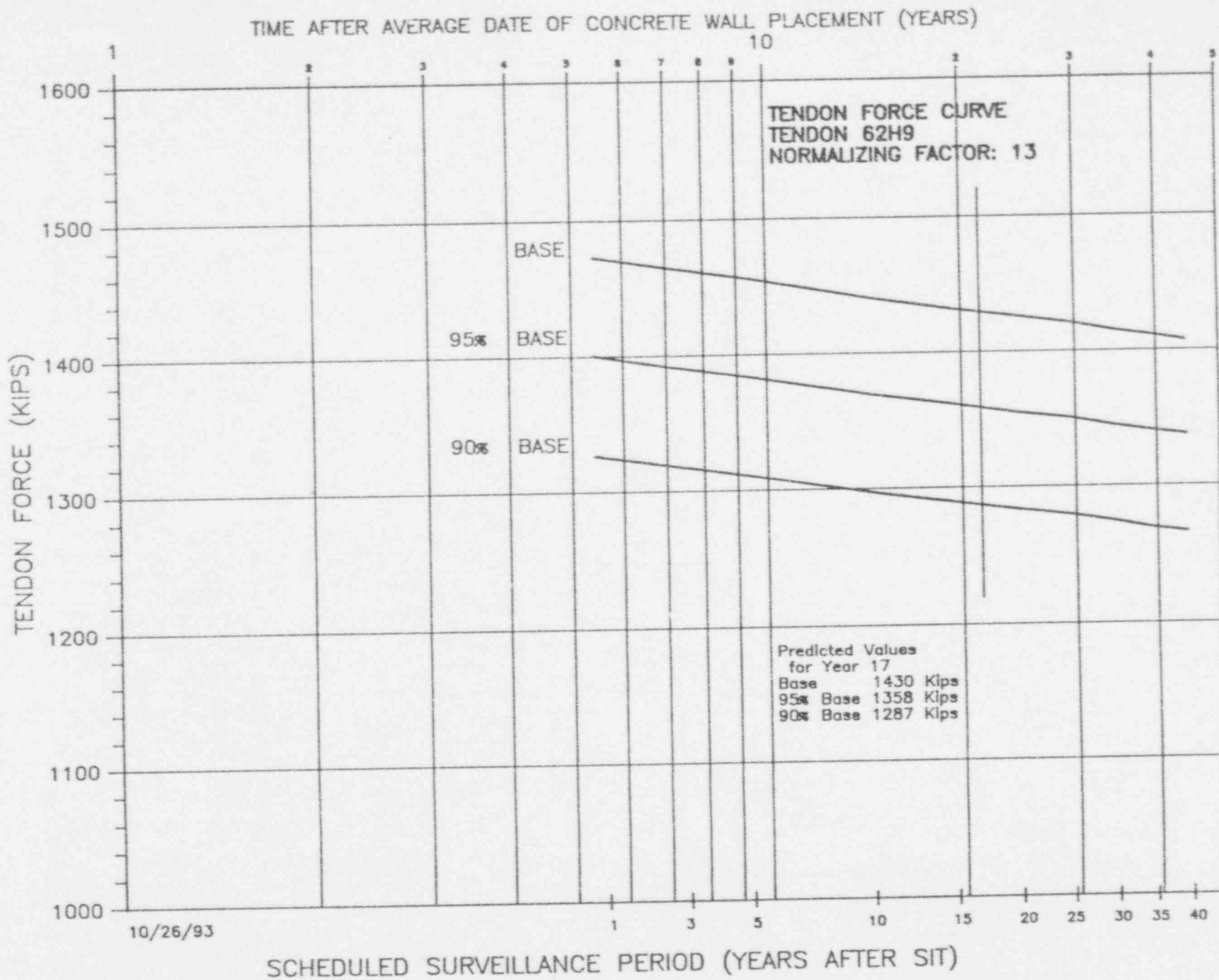


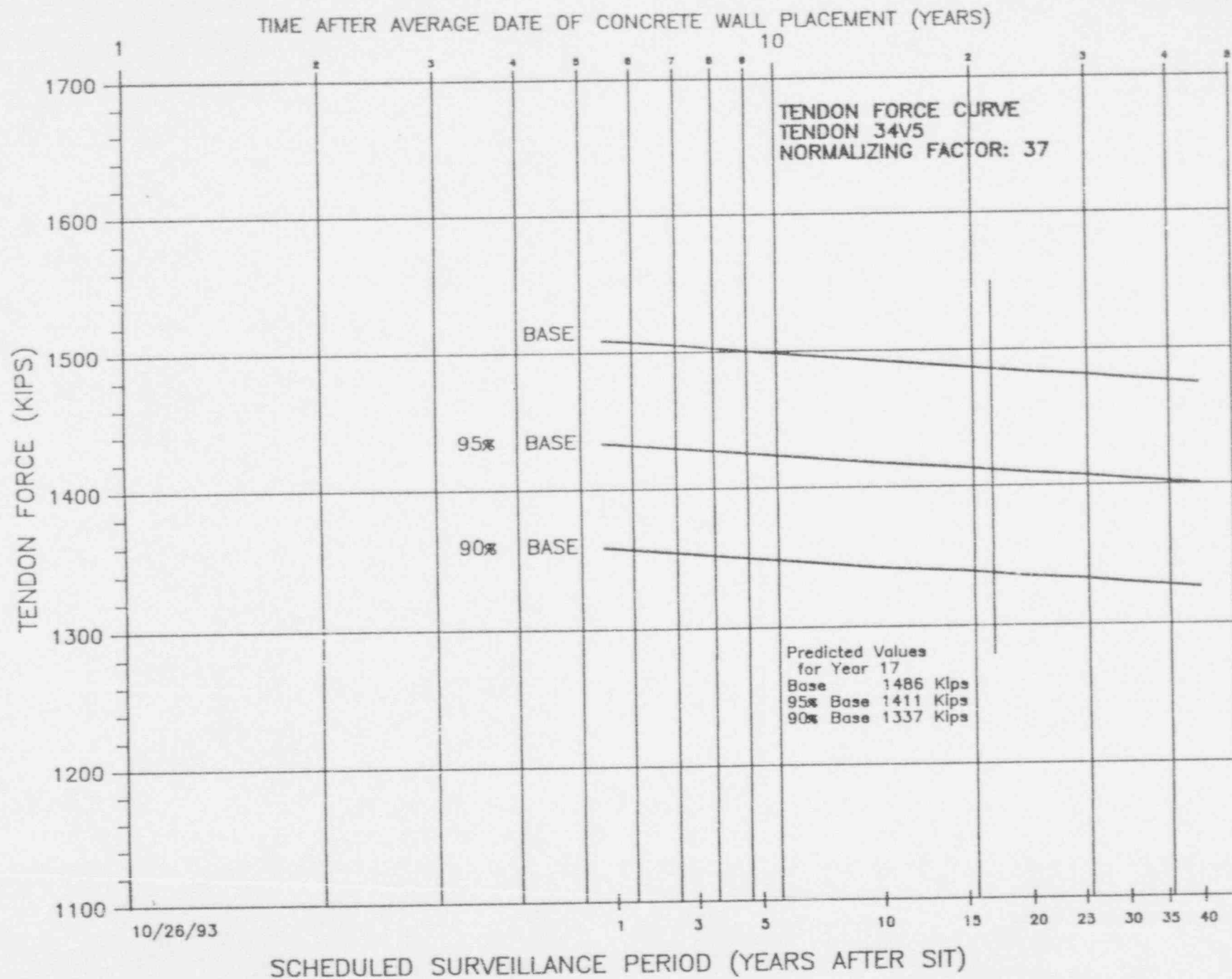


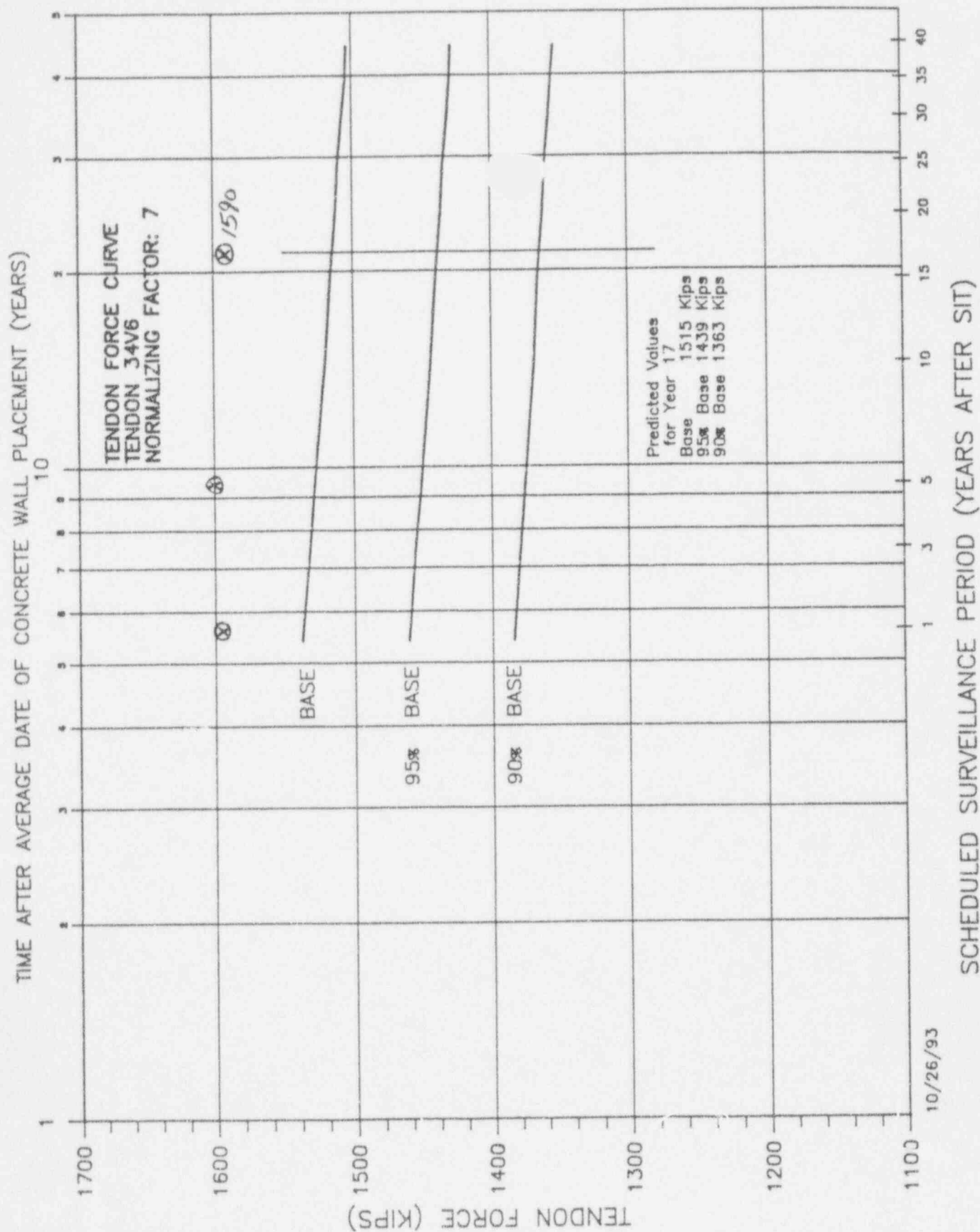


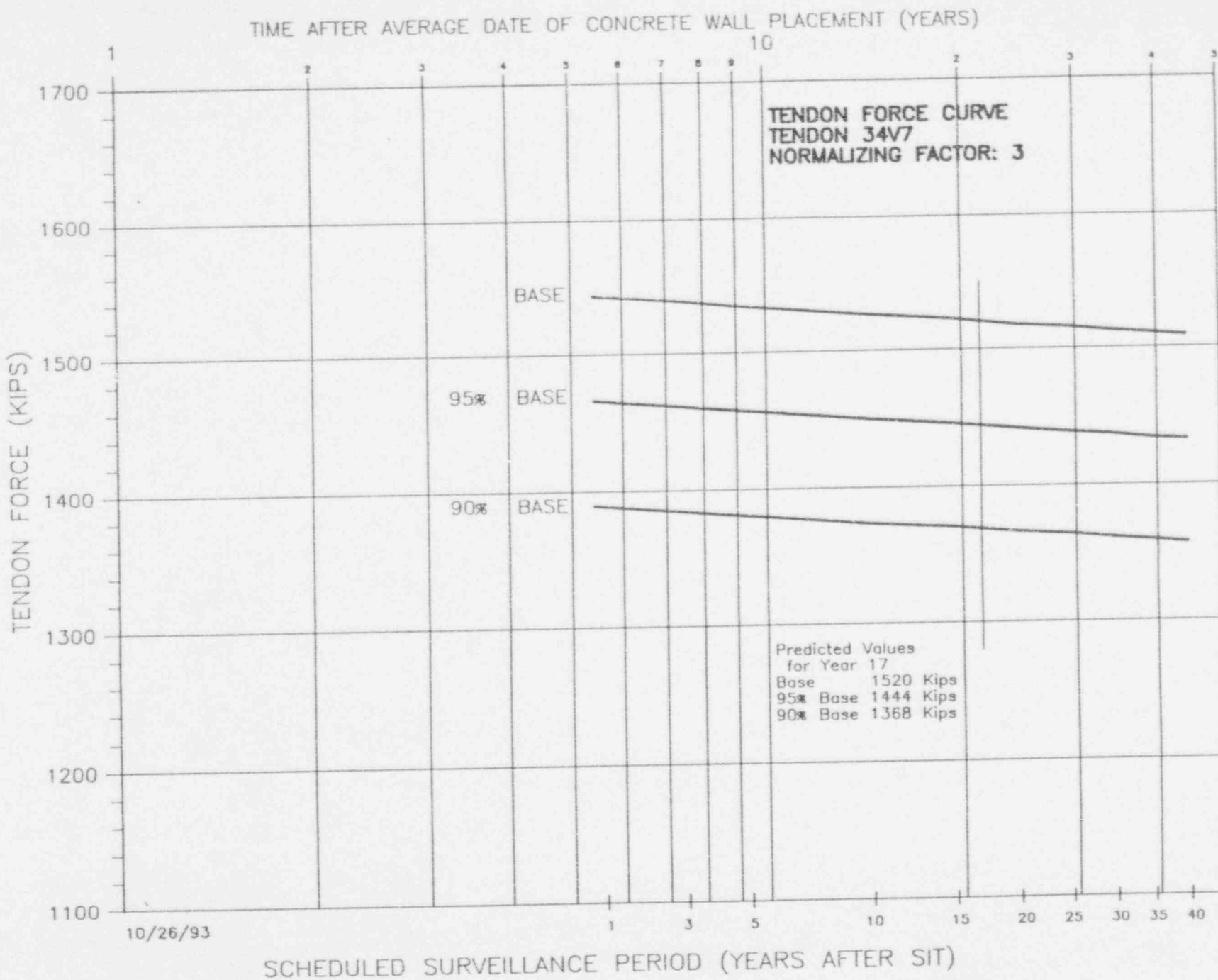


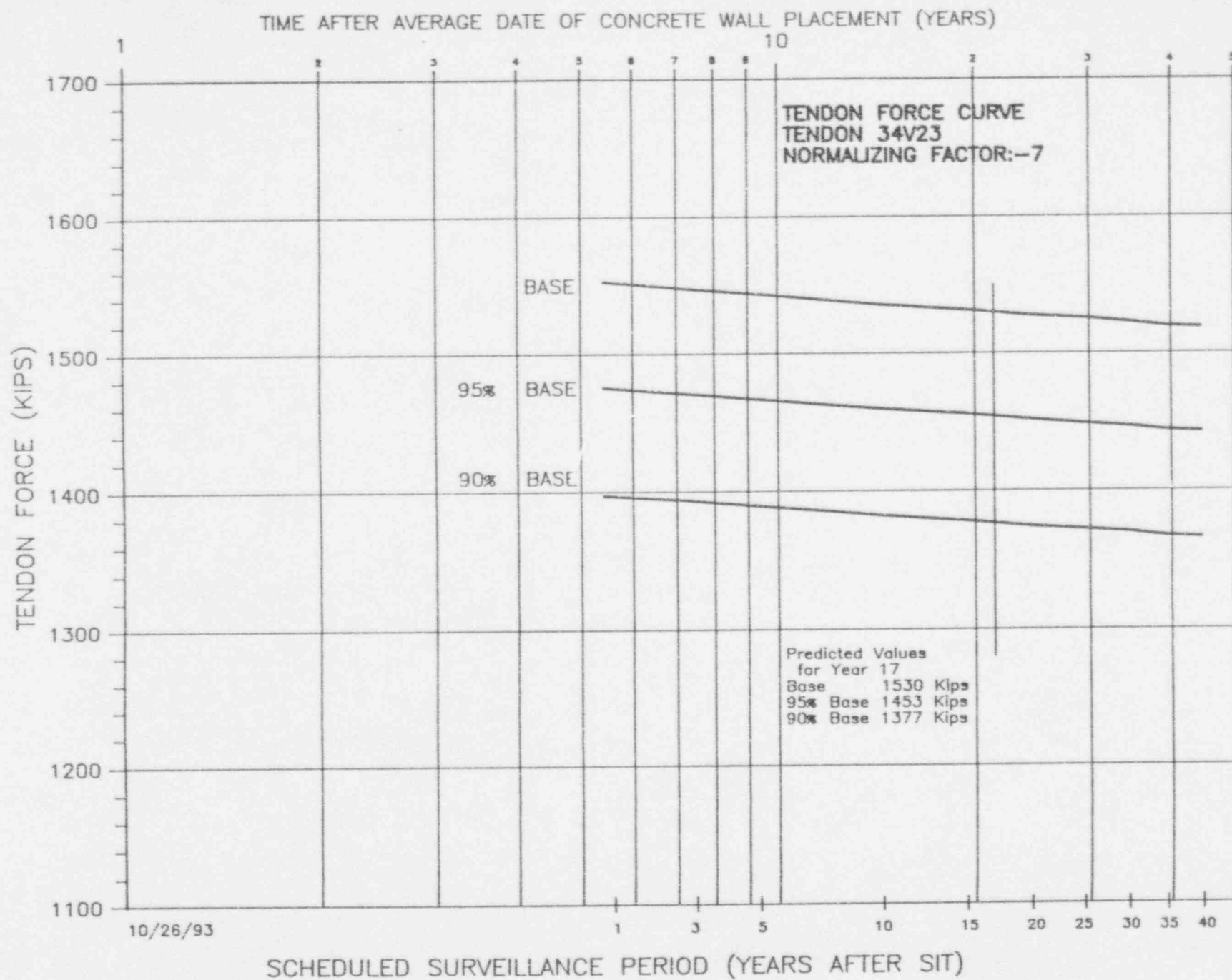


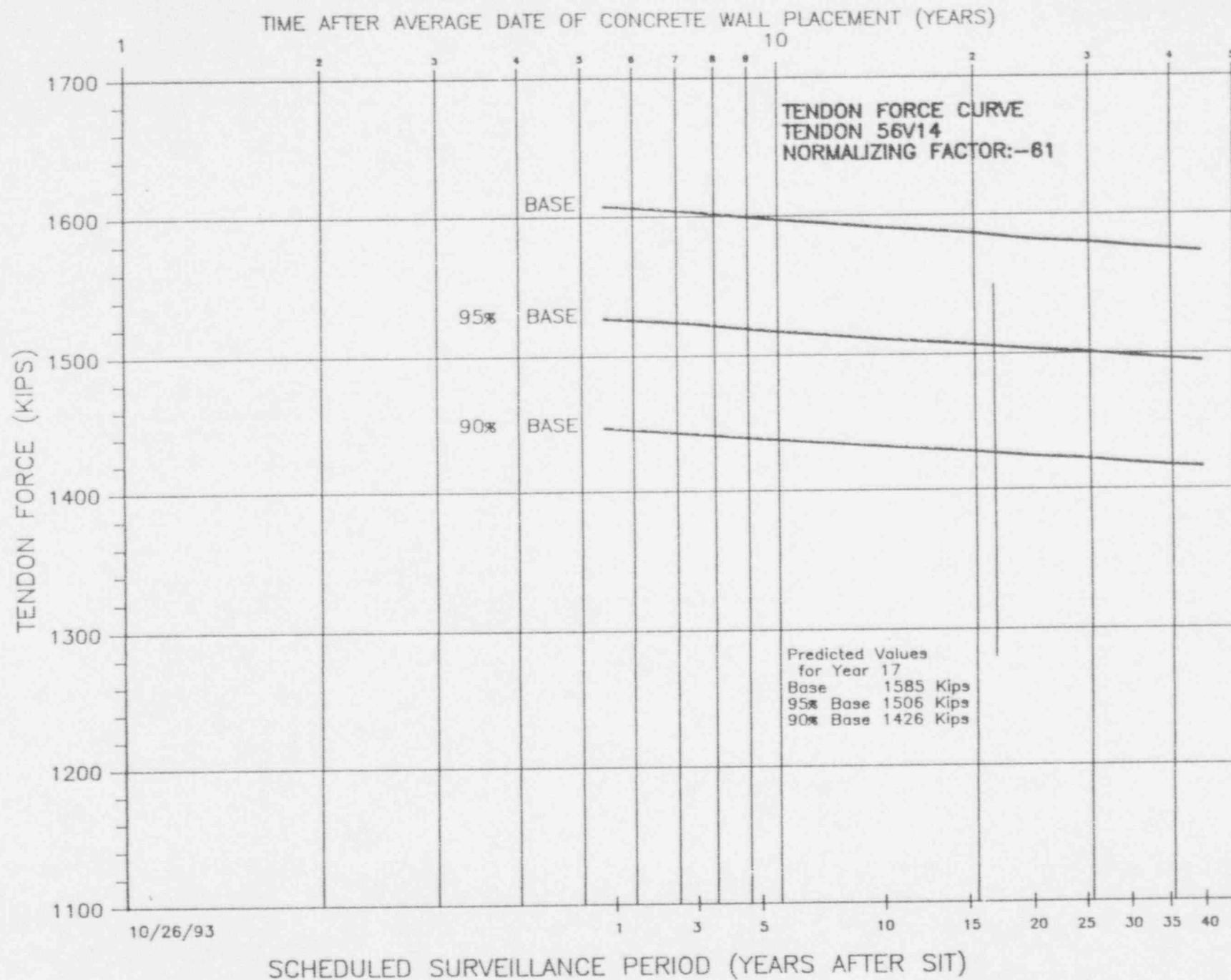


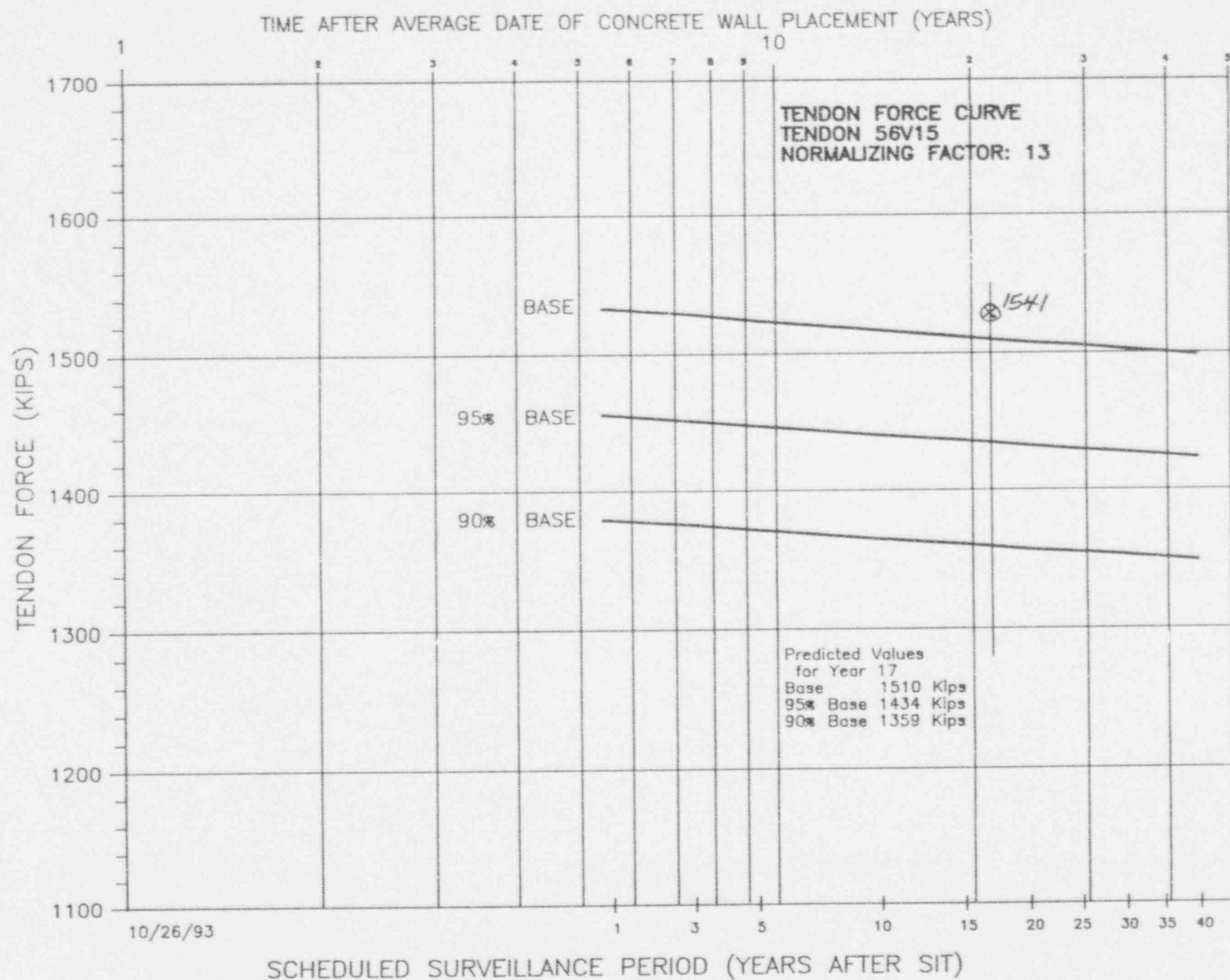


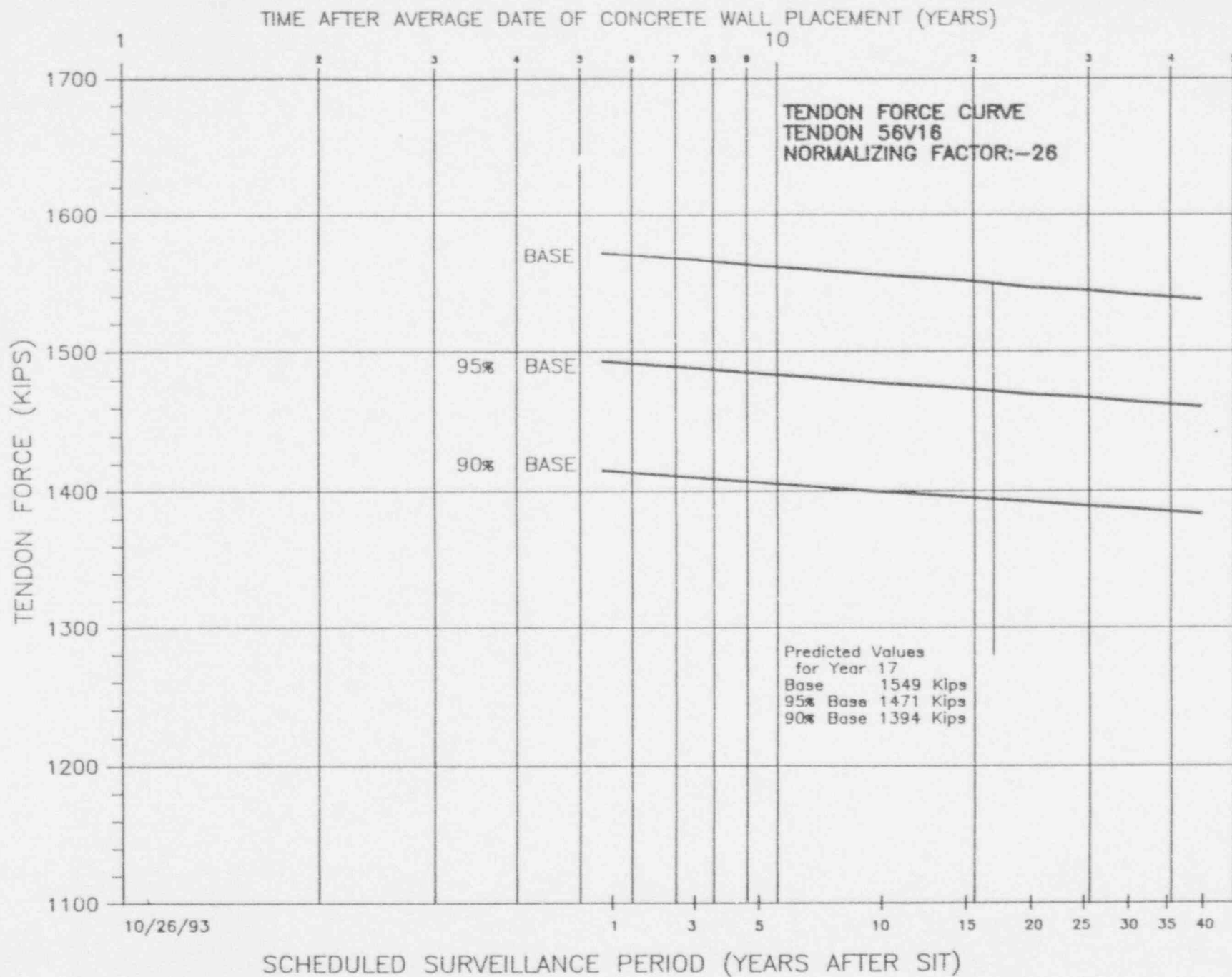


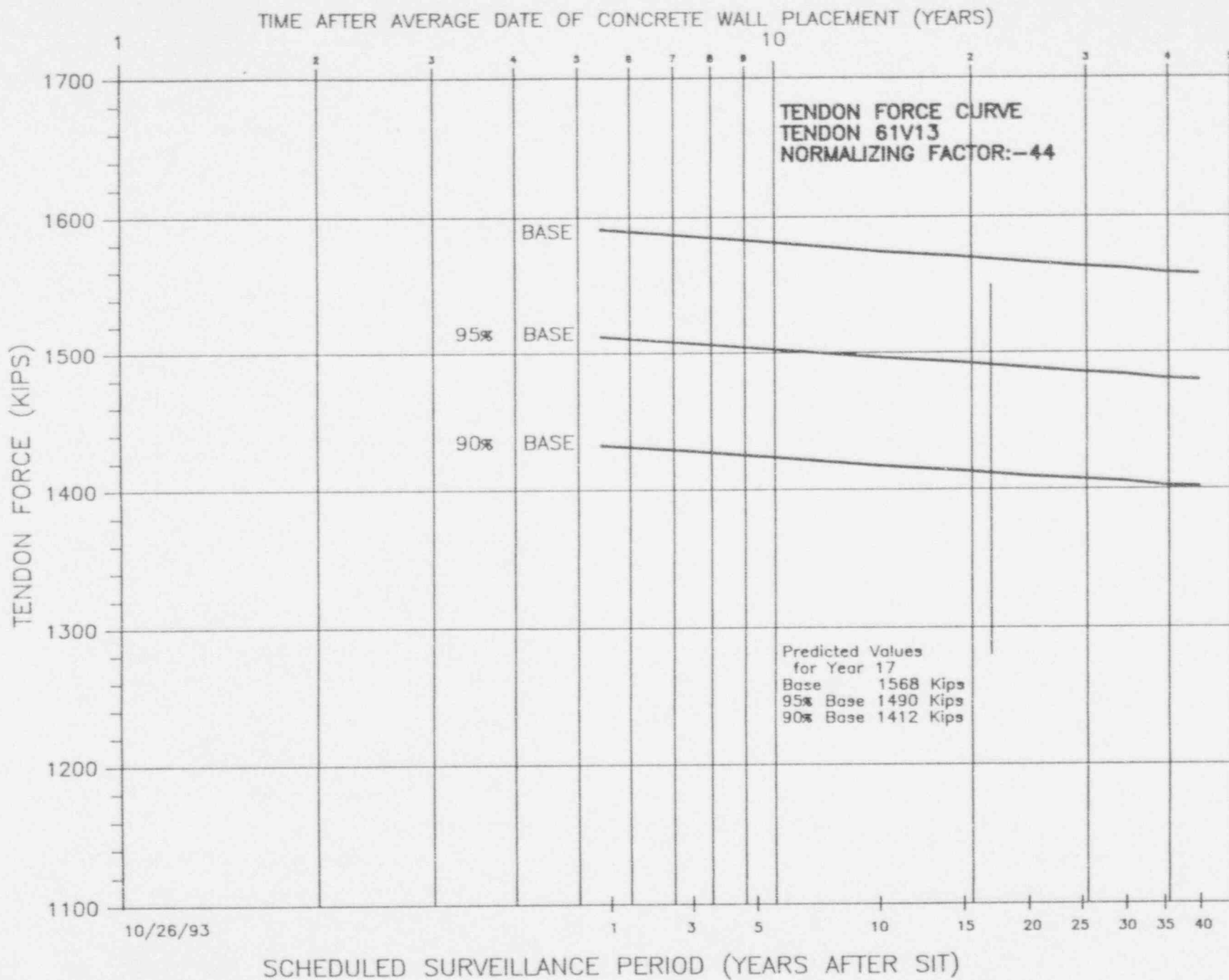


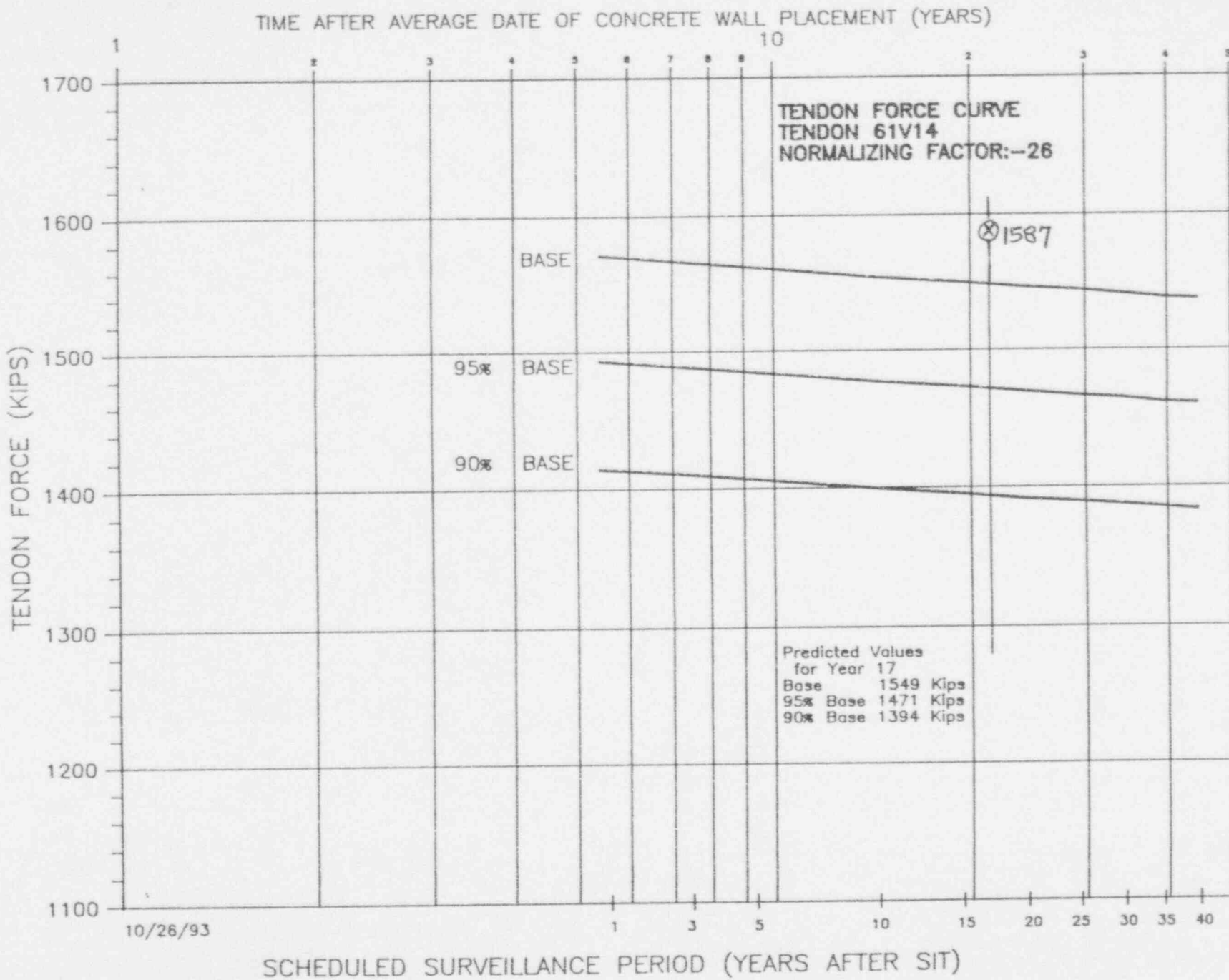


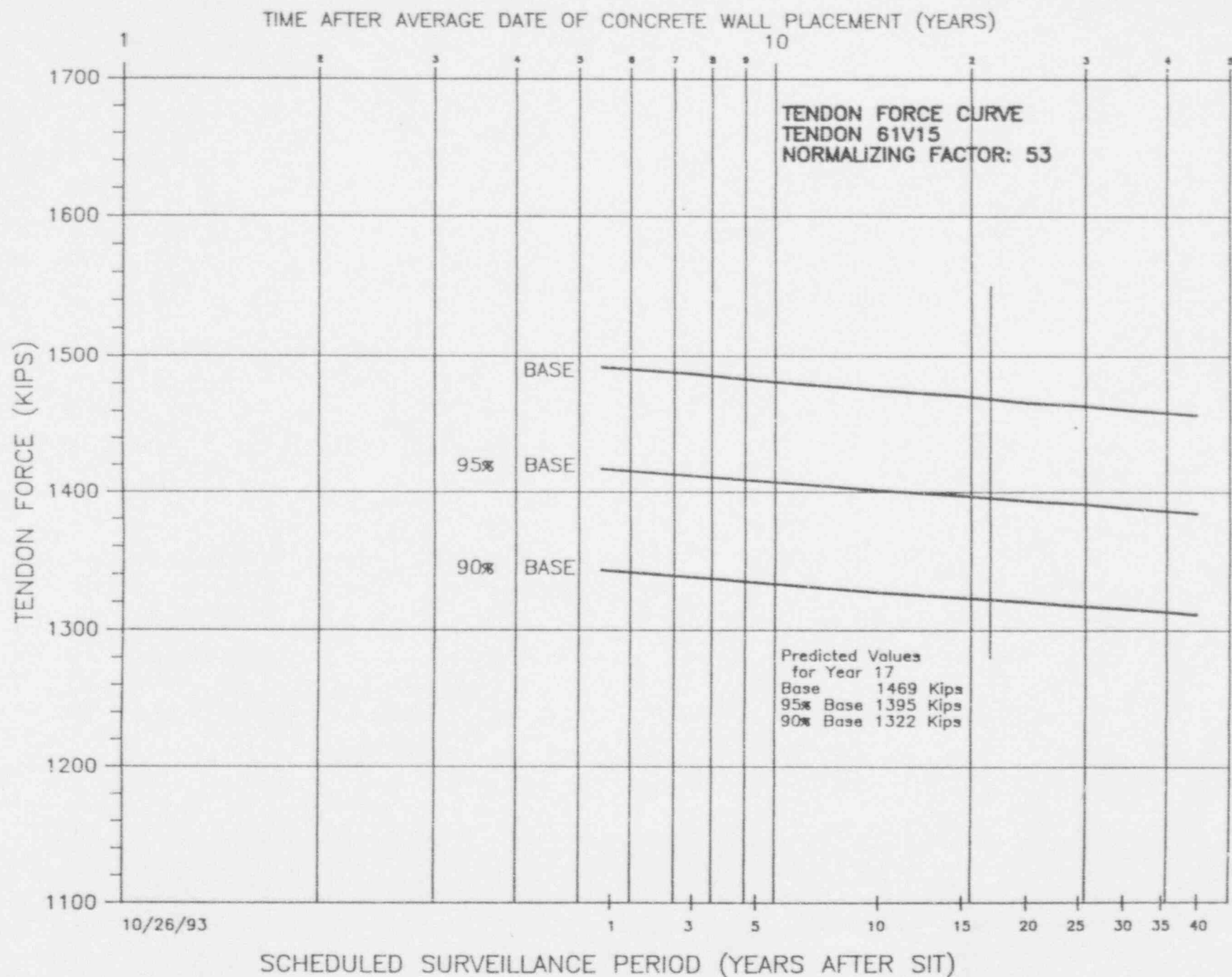












APPENDIX B

AVERAGE NORMALIZED LIFTOFF FORCE

AND NORMALIZATION FACTORS

There are minor corrections made to some normalization factors presented in Enclosure 42 of Revision 11 of SP-182 and used in this surveillance. These corrections affect the calculations in Enclosure 41 and are noted as follows:

<u>Tendon</u>	<u>NF in SP-182</u> <u>Rev 11</u>	<u>Corrected</u> <u>NF</u>
42H1	11	12
62H7	-3	48
62H8	-51	-22
46H21	N/A	-12

Note that tendon 46H21 was not originally presented in Enclosure 42 since it was added during the course of the surveillance.

The effect of the above corrections is not significant. Force curves attached in Appendix A are corrected with the information. The VSL Report will be updated to reflect these corrections. This report utilized all corrected data in the various tables and analyses.

ENCLOSURE 41

AVERAGE OF THE NORMALIZED LIFT OFF FORCE

Tendon ID	(1) Lift Off Force	(2)* Normalizing Factor (NF)	(3) Normalized Lift Off (1)+(2)	(4) Acceptance Yes No
<u>Dome Tendons**</u>				
1. D215	1518	27	1545	(Average equal to or greater than 1215 kips)
2. D224	1425	17	1442	
3. D231	1335	31	1374	
4. _____	_____	_____	_____	
5. _____	_____	_____	_____	
6. _____	_____	_____	_____	
7. _____	_____	_____	_____	
	Total Average		4361 1454	YES ✓

Vertical Tendons**

1. 34V6	1590	7	1597	(Average equal to or greater than 1149 kips)
2. 61V14	1537	-26	1561	
3. 56V15	1541	13	1554	
4. _____	_____	_____	_____	
5. _____	_____	_____	_____	
6. _____	_____	_____	_____	
7. _____	_____	_____	_____	
8. _____	_____	_____	_____	
	Total Average		4712 1571	YES ✓

Hoop Tendons**

CORRECTED 5/17/94 m.m.

1. 35H1	1572	19	1591	(Average equal to or greater than 1252 kips)
2. 42H1	1560	-12	1571	
3. 46H47	1468	-3	1465	
4. 62H8	1435	-21	1414	
5. 46H29	1300	-32	1268	
6. 46H28	1375	-77	1298	
7. 46H30	1382	-7	1375	
8. 46H21	1425	-12	1413	
9. _____	_____	_____	_____	
10. _____	_____	_____	_____	
11. _____	_____	_____	_____	
12. _____	_____	_____	_____	
	Total Average		11395 1424	YES ✓

* See Enclosure 42 for Normalizing Factors

** Include adjacent tendons, if any, in the above tendon list.

Contract Reviewed By: James M. McLDate: 1/5/94FPC Approval By: [Signature]Date: 1/10/94

ENCLOSURE 42

TENDON NORMALIZING FACTORS

<u>Tendon No.</u>	<u>NF</u>	<u>Tendon No.</u>	<u>NF</u>	<u>Tendon No.</u>	<u>NF</u>
D137	-34	34V5	37	42H1	11 12
D138	-69	34V6	7	42H2	-49
D139	-19	34V7	3	42H3	2
D214	-73	56V14	-61	46H28	-77
D215	27	56V15	13	46H29	-32 OK PRIOR TO BRACKET WIRES
D216	2	56V16	-26	46H30	-7
D230	-109	61V13	-44	35H1	19
D231	39	61V14	-26	35H2	14
D232	22	61V15	53	35H3	59
D224	17	34V23	-7	46H45	-14
				46H46	-23
				46H47	-3
				62H7	3 48
				62H8	51 -22
				62H9	13
				46H3	8
				46H21	-12

Corrected 5/17/94
MM.

APPENDIX C
TENDON WIRE SUMMARIES
DOME, HOOP AND VERTICAL GROUPS

INEFFECTIVE WIRE SUMMARY UPDATED TO FIFTH SURVEILLANCE

Acceptance Criteria

1. Maximum of 8 ineffective wires per tendon.
2. Maximum of 3% ineffective wires per 10 consecutive tendons.
3. Maximum of 2% ineffective wires per group.
The vertical tendons group consists of one stressing sequence quadrant of 36 tendons. The dome tendons group consists of one series layer of 41 tendons, i.e. D100, D200 & D300 groups. The hoop tendons group consists of one side of a buttress or 47 tendons.

The results of all tabulated data are summarized as follows:

<u>Tendon Group</u>	<u>Max/Tendon</u>	<u>Max/10 Tendons</u>	<u>Max/Group</u>
Domes			
Actual	7 (Note 1)	30	67
Allowable	8	49	134
Verticals			
Actual	6	21	37
Allowable	8	49	117
Hoops			
Actual	6	18	49
Allowable	8	49	153

Notes -

1. Dome tendons D-217 and D-233 with 16 and 12 ineffective wires respectively exceed the 8 wire maximum per tendon but were previously accepted for that condition. These two tendons are reduced force dome tendons and it was determined that the high number of ineffective wires was due to unseating as a result of the reduced tensioning force in the tendons. See Ineffective Wire Summary, Update 2, 8/14/78, for additional information.
2. The calculation for the ten consecutive tendons for the last nine tendons was performed by using the data from first tendons at the top of the listing.
3. Maximum wires per group are noted on the tendon group sheets.

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
DOME TENDONS WIRE SUMMARY
UPDATED TO 5TH SURVEILLANCE

Originator: R. Chang Date: 05/23/94
Verifier: M. D. Marcellus Date: 05/23/94

FILE: DWIRE.WK3

D100 GROUP						D200 GROUP						D300 GROUP					
TENDON NO.	EFF. WIRES	INEFF. WIRES	IF GREATER THAN #	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 40 (%)	TENDON NO.	EFF. WIRES	INEFF. WIRES	IF GREATER THAN #	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 40 (%)	TENDON NO.	EFF. WIRES	INEFF. WIRES	IF GREATER THAN #	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 40 (%)
D 101 **	162	1		9		D 201 **	163	0		10		D 301 **	162	1		19	
D 102	163	0		8		D 202	162	1		11		D 302	156	7		18	
D 103	163	0		8		D 203	163	0		11		D 303	161	2		11	
D 104	157	6		8		D 204	161	2		11		D 304	163	0		9	
D 105	162	1		3		D 205	160	3		11		D 305	160	3		11	
D 106	162	1		2		D 206	163	0		8		D 306	161	2		9	
D 107	163	0		2		D 207	161	2		8		D 307	163	0		7	
D 108	163	0		2		D 208	161	2		22		D 308	160	3		7	
D 109 **	163	0		2		D 209 **	163	0		25		D 309 **	163	0		6	
D 110	163	0		2		D 210	163	0		25		D 310	162	1		6	
D 111	163	0		2		D 211	162	1		27		D 311	163	0		8	
D 112	163	0		3		D 212	162	1		27		D 312	163	0		8	
D 113	163	0		3		D 213	163	0		26		D 313	163	0		10	
D 114	162	1		4		D 214	161	2		26		D 314	161	2		12	
D 115	163	0		3		D 215	163	0		26		D 315	162	1		10	
D 116	162	1		3		D 216	163	0		30		D 316	163	0		10	
D 117 **	163	0		2		D 217 **	147	16	*	36		D 317 **	163	0		10	
D 118	163	0		2		D 218	158	5		14		D 318	161	2		10	
D 119	163	0		6		D 219	163	0		9		D 319	163	0		8	
D 120	163	0		8		D 220	161	2		9		D 320	160	3		9	
D 121	162	1		0		D 221	162	1		7		D 321	163	0		7	
D 122	163	0		0		D 222	163	0		10		D 322	161	2		9	
D 123	162	1		10		D 223	163	0		10		D 323	161	2		9	
D 124	163	0		12		D 224	161	2		22		D 324	163	0		10	
D 125 **	163	0		13		D 225 **	159	4		21		D 325 **	162	1		11	
D 126	163	0		14		D 226	163	0		18		D 326	163	0		14	
D 127	163	0		15		D 227	163	0		19		D 327	163	0		14	
D 128	159	4		22		D 228	163	0		19		D 328	163	0		14	
D 129	161	2		19		D 229	163	0		19		D 329	162	1		15	
D 130	163	0		17		D 230	163	0		19		D 330	162	1		17	
D 131	161	2		17		D 231	159	4		19		D 331	161	2		16	
D 132	162	1		15		D 232	163	0		19		D 332	161	2		16	
D 133 **	160	3		15		D 233 **	151	12	*	19		D 333 **	160	3		15	
D 134	162	1		12		D 234	162	1		8		D 334	162	1		19	
D 135	162	1		11		D 235	162	1		7		D 335	159	4		20	
D 136	162	1		16		D 236	162	1		8		D 336	163	0		16	
D 137	156	7		16		D 237	163	0		10		D 337	163	0		19	
D 138	162	1		10		D 238	163	0		10		D 338	162	1		21	
D 139	163	0		9		D 239	163	0		12		D 339	160	3		20	
D 140	163	0		9		D 240	163	0		14		D 340	163	0		20	
D 141 **	163	0		9		D 241 **	159	4		14		D 341 **	161	2		20	
TOTAL	640	36	OK	134		TOTAL	646	67	OK	134		TOTAL	603	52	OK	134	
MAXIMUM 2% /GROUP						MAXIMUM 2% /GROUP						MAXIMUM 2% /GROUP					

** REDUCED FORCE TENDONS
MAXIMUM WIRES PER GROUP = 41 X 163 = 6663

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
HOOP TENDONS WIRE SUMMARY
UPDATED TO 5TH SURVEILLANCE

Originator: R. Chang Date: 05/23/94
Verifier: M.D. Marcellus Date: 05/23/94
SHEET 1 OF 2
FILE: HWIRE1.WK1

13HXX GROUP						35HXX GROUP						51HXX GROUP					
TENDON NO.	EFF. WIRES	INEFF. WIRES	IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 4% (3%)	TENDON NO.	EFF. WIRES	INEFF. WIRES	IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 4% (3%)	TENDON NO.	EFF. WIRES	INEFF. WIRES	IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 4% (3%)
13H 1	161	2		4		35H 1	161	2		14		51H 1	163	0		11	
13H 2	163	0		2		35H 2	162	1		18		51H 2	163	0		11	
13H 3	163	0		2		35H 3	161	2		17		51H 3	162	0		11	
13H 4	163	0		2		35H 4	161	2		17		51H 4	162	1		15	
13H 5	163	0		2		35H 5	160	3		15		51H 5	163	0		14	
13H 6	163	0		2		35H 6	163	0		12		51H 6	161	2		14	
13H 7	163	0		4		35H 7	162	1		12		51H 7	162	1		13	
13H 8	163	0		4		35H 8	161	2		11		51H 8	160	3		12	
13H 9	161	2		7		35H 9	163	0		9		51H 9	161	2		11	
13H 10	163	0		7		35H 10	162	1		10		51H 10	161	2		9	
13H 11	163	0		8		35H 11	157	6		9		51H 11	163	0		7	
13H 12	163	0		13		35H 12	163	0		4		51H 12	163	0		7	
13H 13	163	0		13		35H 13	161	2		4		51H 13	159	4		7	
13H 14	163	0		13		35H 14	163	0		2		51H 14	163	0		3	
13H 15	163	0		13		35H 15	163	0		3		51H 15	163	0		3	
13H 16	161	2		13		35H 16	163	0		4		51H 16	162	1		4	
13H 17	163	0		11		35H 17	163	0		4		51H 17	163	0		3	
13H 18	160	3		11		35H 18	163	0		4		51H 18	161	2		5	
13H 19	161	2		8		35H 19	162	1		4		51H 19	163	0		3	
13H 20	162	1		8		35H 20	163	0		7		51H 20	163	0		3	
13H 21	158	5		7		35H 21	162	1		7		51H 21	163	0		4	
13H 22	163	0		2		35H 22	163	0		6		51H 22	163	0		7	
13H 23	163	0		3		35H 23	163	0		6		51H 23	163	0		8	
13H 24	163	0		4		35H 24	162	1		6		51H 24	163	0		8	
13H 25	163	0		4		35H 25	162	1		5		51H 25	162	1		8	
13H 26	163	0		6		35H 26	163	0		4		51H 26	163	0		7	
13H 27	163	0		9		35H 27	163	0		4		51H 27	161	2		8	
13H 28	163	0		10		35H 28	163	0		4		51H 28	163	0		8	
13H 29	161	2		11		35H 29	159	4		4		51H 29	163	0		9	
13H 30	163	0		10		35H 30	163	0		5		51H 30	162	1		9	
13H 31	163	0		11		35H 31	163	0		5		51H 31	160	3		8	
13H 32	162	1		11		35H 32	163	0		5		51H 32	162	1		5	
13H 33	162	1		10		35H 33	163	0		5		51H 33	163	0		5	
13H 34	163	0		10		35H 34	163	0		6		51H 34	163	0		7	
13H 35	161	2		10		35H 35	163	0		6		51H 35	163	0		8	
13H 36	160	3		9		35H 36	163	0		6		51H 36	162	1		9	
13H 37	162	1		6		35H 37	163	0		6		51H 37	161	2		8	
13H 38	162	1		5		35H 38	163	0		6		51H 38	162	1		7	
13H 39	162	1		6		35H 39	158	5		8		51H 39	163	0		6	
13H 40	162	1		5		35H 40	163	0		4		51H 40	163	0		6	
13H 41	163	0		4		35H 41	163	0		6		51H 41	163	0		6	
13H 42	163	0		4		35H 42	163	0		8		51H 42	162	1		7	
13H 43	162	1		4		35H 43	162	1		11		51H 43	161	2		6	
13H 44	163	0		3		35H 44	163	0		10		51H 44	162	1		6	
13H 45	162	1		3		35H 45	163	0		11		51H 45	162	1		6	
13H 46	163	0		2		35H 46	163	0		13		51H 46	163	0		8	
13H 47	163	0		4		35H 47	163	0		13		51H 47	162	1		10	
TOTAL	7629	32	OK			TOTAL	7625	36	OK			TOTAL	7623	36	OK		
MAXIMUM 2% / GROUP		153				MAXIMUM 2% / GROUP		153				MAXIMUM 2% / GROUP		153			

MAXIMUM WIRES PER GROUP = 47 X 163 = 7661

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
HOOP TENDONS WIRE SUMMARY
UPDATED TO 5TH SURVEILLANCE

Originator: R. Chang Date: 05/23/94
Verifier: M.D. Marcellus Date: 05/23/94
SHEET 2 OF 3
FILE: HWIRE2.WK3

42HXX GROUP						46HXX GROUP						62HXX GROUP					
TENDON NO.	EFF WIRES	INEFF WIRES	IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 49 (%)	TENDON NO.	EFF WIRES	INEFF WIRES	IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 49 (%)	TENDON NO.	EFF WIRES	INEFF WIRES	IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	IF GREATER THAN 49 (%)
42H 1	160	3		8		46H 1	163	0		7		62H 1	162	1		11	
42H 2	160	3		5		46H 2	163	0		10		62H 2	163	0		12	
42H 3	163	0		2		46H 3	163	0		10		62H 3	163	0		12	
42H 4	162	1		3		46H 4	163	0		12		62H 4	161	2		12	
42H 5	163	0		3		46H 5	159	4		12		62H 5	159	4		10	
42H 6	163	0		3		46H 6	163	0		10		62H 6	163	0		8	
42H 7	162	1		3		46H 7	163	0		10		62H 7	162	1		6	
42H 8	163	0		2		46H 8	162	1		12		62H 8	161	2		5	
42H 9	163	0		2		46H 9	162	1		13		62H 9	163	0		3	
42H 10	163	0		2		46H 10	162	1		12		62H 10	162	1		5	
42H 11	163	0		2		46H 11	160	3		14		62H 11	161	2		5	
42H 12	163	0		3		46H 12	163	0		12		62H 12	163	0		4	
42H 13	162	1		4		46H 13	161	2		13		62H 13	163	0		4	
42H 14	162	1		4		46H 14	163	0		14		62H 14	163	0		4	
42H 15	163	0		3		46H 15	161	2		14		62H 15	163	0		4	
42H 16	163	0		3		46H 16	163	0		15		62H 16	163	0		6	
42H 17	163	0		3		46H 17	161	2		15		62H 17	163	0		6	
42H 18	163	0		3		46H 18	161	2		13		62H 18	163	0		6	
42H 19	163	0		3		46H 19	163	0		11		62H 19	161	2		6	
42H 20	163	0		3		46H 20	160	3		15		62H 20	162	1		5	
42H 21	162	1		3		46H 21	162	1		14		62H 21	162	1		4	
42H 22	162	1		2		46H 22	162	1		13		62H 22	163	0		3	
42H 23	162	1		1		46H 23	160	3		12		62H 23	163	0		3	
42H 24	163	0		0		46H 24	163	0		9		62H 24	163	0		4	
42H 25	163	0		3		46H 25	160	3		9		62H 25	161	2		5	
42H 26	163	0		4		46H 26	163	0		6		62H 26	163	0		4	
42H 27	163	0		4		46H 27	163	0		6		62H 27	163	0		4	
42H 28	163	0		4		46H 28	163	0		8		62H 28	163	0		5	
42H 29	163	0		4		46H 29	159	4		9		62H 29	162	1		5	
42H 30	163	0		4		46H 30	161	2		6		62H 30	163	0		5	
42H 31	163	0		5		46H 31	163	0		8		62H 31	163	0		5	
42H 32	163	0		6		46H 32	163	0		8		62H 32	163	0		5	
42H 33	163	0		6		46H 33	163	0		8		62H 33	162	1		5	
42H 34	160	3		6		46H 34	163	0		8		62H 34	162	1		6	
42H 35	162	1		3		46H 35	163	0		8		62H 35	162	1		5	
42H 36	163	0		2		46H 36	163	0		12		62H 36	163	0		5	
42H 37	163	0		2		46H 37	161	2		12		62H 37	162	1		5	
42H 38	163	0		5		46H 38	162	1		12		62H 38	163	0		7	
42H 39	163	0		8		46H 39	162	1		11		62H 39	162	1		8	
42H 40	162	1		11		46H 40	159	4		10		62H 40	163	0		7	
42H 41	162	1		10		46H 41	163	0		6		62H 41	163	0		7	
42H 42	163	0		10		46H 42	163	0		6		62H 42	163	0		9	
42H 43	163	0		10		46H 43	163	0		10		62H 43	161	2		13	
42H 44	163	0		10		46H 44	163	0		10		62H 44	163	0		11	
42H 45	163	0		11		46H 45	159	4		10		62H 45	162	1		12	
42H 46	163	0		11		46H 46	163	0		7		62H 46	163	0		13	
42H 47	160	3		11		46H 47	161	2		8		62H 47	160	3		13	
TOTAL	7636	22	OK			TOTAL	7612	49	OK			TOTAL	7630	31	OK		
MAXIMUM 2% / GROUP		153				MAXIMUM 2% / GROUP		153				MAXIMUM 2% / GROUP		153			

MAXIMUM WIRES PER GROUP = 47 X 163 = 7661

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
VERTICAL TENDONS WIRE SUMMARY
UPDATED TO 5TH SURVEILLANCE

Originator: R. Chang Date: 05/23/94

Verifier: M.D. Marcellus Date: 05/23/94

SHEET 1 OF 2

FILE: VWIRE1WK3

QUADRANT 1 (30° TO 120°)						QUADRANT 2 (300° TO 30°)					
TENDON NO.	EFF. WIRES	INEFF. WIRES	* IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	* IF GREATER THAN 49 (3%)	TENDON NO.	EFF. WIRES	INEFF. WIRES	* IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	* IF GREATER THAN 49 (3%)
23V 1	163	0		0		12V 13	162	1		16	
23V 2	163	0		0		12V 14	163	0		18	
23V 3	163	0		0		12V 15	159	4		19	
23V 4	163	0		0		12V 16	163	0		17	
23V 5	163	0		0		12V 17	160	3		21	
23V 6	163	0		4		12V 18	163	0		18	
23V 7	163	0		4		12V 19	160	3		18	
23V 8	163	0		5		12V 20	163	0		18	
23V 9	163	0		6		12V 21	160	3		18	
23V 10	163	0		6		12V 22	161	2		15	
23V 11	163	0		8		12V 23	160	3		13	
23V 12	163	0		8		12V 24	162	1		10	
23V 13	163	0		8		61V 1	161	2		9	
23V 14	163	0		8		61V 2	159	4		10	
23V 15	159	4		8		61V 3	163	0		6	
23V 16	163	0		4		61V 4	163	0		6	
23V 17	162	1		4		61V 5	160	3		7	
23V 18	162	1		3		61V 6	163	0		7	
23V 19	163	0		3		61V 7	163	0		7	
23V 20	161	2		3		61V 8	163	0		8	
23V 21	163	0		3		61V 9	163	0		8	
23V 22	163	0		4		61V 10	163	0		8	
23V 23	163	0		4		61V 11	160	3		8	
23V 24	163	0		4		61V 12	163	0		5	
12V 1	163	0		4		61V 13	163	0		5	
12V 2	163	0		7		61V 14	162	1		5	
12V 3	163	0		7		61V 15	160	3		4	
12V 4	162	1		7		61V 16	163	0		2	
12V 5	163	0		6		61V 17	162	1		2	
12V 6	161	2		6		61V 18	163	0		5	
12V 7	162	1		4		61V 19	163	0		5	
12V 8	163	0		3		61V 20	163	0		8	
12V 9	163	0		3		61V 21	163	0		8	
12V 10	163	0		3		61V 22	163	0		11	
12V 11	160	3		3		61V 23	163	0		11	
12V 12	163	0		0		61V 24	163	0		14	
TOTAL	5853	15	OK			TOTAL	5831	37	OK		
MAXIMUM 2% / GROUP		117				MAXIMUM 2% / GROUP		117			

MAXIMUM WIRES PER GROUP = 36 X 163 = 5868

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
VERTICAL TENDONS WIRE SUMMARY
UPDATED TO 5TH SURVEILLANCE

Originator: R. Chang Date: 05/23/94
Verifier: M.D. Marcellus Date: 05/23/94
SHEET 2 OF 2
FILE: VWIRE2.WK3

QUADRANT 3 (210° TO 300°)						QUADRANT 4 (120° TO 210°)					
TENDON NO.	EFF. WIRES	INEFF. WIRES	* IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	* IF GREATER THAN 49 (3%)	TENDON NO.	EFF. WIRES	INEFF. WIRES	* IF GREATER THAN 8	TOTAL INEFF. WIRES IN NEXT 10 TENDONS	* IF GREATER THAN 49 (3%)
56V 1	162	1		10		45V 13	163	0		4	
56V 2	162	1		9		45V 14	163	0		4	
56V 3	163	0		8		45V 15	163	0		5	
56V 4	162	1		9		45V 16	163	0		5	
56V 5	162	1		8		45V 17	163	0		6	
56V 6	162	1		10		45V 18	163	0		9	
56V 7	161	2		11		45V 19	163	0		12	
56V 8	161	2		9		45V 20	161	2		12	
56V 9	162	1		7		45V 21	162	1		10	
56V 10	163	0		9		45V 22	162	1		9	
56V 11	163	0		9		45V 23	163	0		10	
56V 12	163	0		11		45V 24	162	1		10	
56V 13	162	1		13		34V 1	163	0		9	
56V 14	163	0		12		34V 2	162	1		9	
56V 15	160	3		12		34V 3	160	3		9	
56V 16	161	2		11		34V 4	160	3		10	
56V 17	163	0		9		34V 5	163	0		8	
56V 18	163	0		10		34V 6	163	0		9	
56V 19	160	3		11		34V 7	163	0		11	
56V 20	163	0		8		34V 8	161	2		11	
56V 21	161	2		9		34V 9	163	0		9	
56V 22	161	2		13		34V 10	163	0		13	
56V 23	163	0		11		34V 11	163	0		13	
56V 24	163	0		11		34V 12	162	1		14	
45V 1	161	2		13		34V 13	159	4		13	
45V 2	163	0		11		34V 14	162	1		9	
45V 3	162	1		11		34V 15	162	1		9	
45V 4	162	1		11		34V 16	161	2		8	
45V 5	163	0		11		34V 17	163	0		6	
45V 6	162	1		11		34V 18	163	0		6	
45V 7	157	6		11		34V 19	159	4		6	
45V 8	163	0		6		34V 20	163	0		2	
45V 9	163	0		7		34V 21	162	1		2	
45V 10	161	2		9		34V 22	163	0		1	
45V 11	163	0		9		34V 23	163	0		3	
45V 12	163	0		10		34V 24	162	1		4	
TOTAL		5832	36	OK		TOTAL		5839	29	OK	
MAXIMUM 2% / GROUP			117			MAXIMUM 2% / GROUP			117		

MAXIMUM WIRES PER GROUP = 36 X 163 = 5868

APPENDIX D
EVALUATION OF REPLACED BULK FILLER

The Crystal River Unit No. 3 (CR3) Surveillance Procedure SP-182, Reactor Building Structural Integrity Tendon Surveillance Program, requires the quantity of removed and replaced bulk filler grease (grease) to be recorded. An engineering evaluation is required when the difference between removed and replaced grease exceeds 4 gallons, (Reference Enclosure Data Sheet 12, SP-182). During the 17th year surveillance which began in November 1993, all 14 of the surveillance tendons exceeded this 4 gallon limit. Furthermore, this exceedance has also occurred in prior tendon surveillance periods.

The purpose of collecting data on the quantity of removed and replaced grease has its background in proposed revisions to Regulatory Guide 1.35 and in ongoing ASME/ACI Committee activity. The issuance of Regulatory Guide 1.35, Revision 3, in July 1990, has formalized the requirement for the amount of grease replaced as a reportable condition when the amount exceeds 5% of the net duct volume.

The essential function of the grease is to prevent corrosion of both the tendon wires and the anchorage components. The material used in the CR3 tendon system, Visconorust 2090 P-2/P-4, accomplishes this by a characteristic which gives the filler material an affinity to adhere to steel surfaces, its ability to emulsify any moisture in the system which nullifies its rusting tendency, and by its resistance to moisture, mild acids, and alkalis. In addition, protection is afforded by each tendon wire being individually coated with a heavy wax base corrosion inhibitor in the tendon fabricating shop.

This coating is chemically absorbed on the surface of the wire and cannot be removed by any mechanical means which does not also remove the surface of the steel wire.

As indicated by the quantity of grease replaced, the voids in the tendon sheathing varied from 9.8% to 30.5%, and averaged 16.7% for the 14 surveillance tendons. The individual tendon results are given in Table D-1.

TABLE D-1
TENDON SURVEILLANCE GREASING SUMMARY

<u>TENDON</u>	<u>NET DUCT VOLUME (GAL.)</u>	<u>NET GREASE ADDED (GAL.)</u>	<u>% GREASE ADDED</u>
D215	111.8	32.0	28.6
D224	111.8	13.0	11.6
D231	111.8	11.0	9.8
34V6	135.9	41.5	30.5
56V15	135.9	20.0	17.4
61V14	135.9	18.0	15.6
35H1	115.2	20.0	17.4
42H1	115.2	20.0	17.4
46H21	115.2	15.0	13.0
46H28	115.2	15.5	13.4
46H29	115.2	15.0	13.0
46H30	115.2	13.0	11.3
46H47	115.2	20.0	17.4
62H8	115.2	20.0	17.4
		Average	16.7

Contributing to the indicated voids may be a number of factors:

1. The grease has a coefficient of expansion which yields an expansion of about 1% per every 20° F change in temperature. Initial filling temperature of the grease averaged 140° F. During the subject tendon surveillance the ambient temperature of insitu grease was about 80° F, giving a contraction of about 3% from initial fill.
2. Calculated voids between the wires which comprise the tendon bundle are approximately 3% to 4% of the net duct volume. During the initial filling operation the tendon bundle was at ambient temperature. As the heated grease was pumped into the sheathing it solidified on the surface of the tendon bundle, leaving small voids between the wires. As the grease gradually heated the tendon bundled wires it is likely that the voids between the wires allowed migration of the grease into the tendon bundle. Because this process is slow and gradual, it is reasonable to expect that it took place substantially after the filling operation was complete and possibly during the surveillance refill operation. This type of migration could also occur at other areas, such as where tendons are in contact with the sheathing.
3. During the initial grease filling operation pumping operations may have introduced air into the grease. This may amount to as much as 2% of the net duct volume.

Thus it has been demonstrated that under optimum filling operations voids ranging from 8 to 9% could be expected after the initial filling operation.

The tendons at CR3 were initially greased between late 1974 and early 1975 using current industry standard filling procedures. It was not required to record the amount of grease used for each tendon. Tendon fill was accomplished by the pumping of grease through the tendon sheath and exiting the other end.

During the past four surveillances and during this surveillance, the reactor building has been inspected with no sign of grease seepage from the tendon duct. Additionally there have been no reported instances of grease seepage on/from the reactor building. Therefore, it is concluded that the voids existed within the tendon duct boundary.

The CR3 tendons requiring net refill volumes of the grease in excess of the 4 gallon criteria or the 5% net duct volume criteria have not shown any abnormal deterioration or degradation of strength. The lift off forces for those tendons are within the acceptable range. Examination and testing of the individual wires from detensioned tendons has revealed that there is no evidence of corrosion and that wire strength exceeds the minimum required ultimate strength throughout the wires. Examination of the grease has shown virtually no change in the physical appearance or chemical properties. Test results indicate that the amount of chlorides, sulfides, nitrates, and moisture fall far below the maximum allowed limits. Visual inspection of the grease protected components of the anchorage system revealed proper coverage by the grease with no sign of new corrosion or presence of water.

As indicated by the test results, the function of the grease in protecting the post-tensioning system is being maintained. Voids can be expected due to the characteristics of the filler material and initial filling operations as previously noted. Since each wire has individual pre-coated, the degree of filling interstitial spaces, which compromise the net duct volume, is not directly related to the degree of coating which occurs. Based on physical tests on the tendon wires and chemical tests of the grease, there seems to be little correlation between the 5% maximum void requirement and the structural integrity of the tendon and anchorage system.

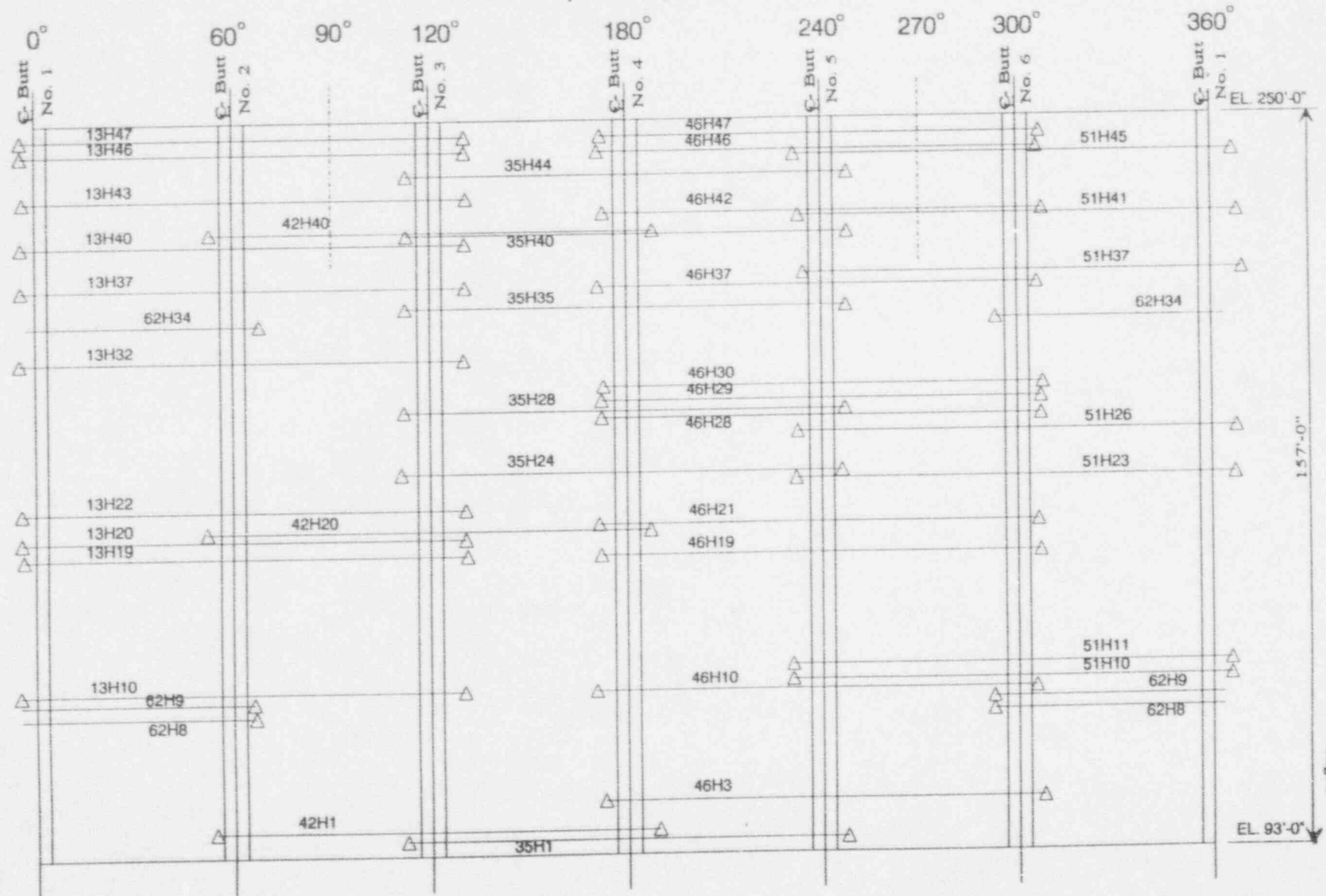
Based on the above discussion, it is obvious that CR3 cannot meet the grease replacement criteria to be less than 5% of the net duct volume. The corrosion protection system is functioning as designed and maintaining the structural integrity of the system. Future surveillances will continue to monitor the tendons against the 5% criteria as required by the Regulatory guide and will also include building inspections for leaking grease and other problems.

APPENDIX E
LOCATION PLOTS OF HOOP TENDONS
INSPECTED IN ALL SURVEILLANCES

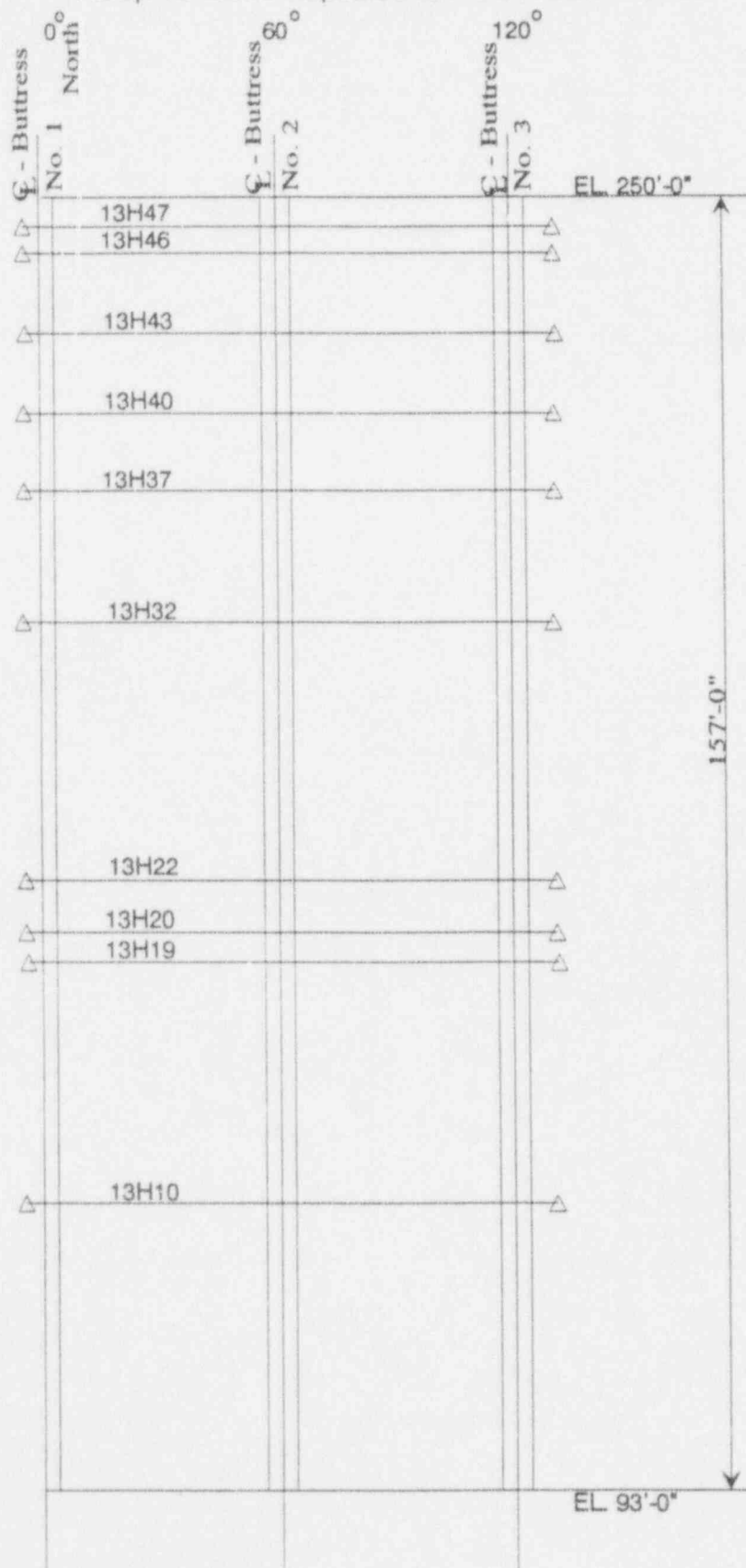
Note

A total of 40 tendons are shown on the attached plots. While there has been 43 hoop tendon inspections to date, 3 were repeated.

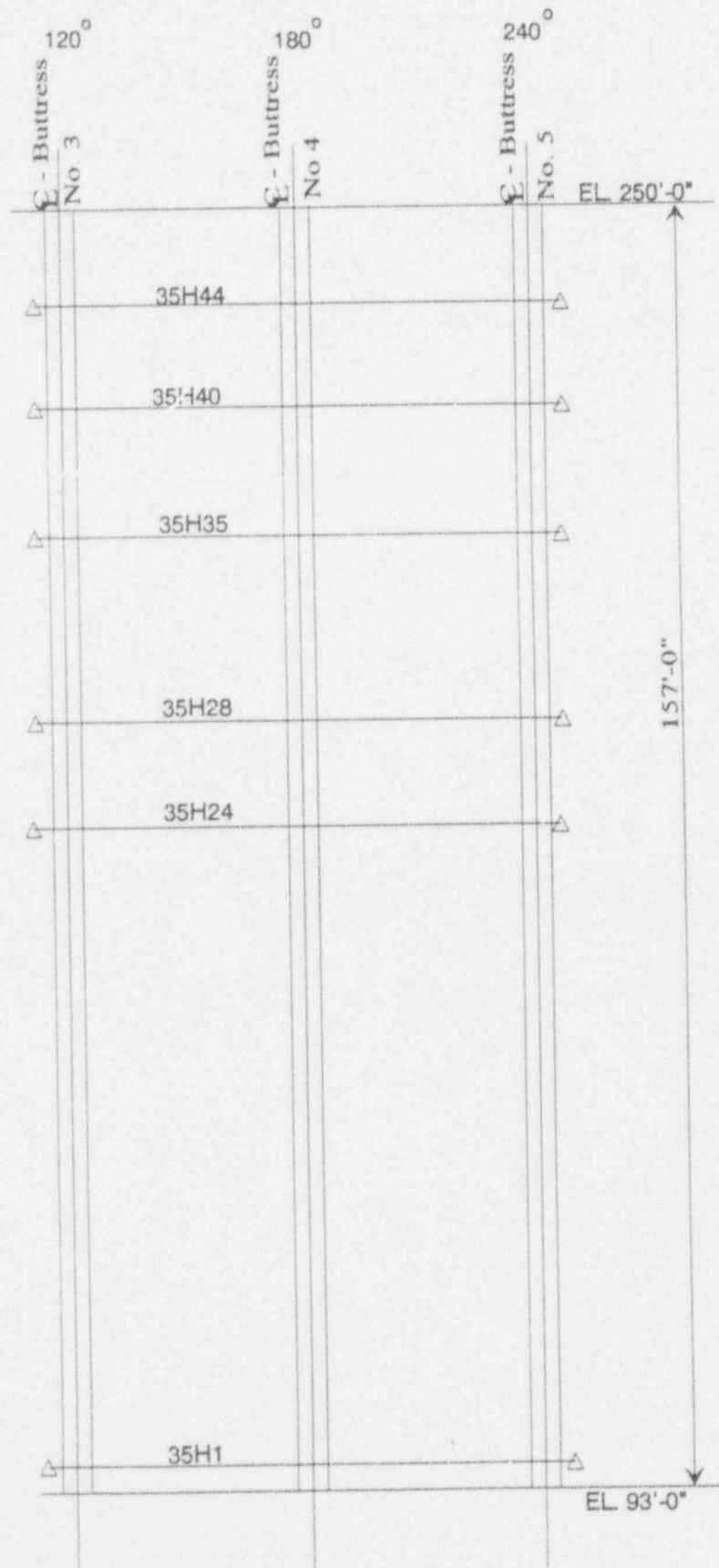
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Layout
Tendons Inspected up to 5th Surveillance



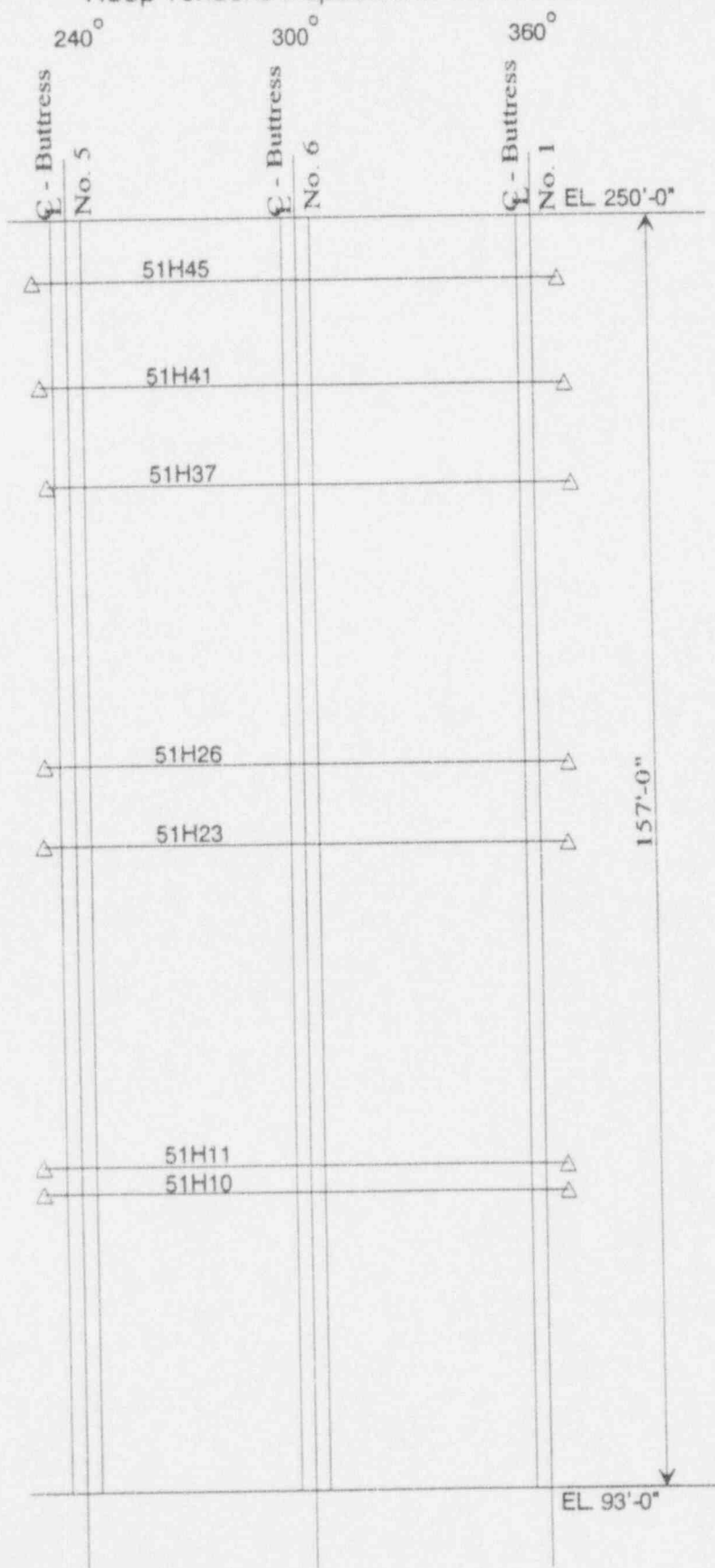
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



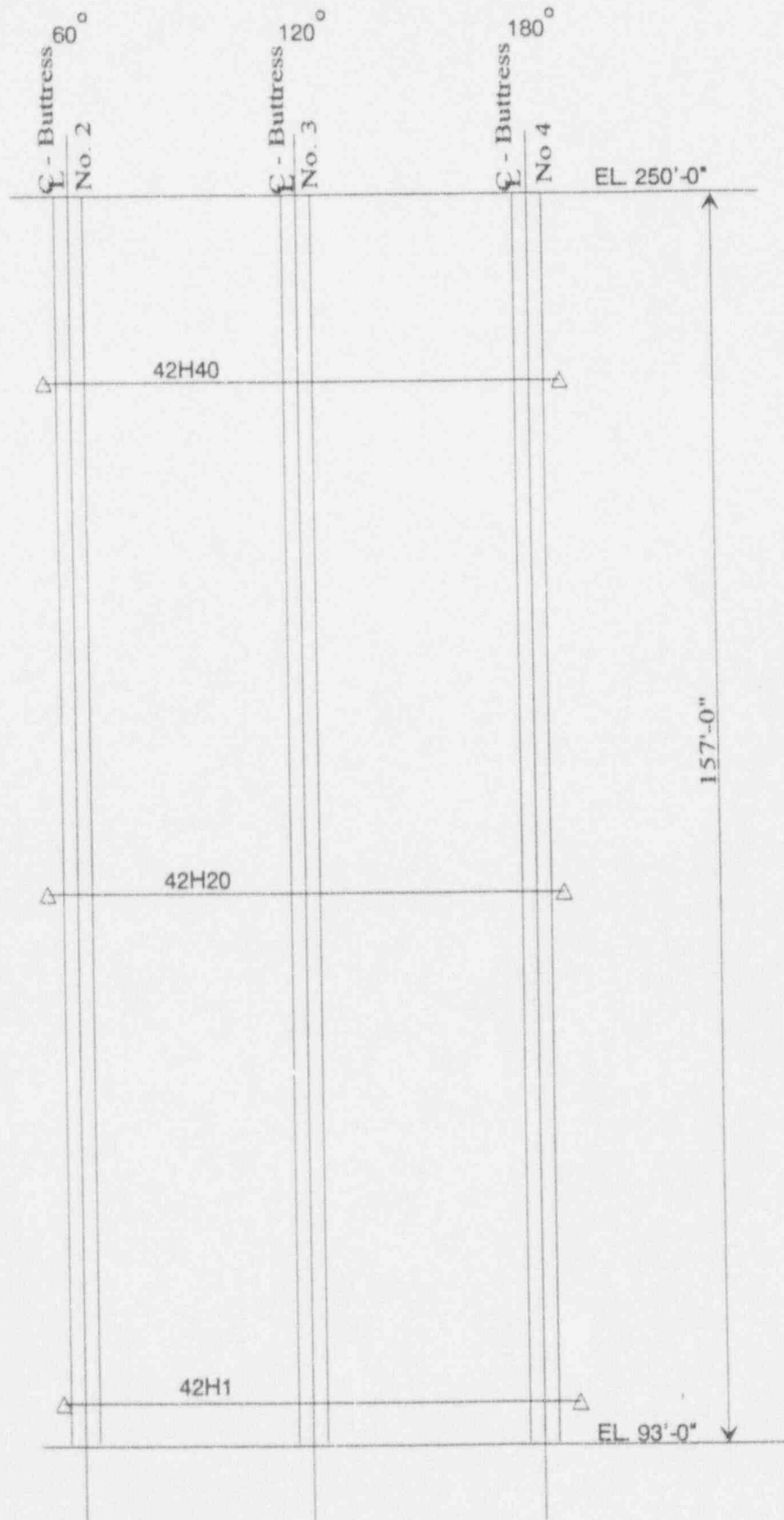
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



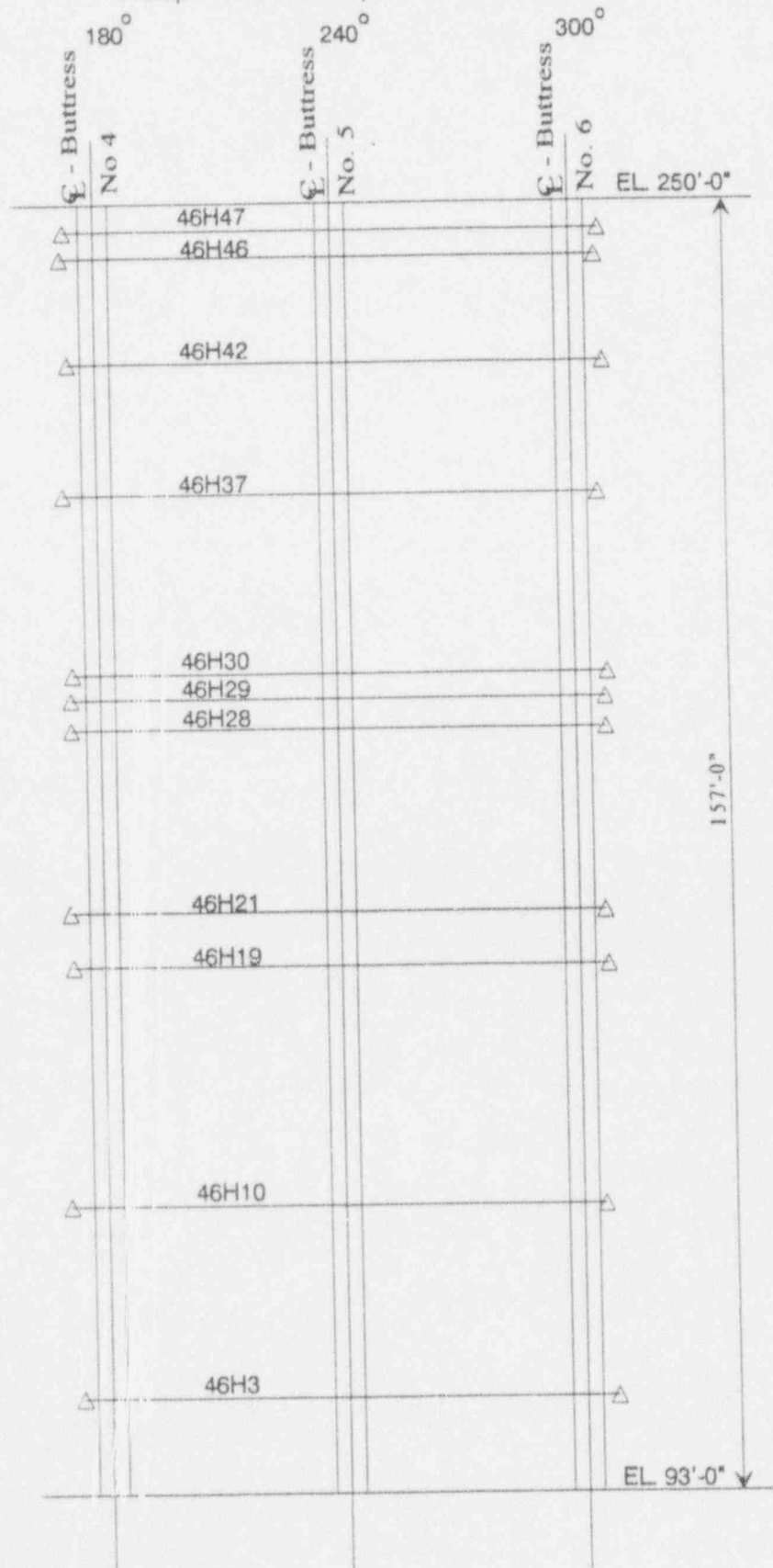
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



Crystal River Unit #3
Tendon Surveillance program
Hoop Tendons Inspected to the 5th Surveillance

