FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
TENDON SURVEILLANCE PROGRAM

# ENGINEERING EVALUATION REPORT FOR THE FIFTH TENDON SURVEILLANCE INSPECTION PERIOD

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Report Date: 20 JUNE 1994

Gilbert/Commonwealth
Reading, Pa.

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# 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 cf 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 to 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:

| DOME | HOOP | VERTICAL |
|---|---|---|
| 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:

<u>HOOP</u>
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 breech 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 shims 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:

| CATEGORY | | DESCRIPTION |
|---|---|---|
| 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
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| 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 | 1515 | 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.

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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.

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

23-May-94
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| Tendon Number | Average Liftoff (Kips) | Field End Force (Kips) | Field End Ram No. | Shop End Force (Kips) | Shop End Ram No. | Date | Difference at Ends \|3-4\| (Kips) | % Difference Of Average \|(3-4)/2\| |
|---|---|---|---|---|---|---|---|---|
| 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 | 1468 | 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.

File: LIFTOFF5.WK3

## 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:

| Tendon Group | Required Minimum Design Prestress Force Average |
|---|---|
| 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:

| Tendon | Surveillance | % below |
|---|---|---|
| 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.)

| Group | Above RG 95% Base Lower Limit | Above Tech. Spec. Lower limit |
|---|---|---|
| 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 | REV -- | | REV -- | | REV 4 | | REV 7 | | REV 10 & 11 | | |
| G/C REPORT | 3/78 | | 5/80 | | 5/19/82 | | 3/10/88 | | 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 | | | | | | |
| TOTAL TENDONS = 549 | 46H46 | | 46H42 | | 46H10 | D | | | | | |
| TOTAL INSPECTED | 23 | | 22 | | 21 | | 11 | | 14 | | 91 TOTAL INSPECTED |
| LEGEND - | A, ALTERNATE | | C, CONTROL | | D, DETENSIONED | | R, REPEATED | | ADJ., ADJACENT | | FILE-CR3R5TSP.WK1 |

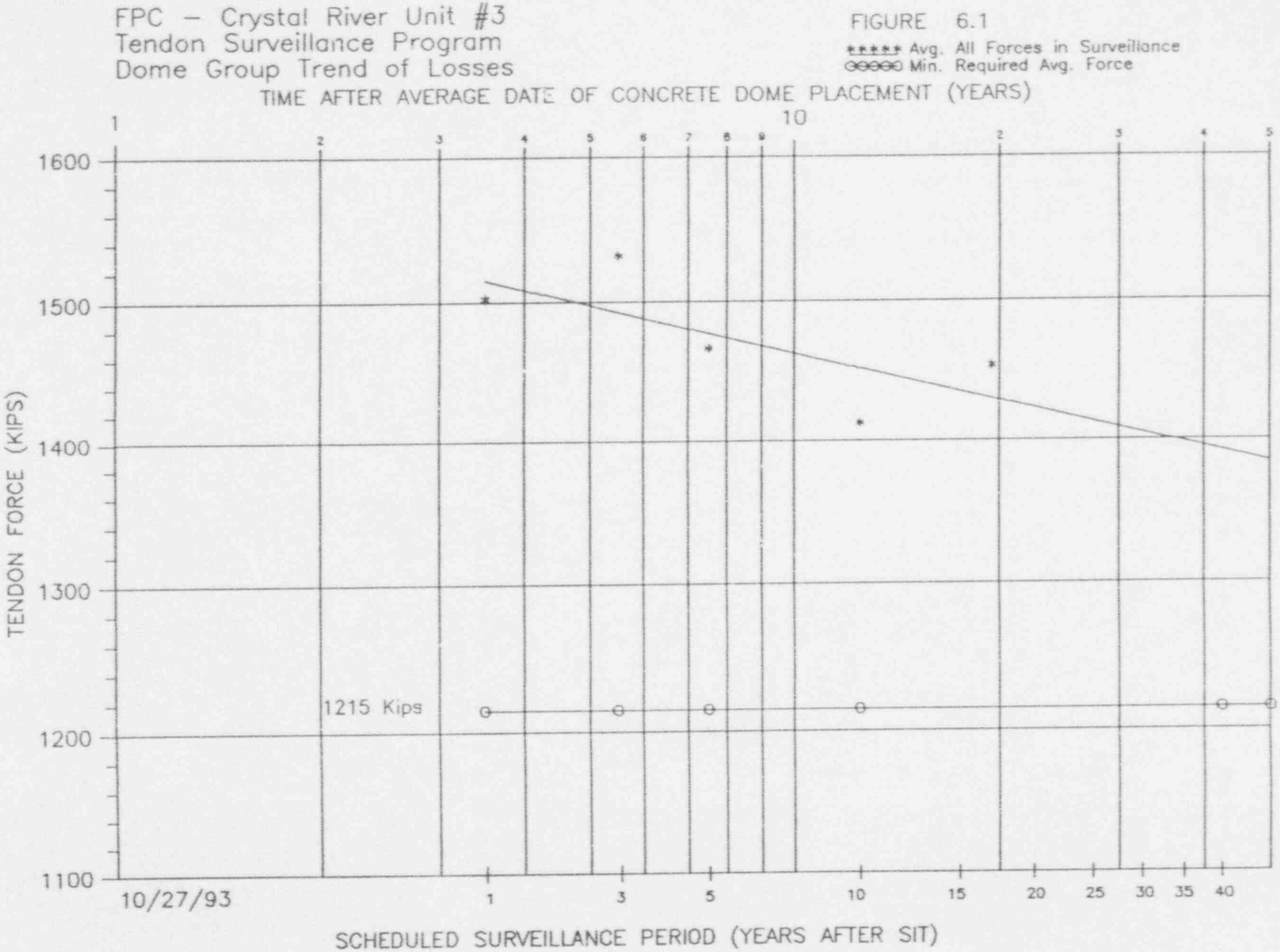
# TABLE 6.1
## SUMMARY OF DOME TENDON FORCES THROUGH FIFTH SURVEILLANCE
### SORTED BY SURVEILLANCE NO. / TENDON NO.

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.)

File: DOME5.WK3


FPC – Crystal River Unit #3
Tendon Surveillance Program
Dome Group Trend of Losses
FIGURE 6.1
***** Avg. All Forces in Surveillance
ooooo Min. Required Avg. Force
TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE (KIPS)
1215 Kips
10/27/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

20-Jun-94
11:04:01 AM

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

| 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 | 2.0 | 17.2 | -20 | 1444 | 1252 |
| 51H11 | 1615 | 1474 | 1 | 1363 | 1249 | 8.1 | 18.0 | 58 | 1532 | 1252 |
| 62H9 | 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 | |

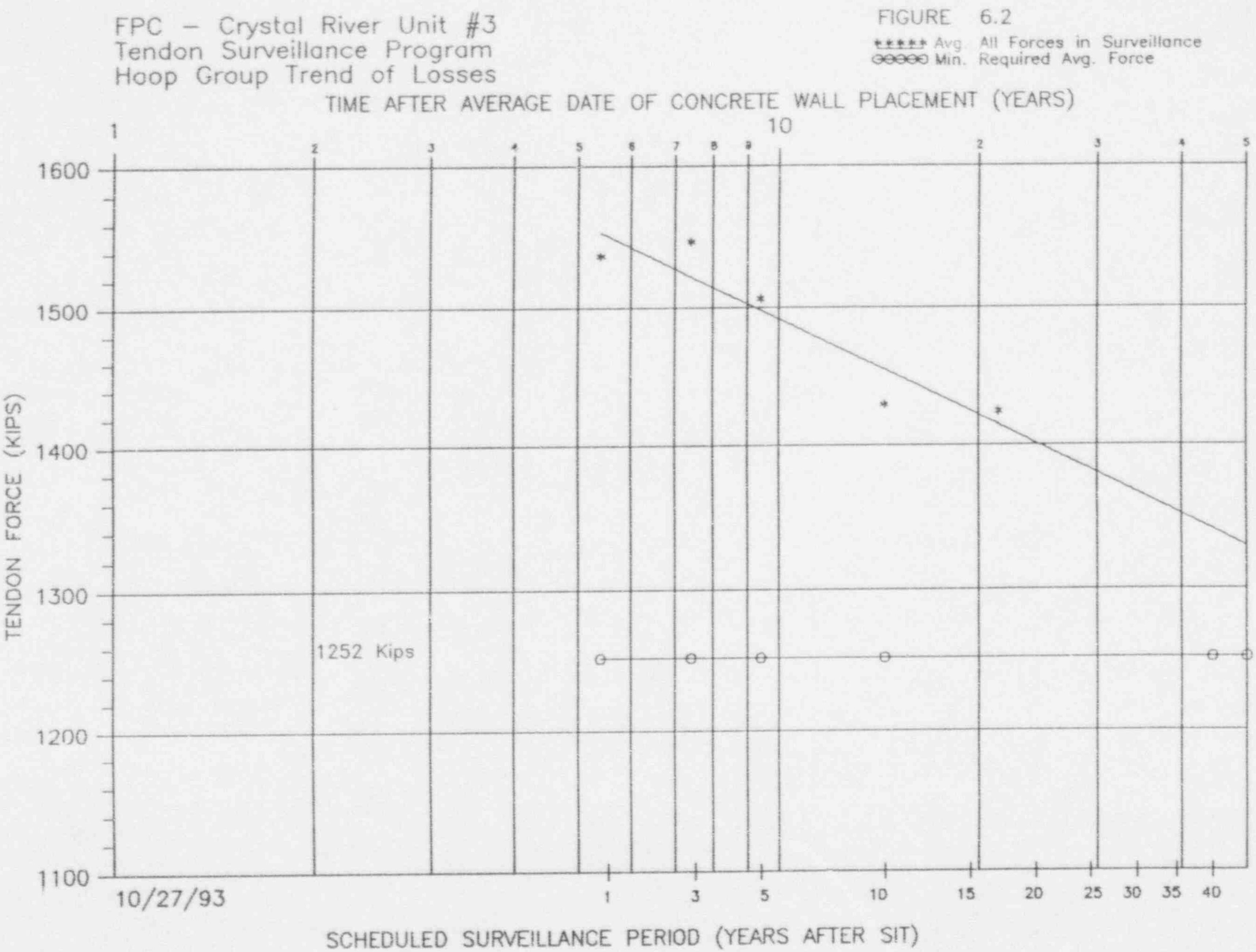
## TABLE 6.2
## SUMMARY OF HOOP TENDON FORCES THROUGH FIFTH SURVEILLANCE
### SORTED BY SURVEILLANCE NO. / TENDON NO.

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.)

File: HOOP5.WK3


FPC – Crystal River Unit #3
Tendon Surveillance Program
Hoop Group Trend of Losses
FIGURE 6.2
***** Avg. All Forces in Surveillance
ooooo Min. Required Avg. Force
TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
1
10
2
3
4
5
6
7
8
9
2
3
4
5
1600
1500
1400
1300
1200
1100
TENDON FORCE (KIPS)
1252 Kips
10/27/93
1
3
5
10
15
20
25
30
35
40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

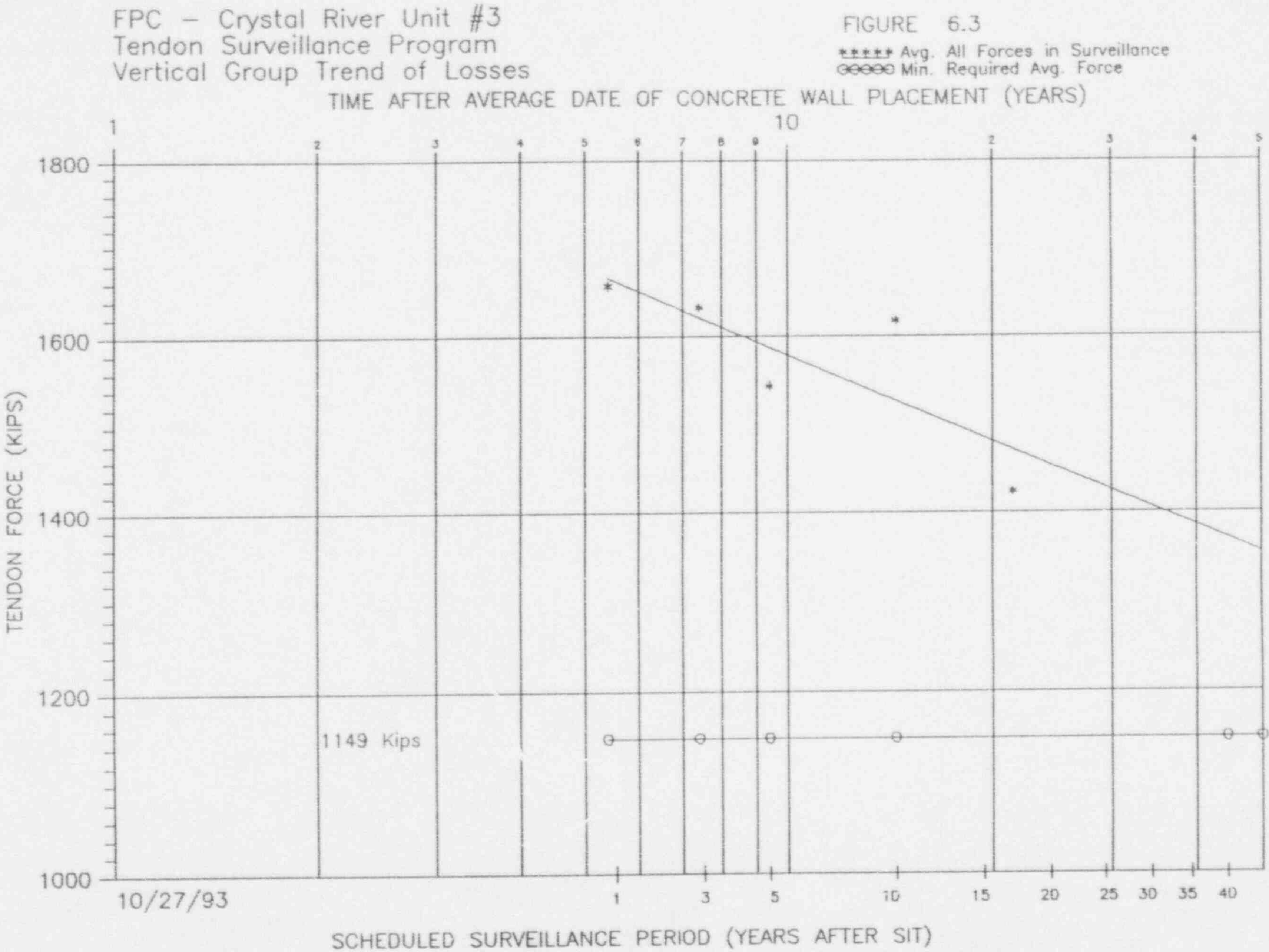
## TABLE 6.3
## SUMMARY OF VERTICAL TENDON FORCES THROUGH FIFTH SURVEILLANCE
### SORTED BY SURVEILLANCE NO. / TENDON NO.

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.)

File: VER5.WK3


FPC - Crystal River Unit #3
Tendon Surveillance Program
Vertical Group Trend of Losses
FIGURE 6.3
***** Avg. All Forces in Surveillance
OOOOO Min. Required Avg. Force
TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE (KIPS)
1149 Kips
10/27/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

## 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:

| Tendon | Elongation |
|---|---|
| 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 spall 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:

| | Acceptance Criteria |
|---|---|
| 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:

| Grease Type | Minimum Installed R.A. Value | Acceptable R.A. Value |
|---|---|---|
| 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. FPC 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*

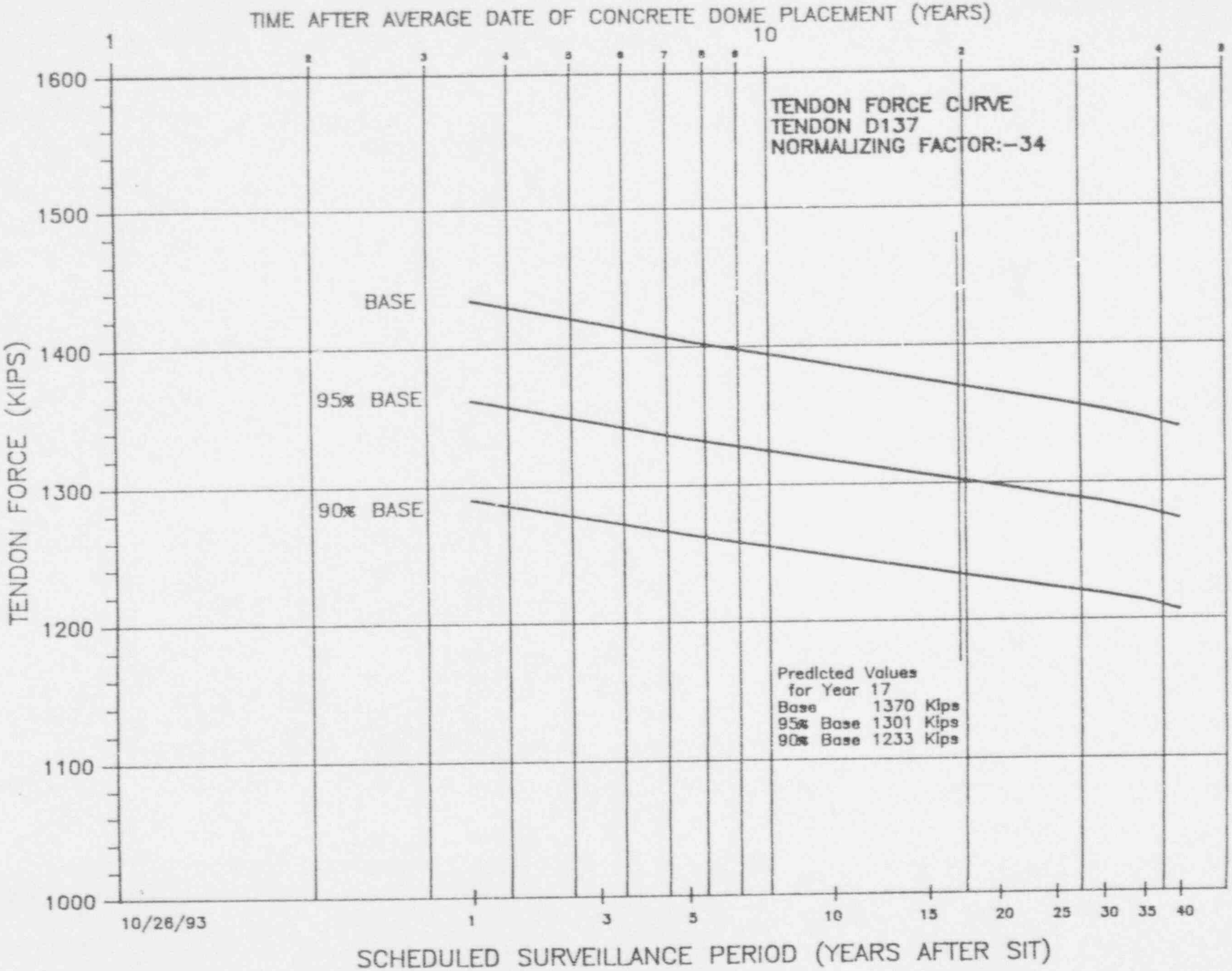
*FOR THE FIFTH TENDON SURVEILLANCE*

<u>Notes</u> -

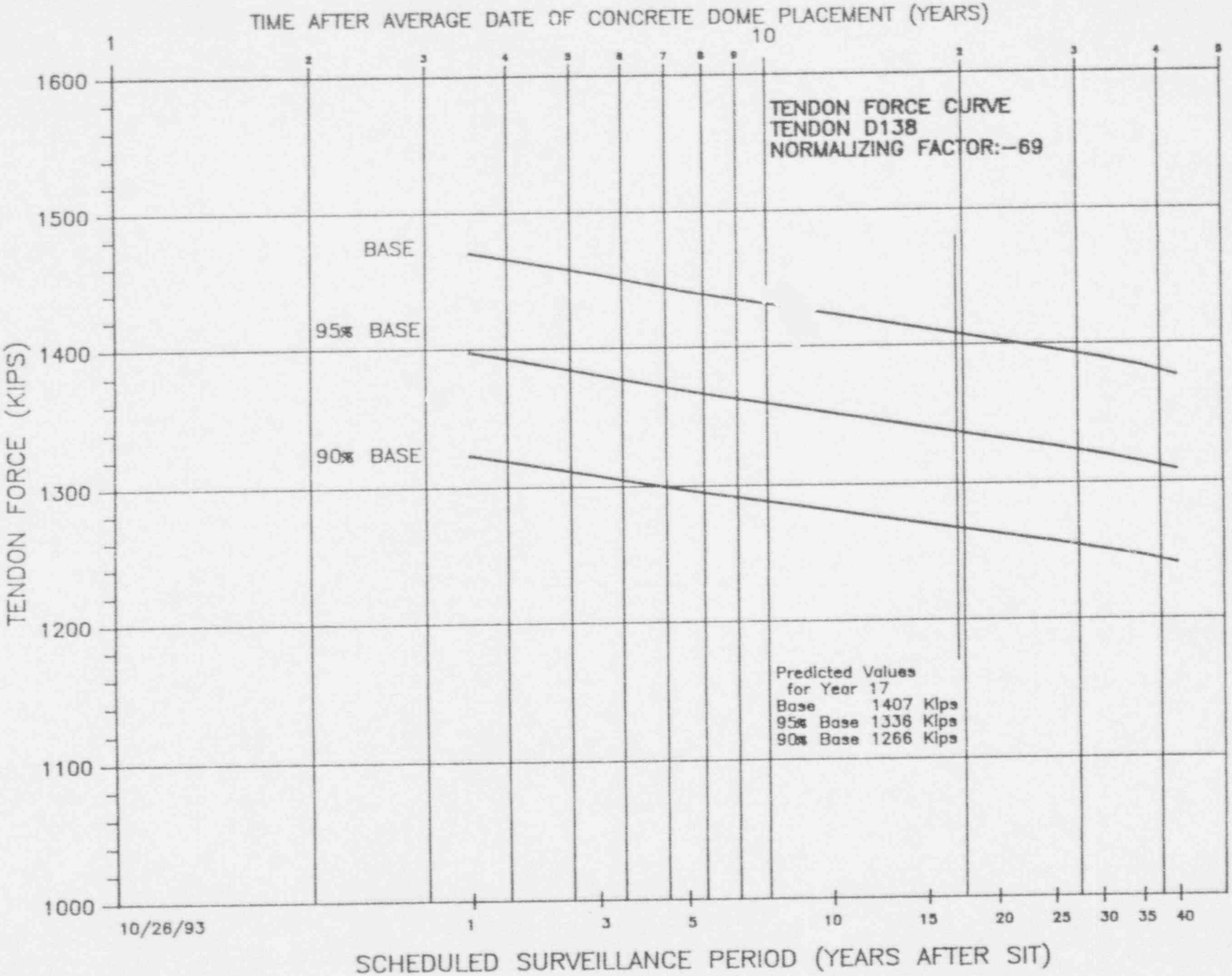
1. Normalization factors on two of the original prepared force curves were in error with the wrong number presented in Revision 11 of SP-182 and in the current VSL Report. Corrections were made in the following curves and in a corrected version of Enclosure 41 contained in Appendix B. Curves affected include 42H1, 62H7 and 62H8.

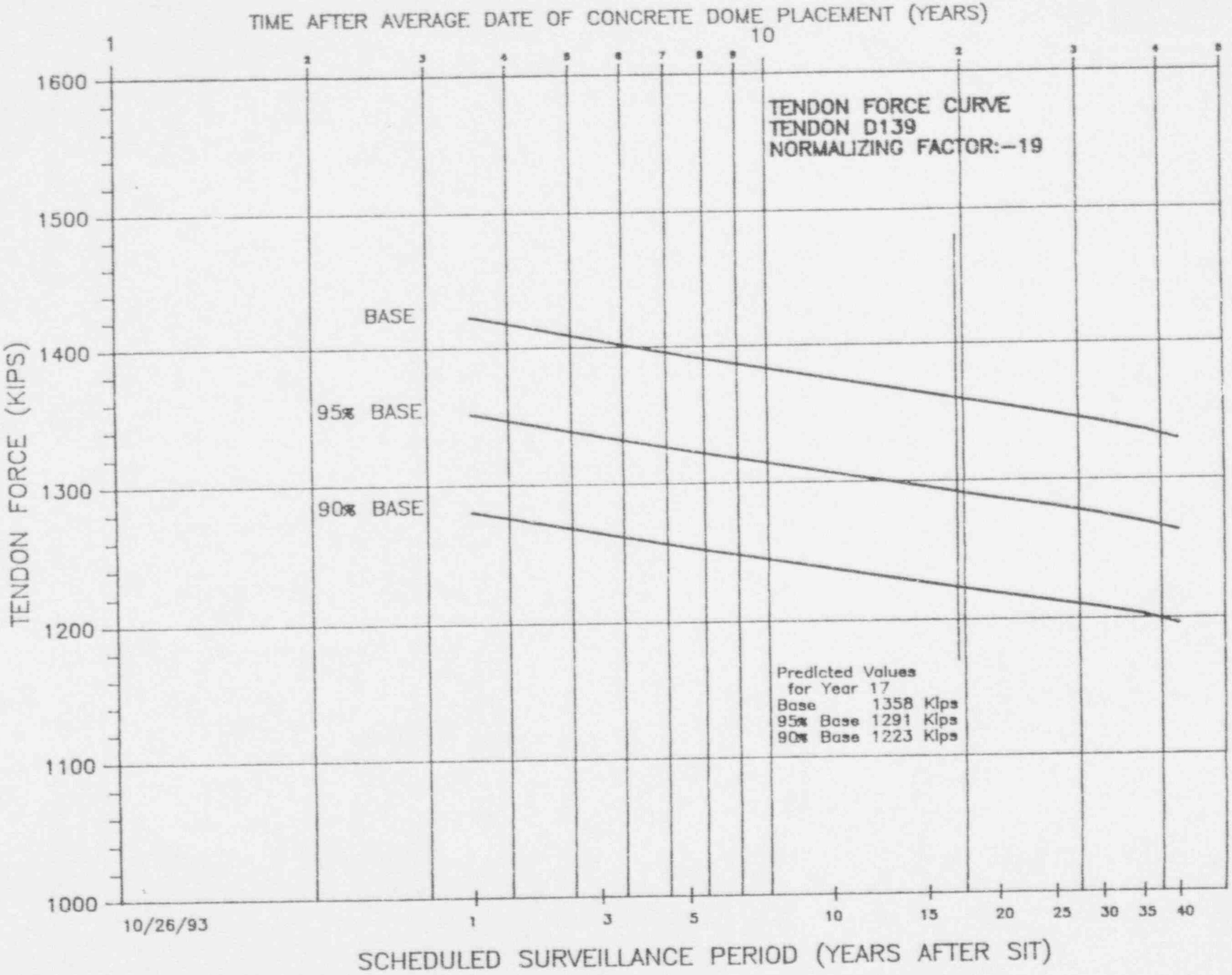
2. Tendon 46H21 was added to the scope of tendons to be inspected during this fifth surveillance. The force curve was not included in SP-182 but was prepared separately and is attached in this Appendix.

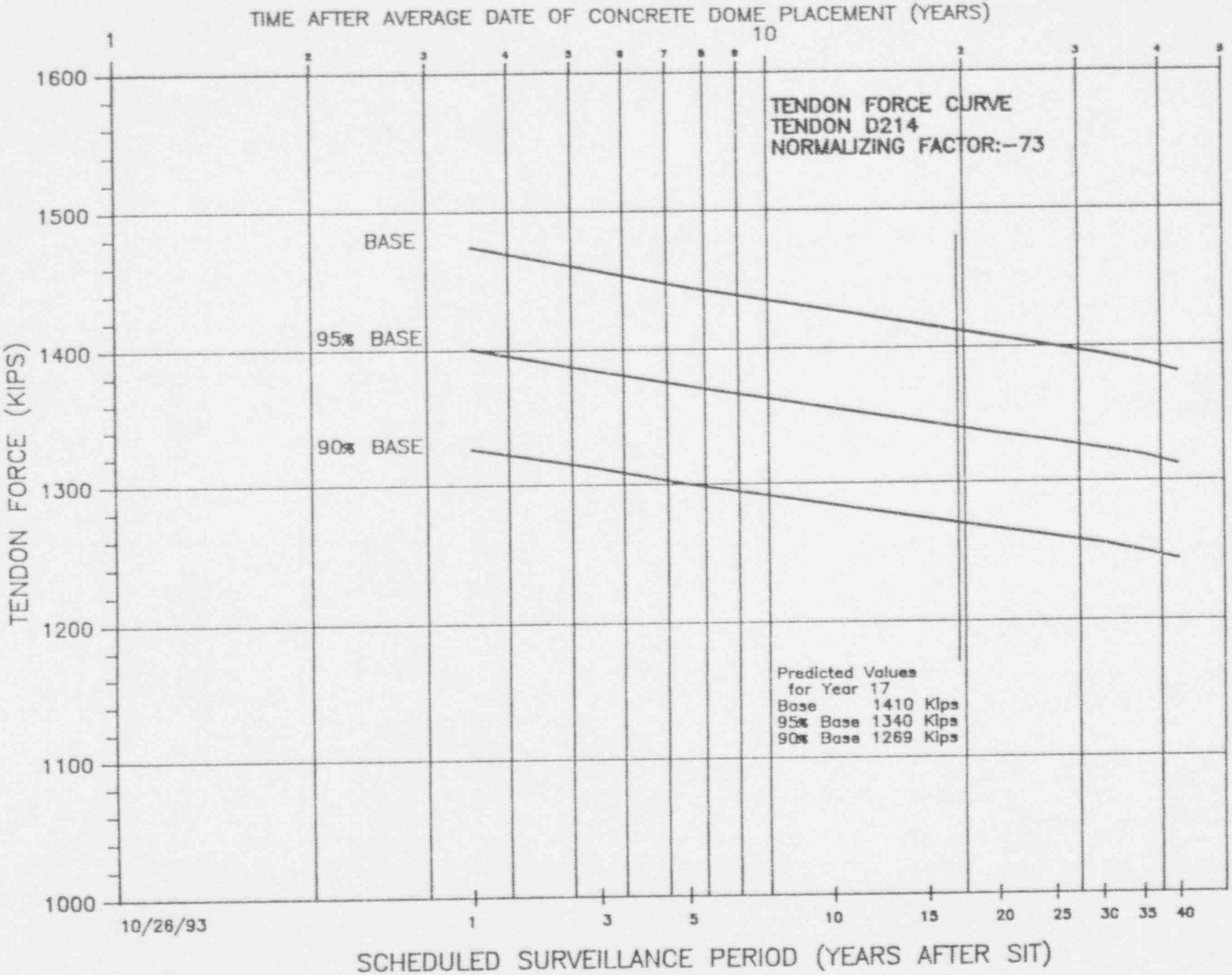
3. A second force curve for tendon 46H29 was prepared and is attached. The original curve represented a full 163 wire tendon. The second curve was prepared and represents a 159 wire tendon, since one wire was removed and three wires were broken.

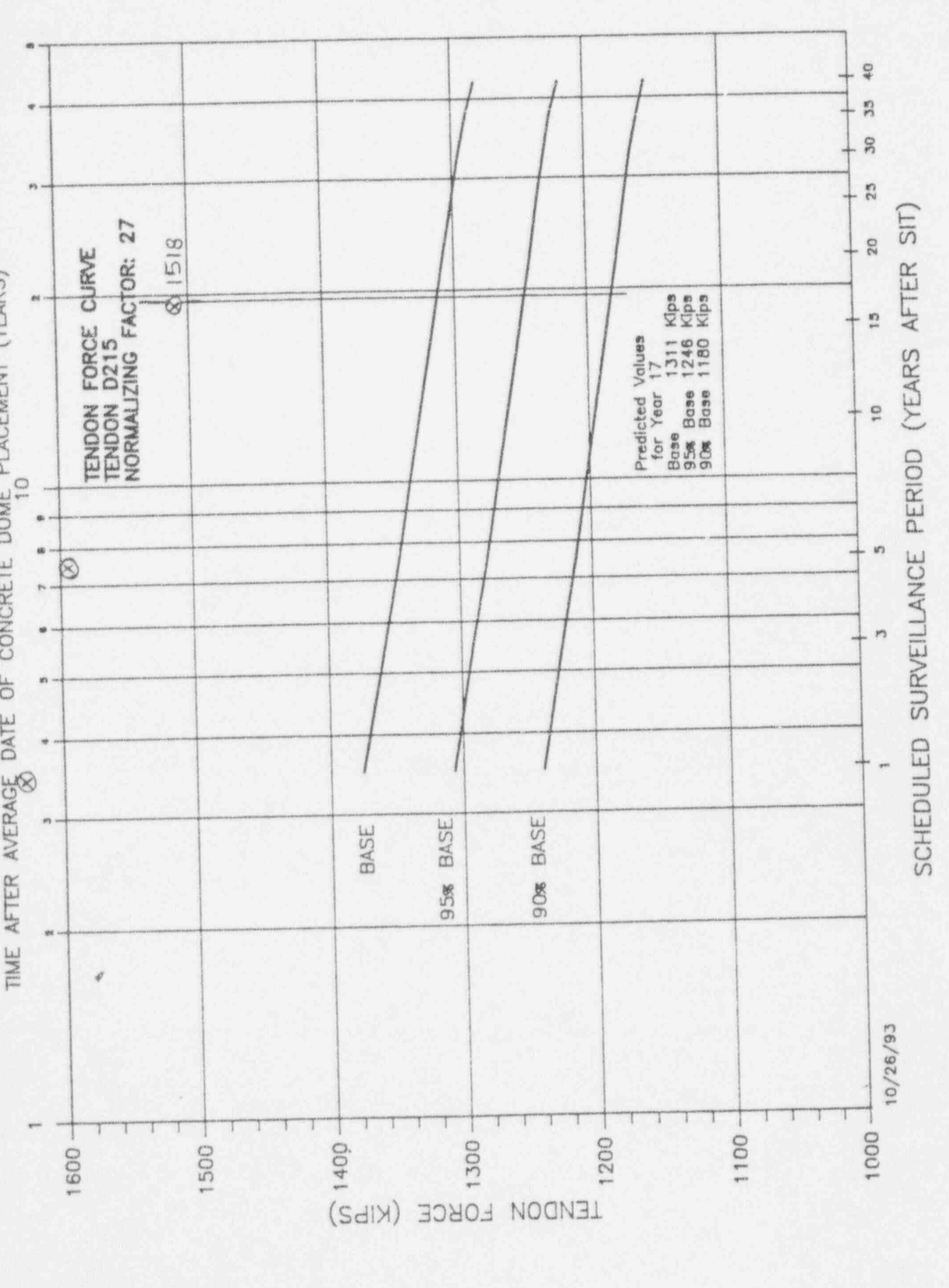


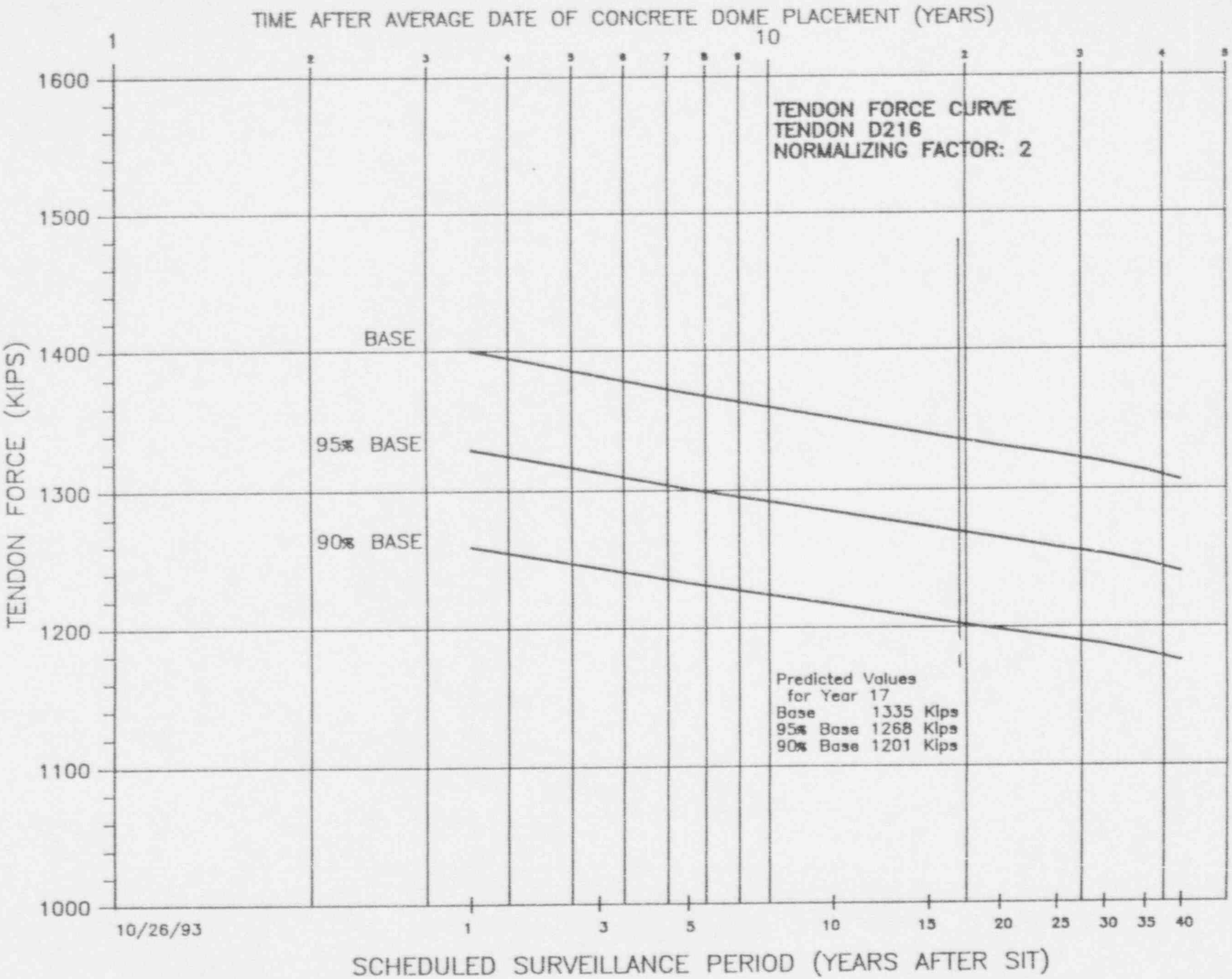
TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D137
NORMALIZING FACTOR:-34
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1370 Kips
95% Base 1301 Kips
90% Base 1233 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

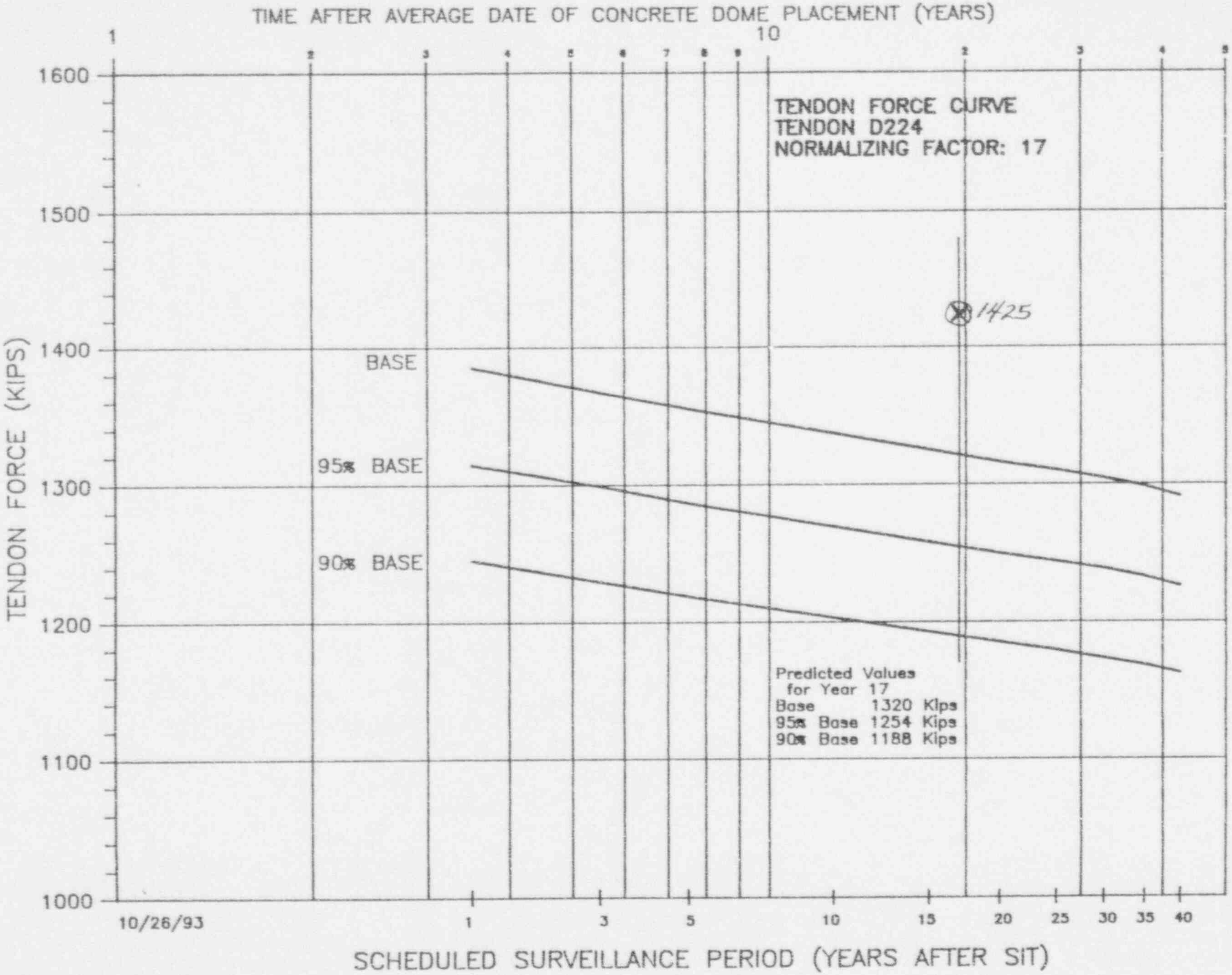

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D138
NORMALIZING FACTOR:-69
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1407 Kips
95% Base 1336 Kips
90% Base 1266 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

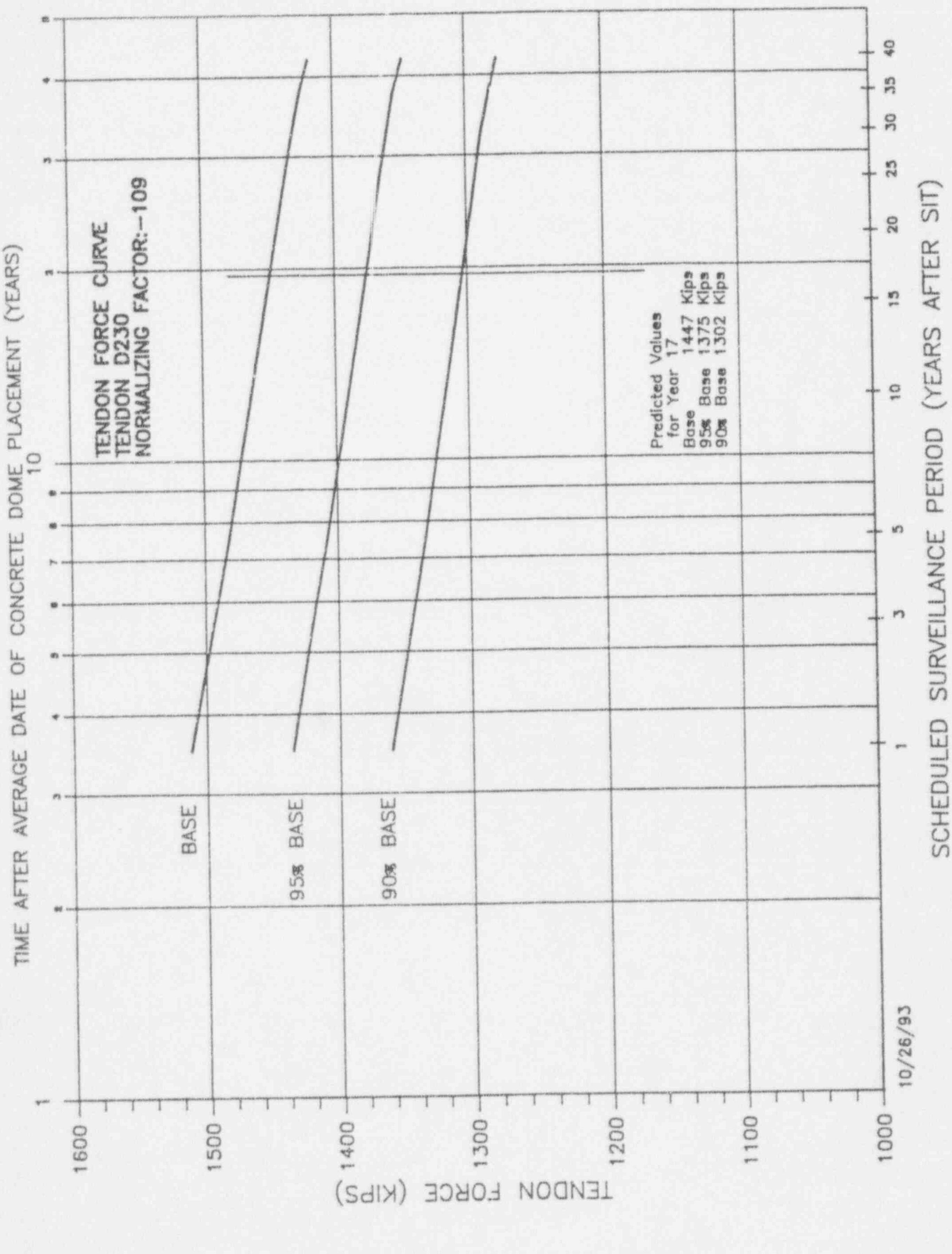

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D139
NORMALIZING FACTOR:-19
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000
Predicted Values
for Year 17
Base 1358 Kips
95% Base 1291 Kips
90% Base 1223 Kips
10/26/93
1
3
5
10
15
20
25
30
35
40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

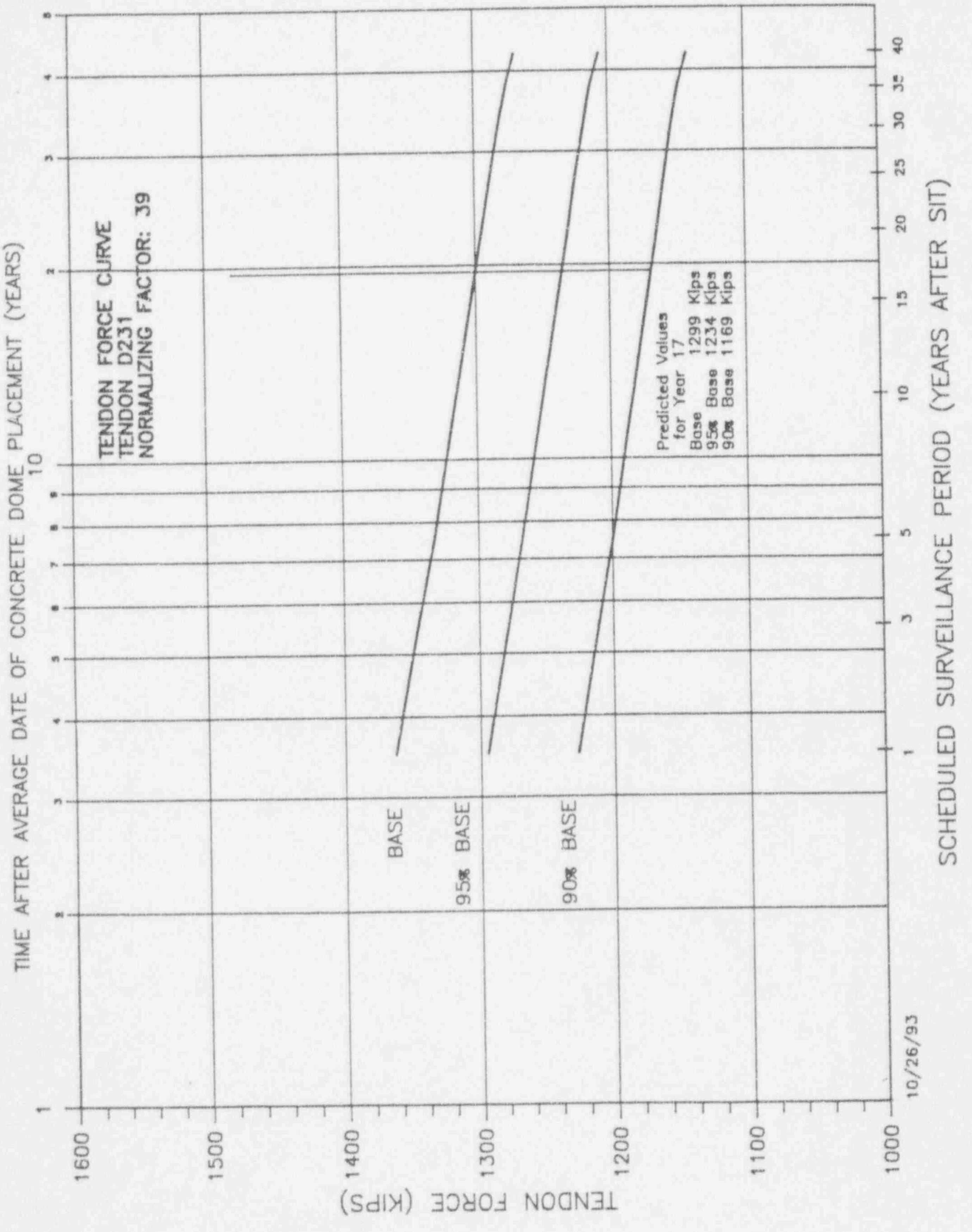

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D214
NORMALIZING FACTOR:-73
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1410 Kips
95% Base 1340 Kips
90% Base 1269 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

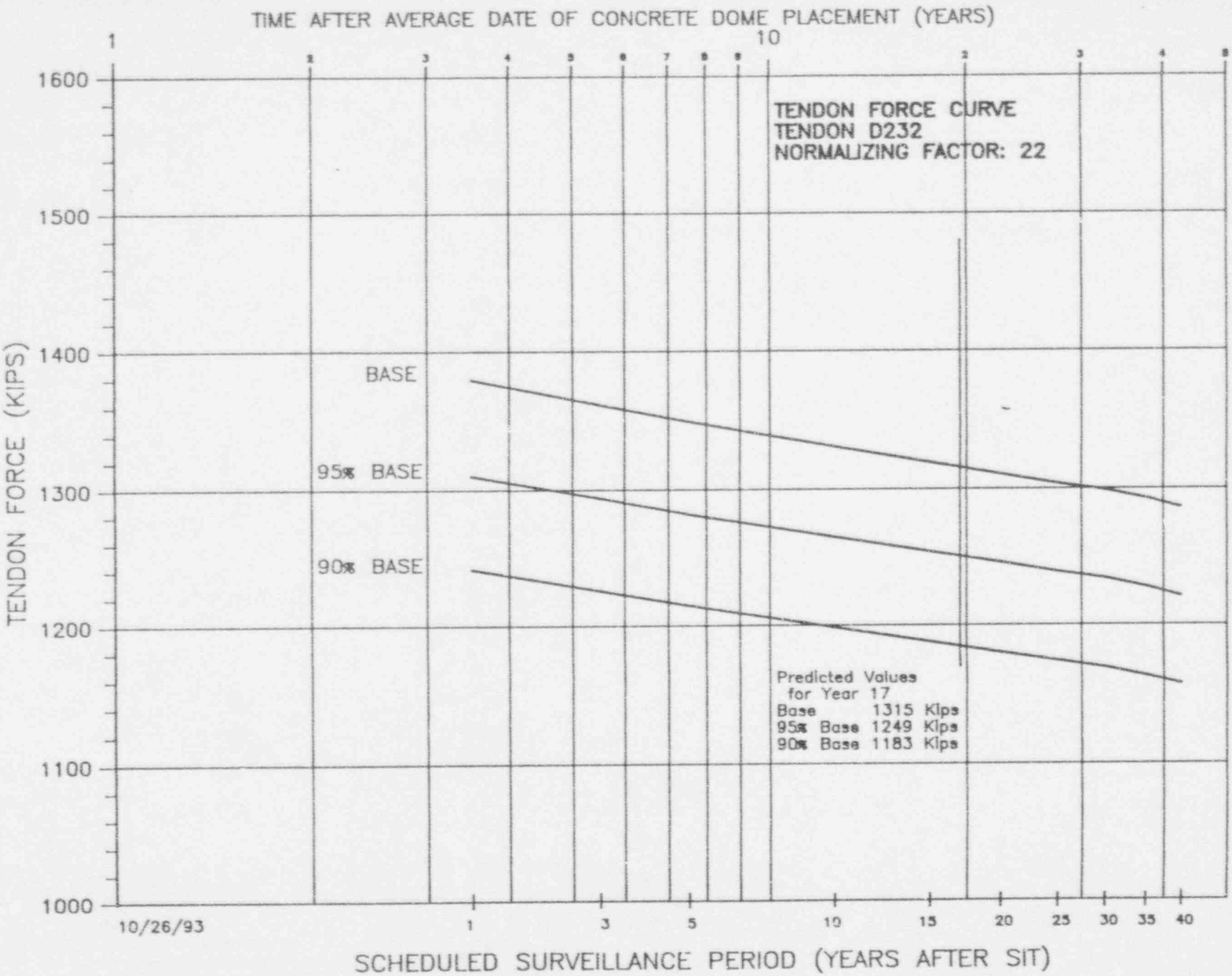

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D215
NORMALIZING FACTOR: 27
1518
Predicted Values
for Year 17
Base 1311 Kips
95% Base 1246 Kips
90% Base 1180 Kips
BASE
95% BASE
90% BASE
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)
10/26/93
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000

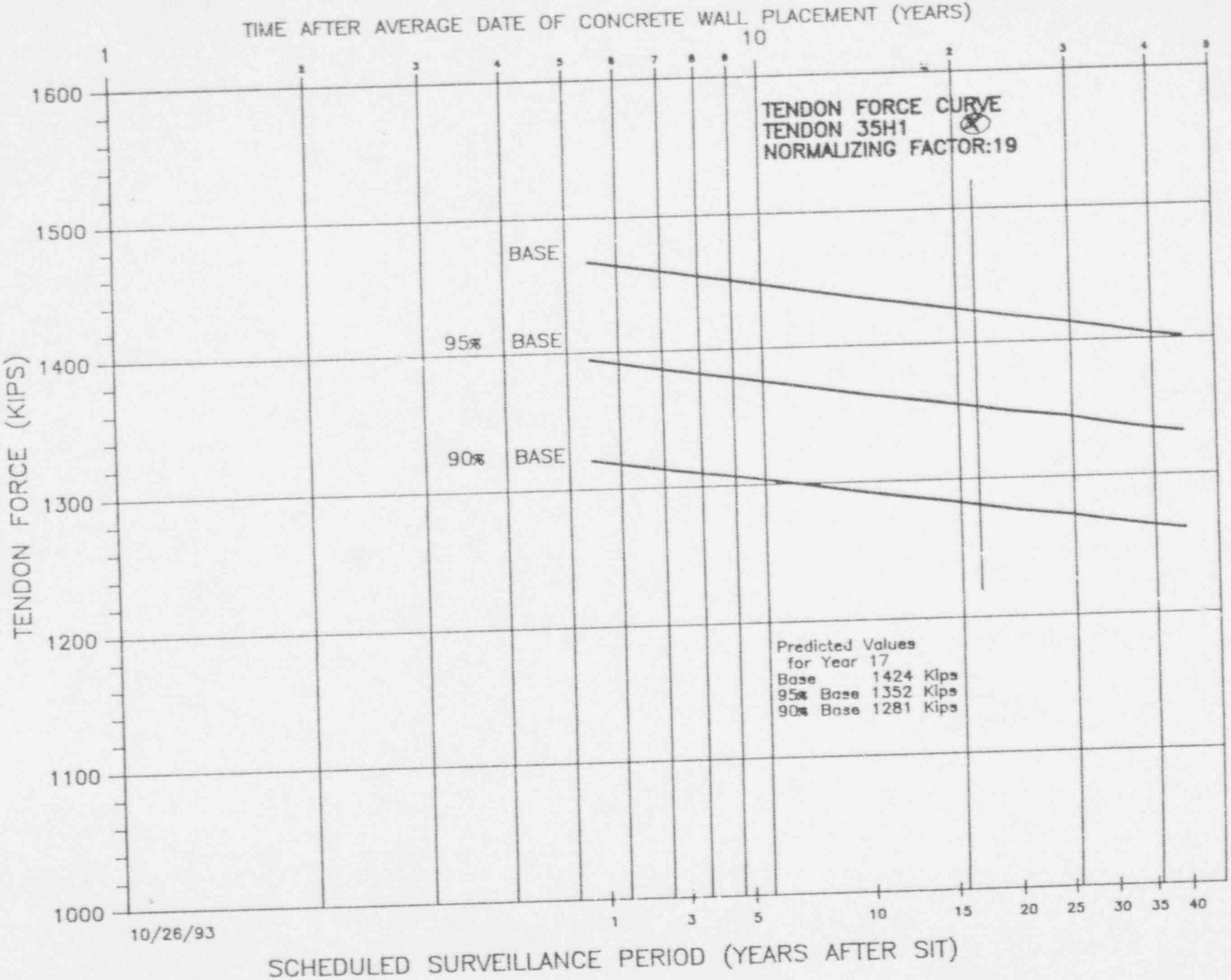

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D216
NORMALIZING FACTOR: 2
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
Predicted Values
for Year 17
Base 1335 Kips
95% Base 1268 Kips
90% Base 1201 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

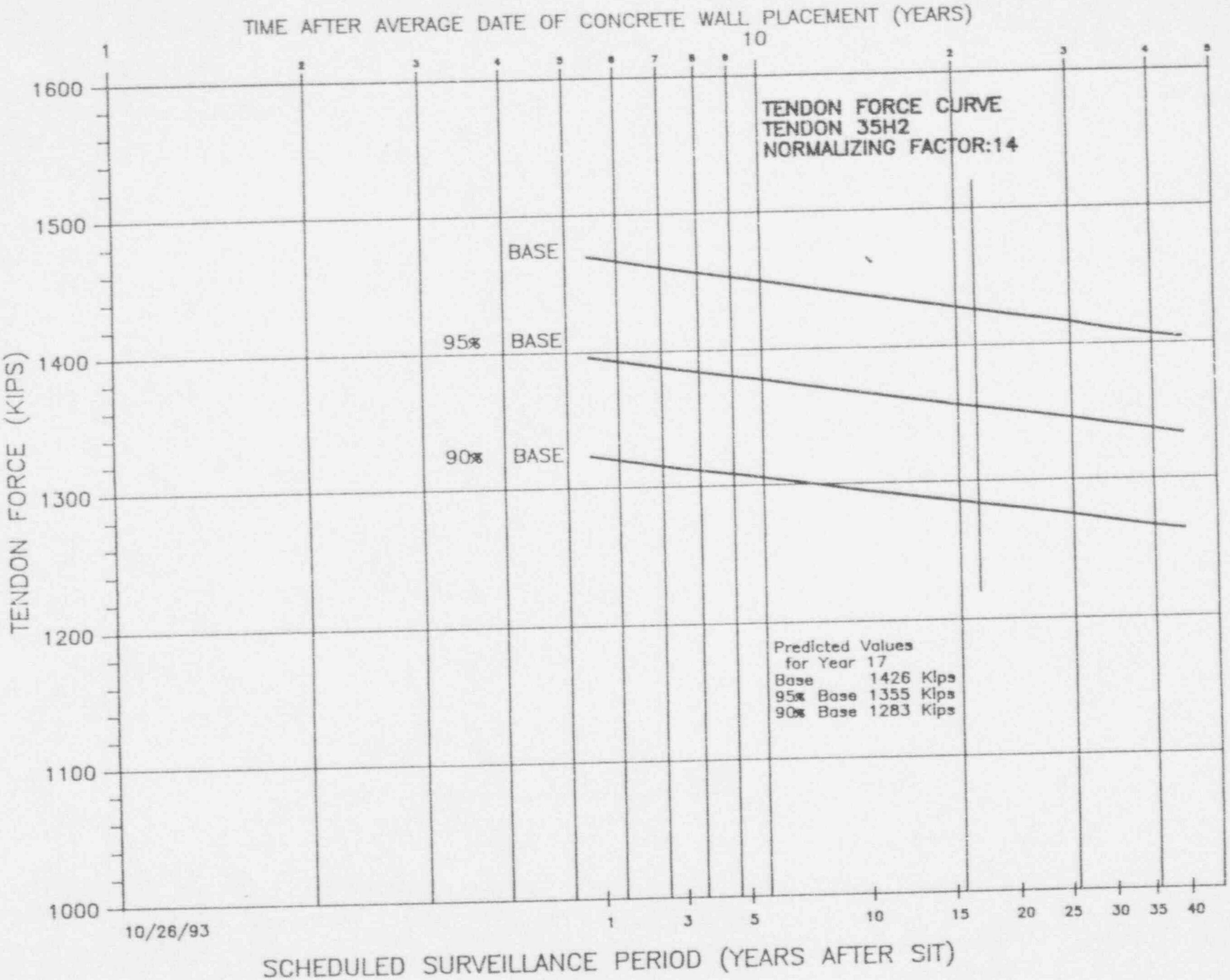

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D224
NORMALIZING FACTOR: 17
1425
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1320 Kips
95% Base 1254 Kips
90% Base 1188 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

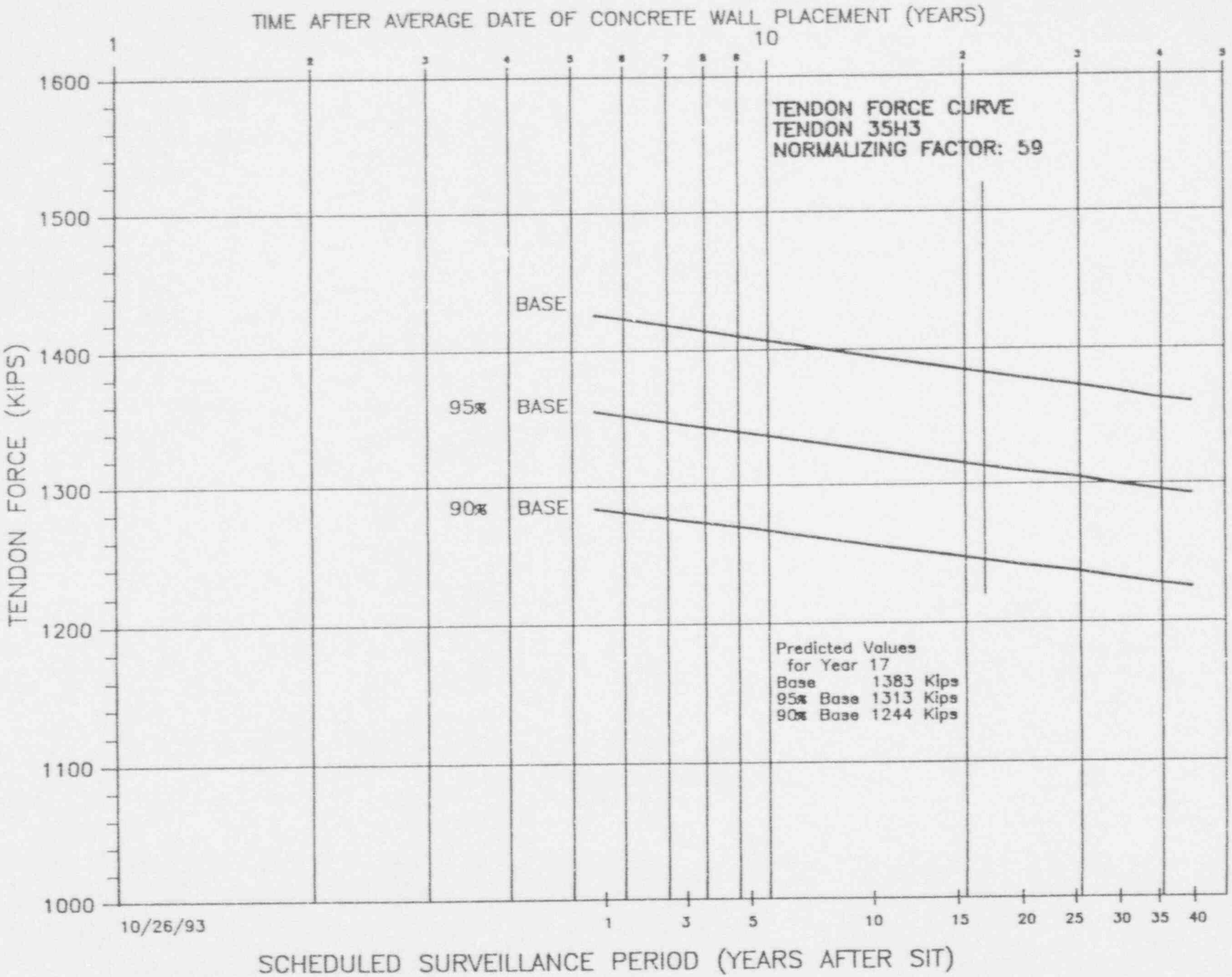

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D230
NORMALIZING FACTOR:-109
Predicted Values
for Year 17
Base 1447 Kips
95% Base 1375 Kips
90% Base 1302 Kips
BASE
95% BASE
90% BASE
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000
10/26/93
1
3
5
10
15
20
25
30
35
40

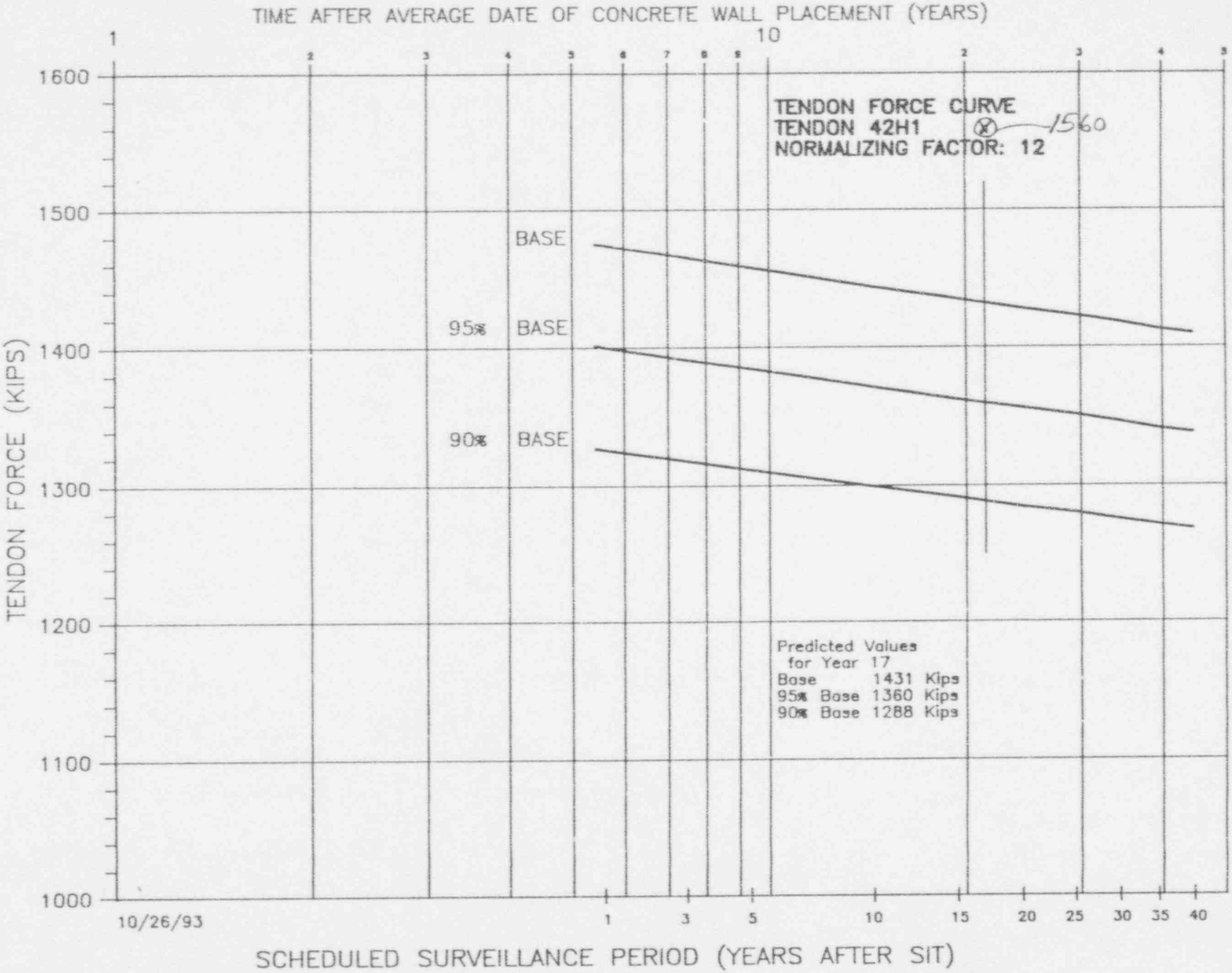

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D231
NORMALIZING FACTOR: 39
Predicted Values
for Year 17
Base 1299 Kips
95% Base 1234 Kips
90% Base 1169 Kips
BASE
95% BASE
90% BASE
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)
1 3 5 10 15 20 25 30 35 40
TENDON FORCE (KIPS)
1600 1500 1400 1300 1200 1100 1000
10/26/93

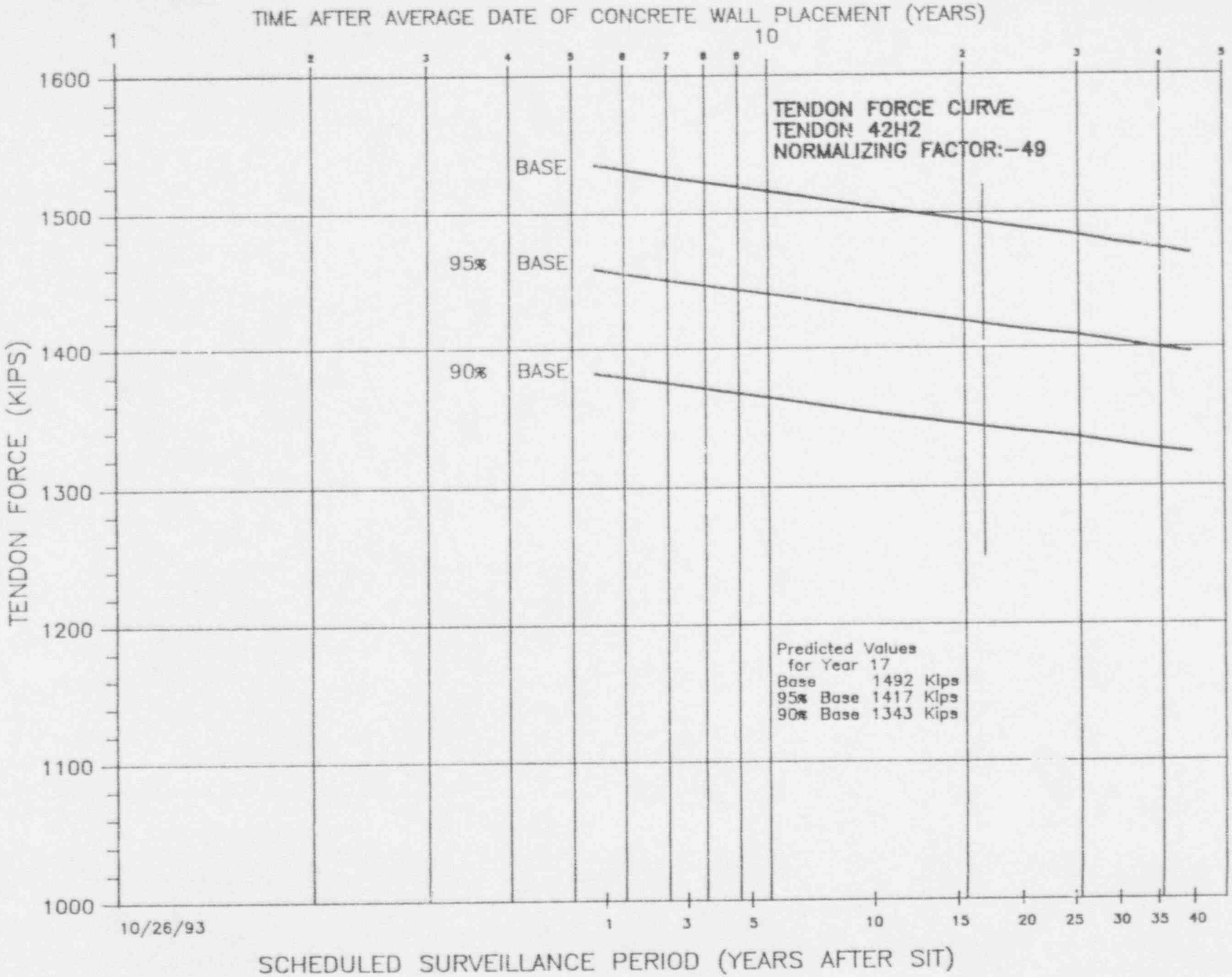

TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON D232
NORMALIZING FACTOR: 22
TENDON FORCE (KIPS)
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1315 Kips
95% Base 1249 Kips
90% Base 1183 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

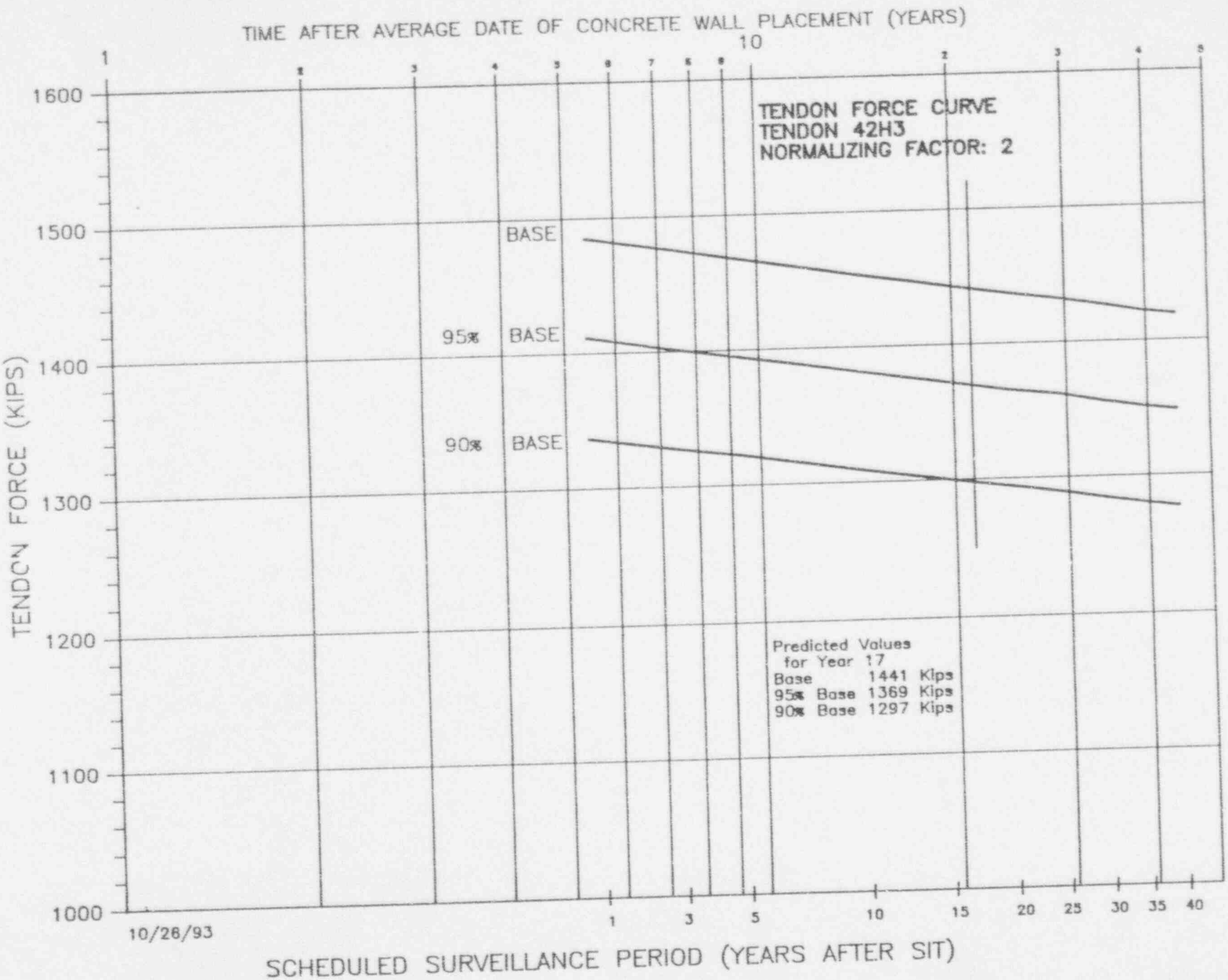

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 35H1
NORMALIZING FACTOR:19
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
Predicted Values
for Year 17
Base 1424 Kips
95% Base 1352 Kips
90% Base 1281 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

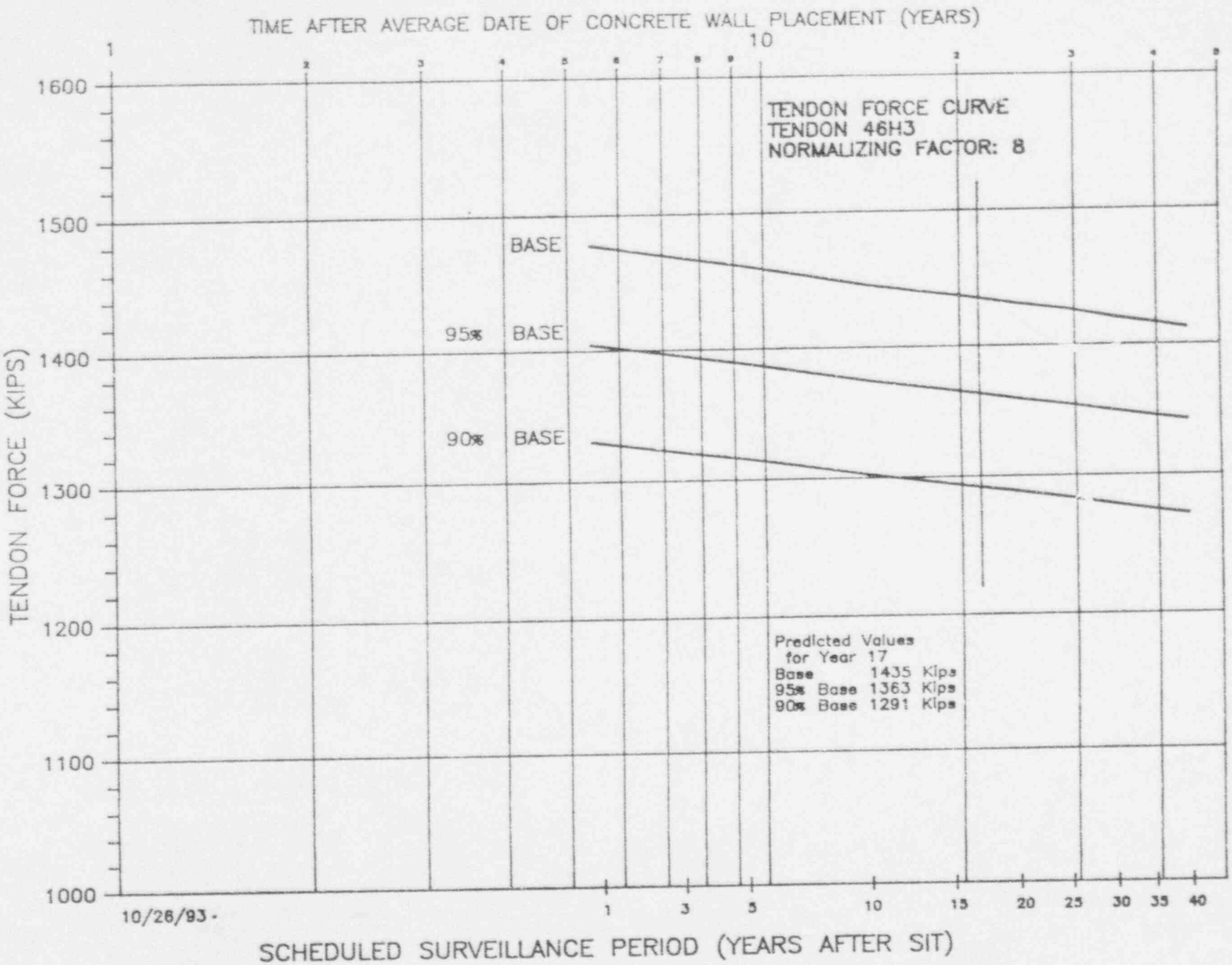

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
1
10
TENDON FORCE CURVE
TENDON 35H2
NORMALIZING FACTOR:14
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000
Predicted Values
for Year 17
Base 1426 Kips
95% Base 1355 Kips
90% Base 1283 Kips
10/26/93
1
3
5
10
15
20
25
30
35
40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

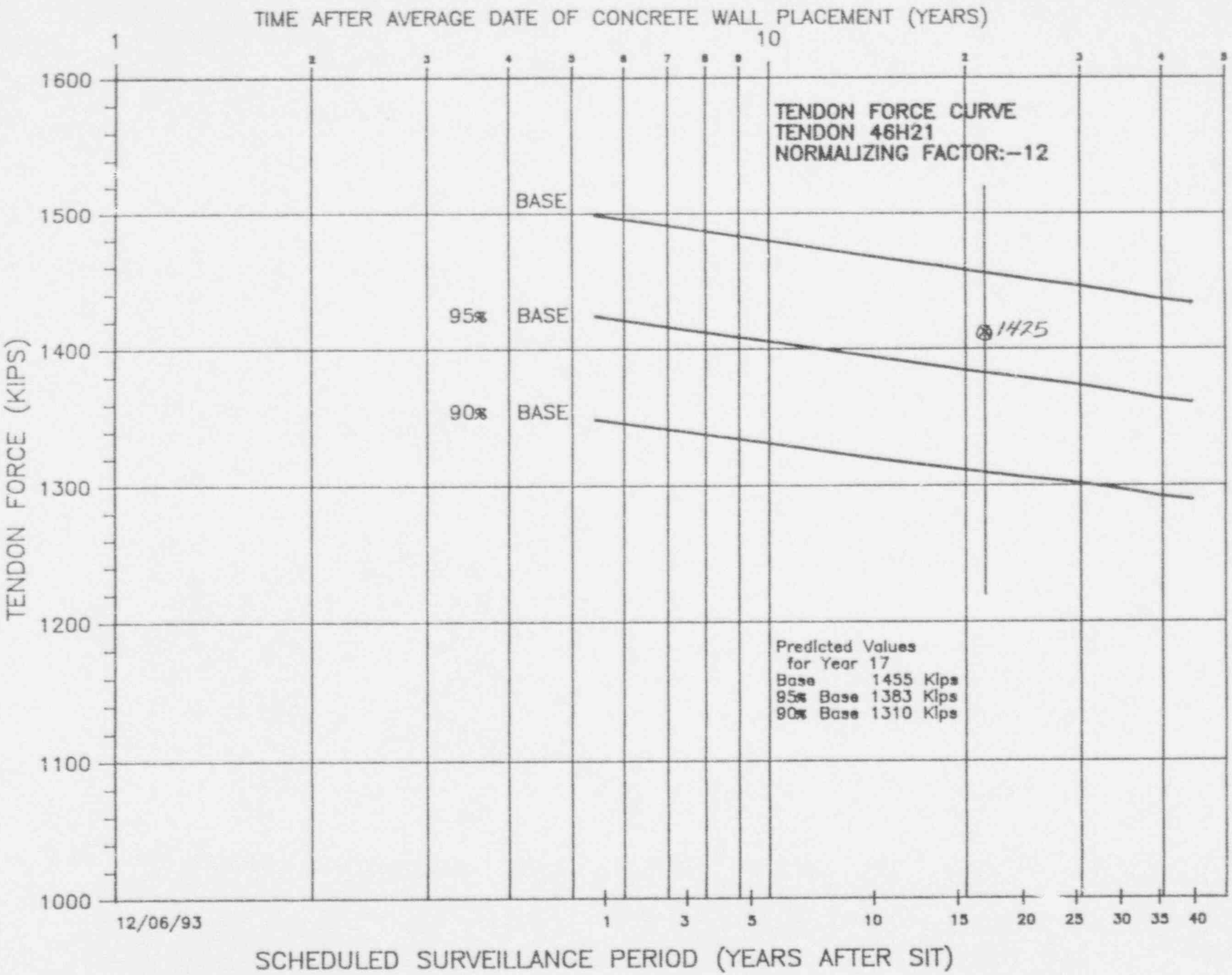

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 35H3
NORMALIZING FACTOR: 59
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1383 Kips
95% Base 1313 Kips
90% Base 1244 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

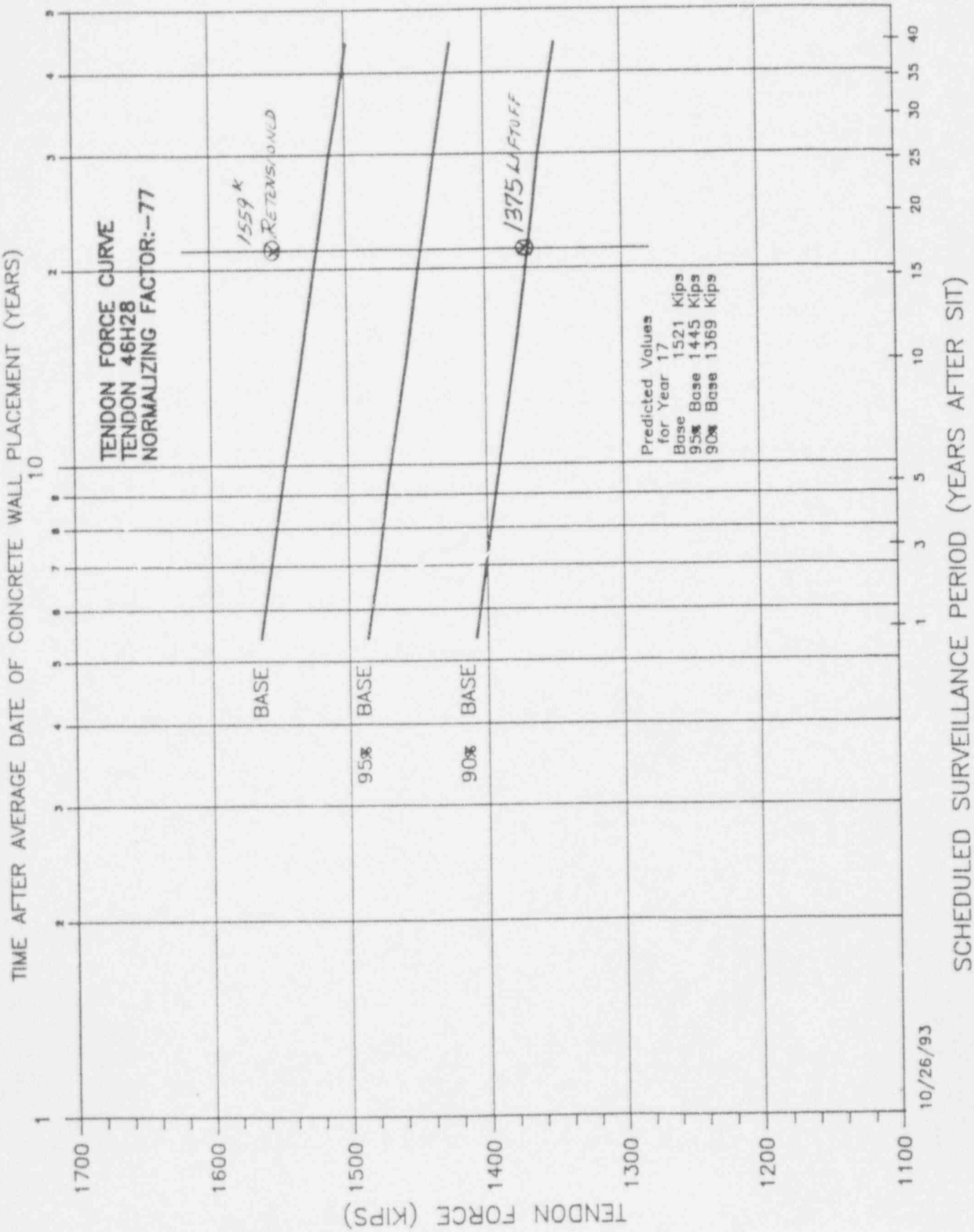

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 42H1
1560
NORMALIZING FACTOR: 12
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1431 Kips
95% Base 1360 Kips
90% Base 1288 Kips
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

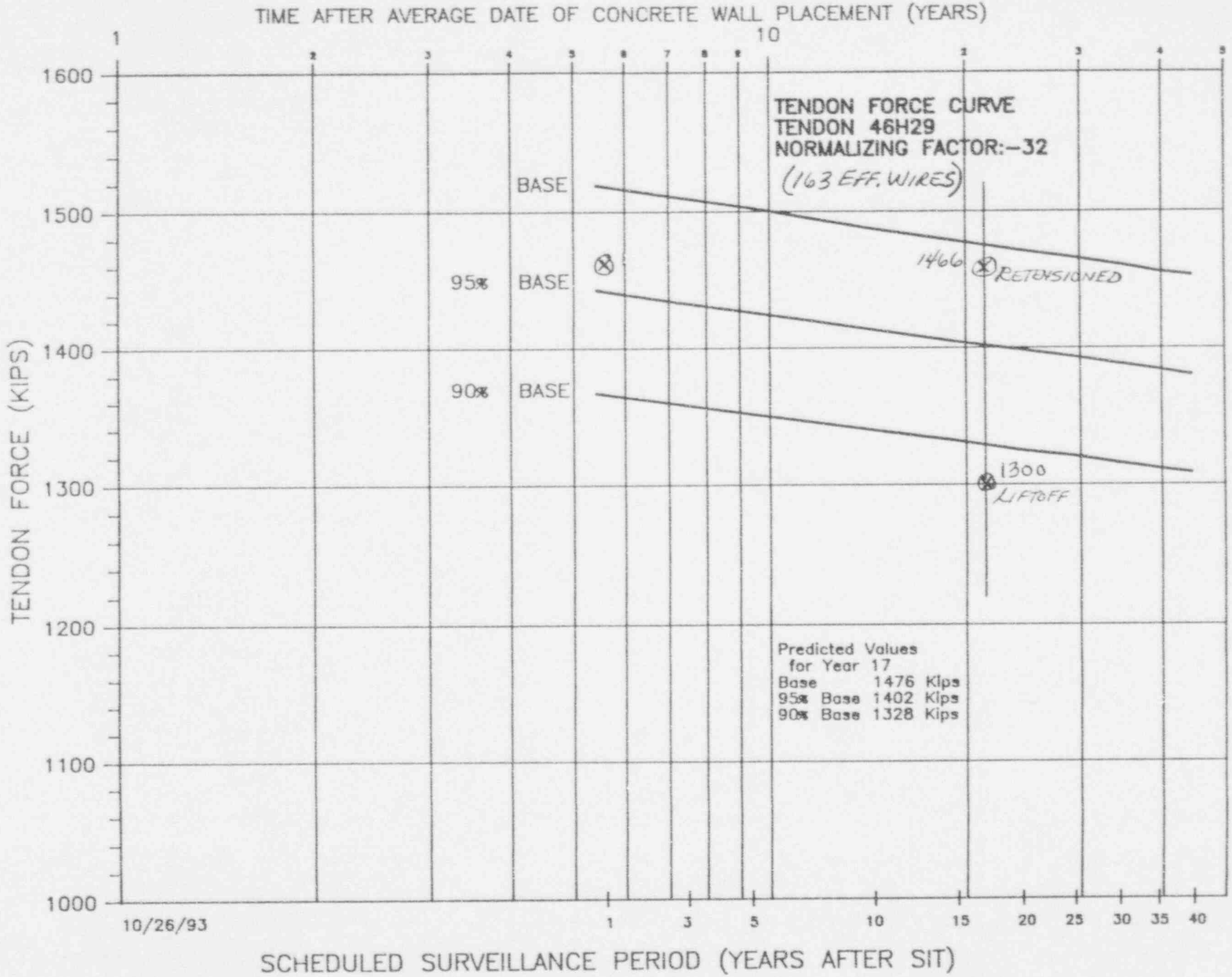

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 42H2
NORMALIZING FACTOR:-49
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1492 Kips
95% Base 1417 Kips
90% Base 1343 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

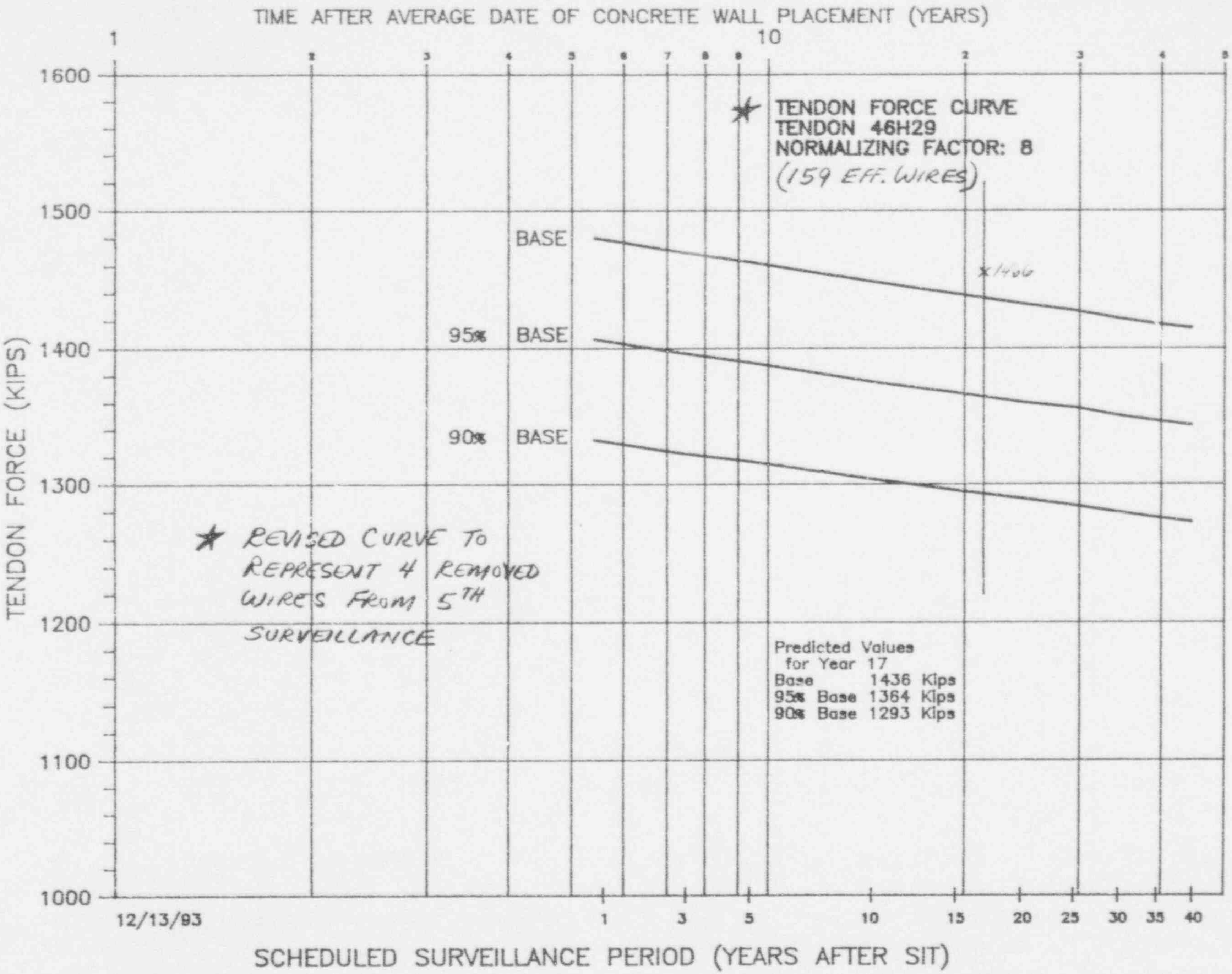

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 42H3
NORMALIZING FACTOR: 2
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000
Predicted Values
for Year 17
Base 1441 Kips
95% Base 1369 Kips
90% Base 1297 Kips
10/26/93
1 3 5 10 15 20 25 30 35 40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

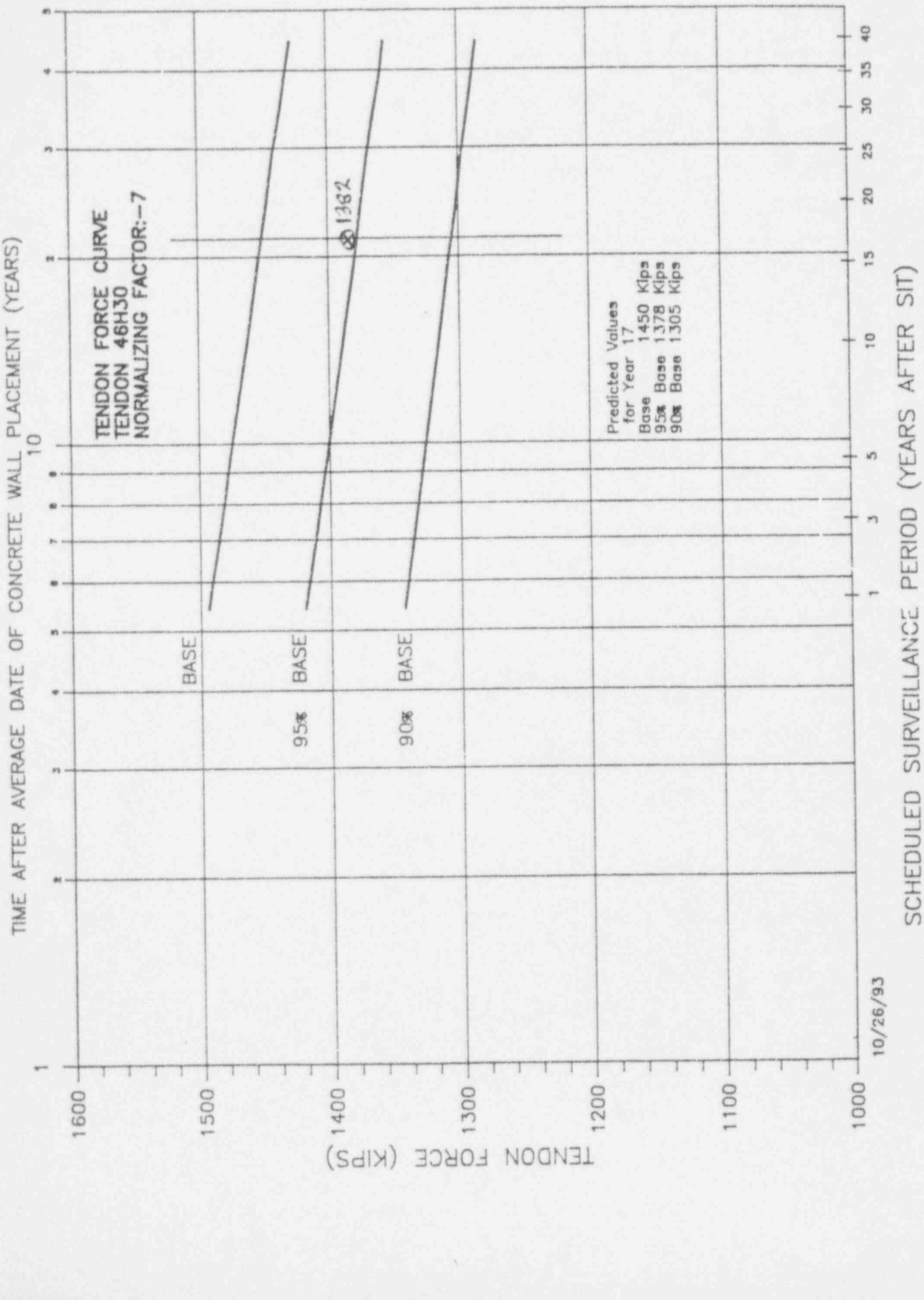

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H3
NORMALIZING FACTOR: 8
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1435 Kips
95% Base 1363 Kips
90% Base 1291 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

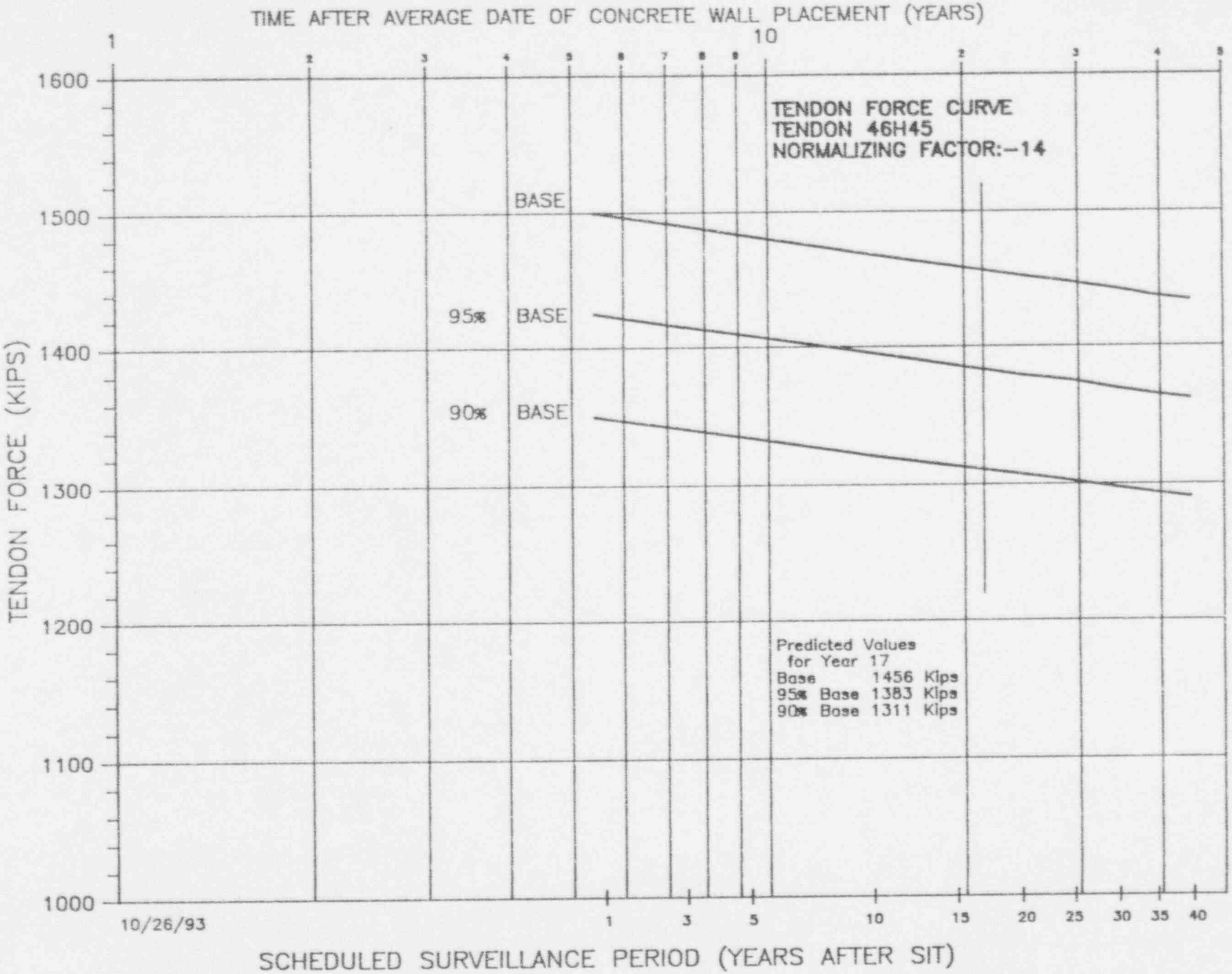

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H21
NORMALIZING FACTOR:-12
BASE
95% BASE
90% BASE
1425
Predicted Values
for Year 17
Base 1455 Kips
95% Base 1383 Kips
90% Base 1310 Kips
TENDON FORCE (KIPS)
12/06/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

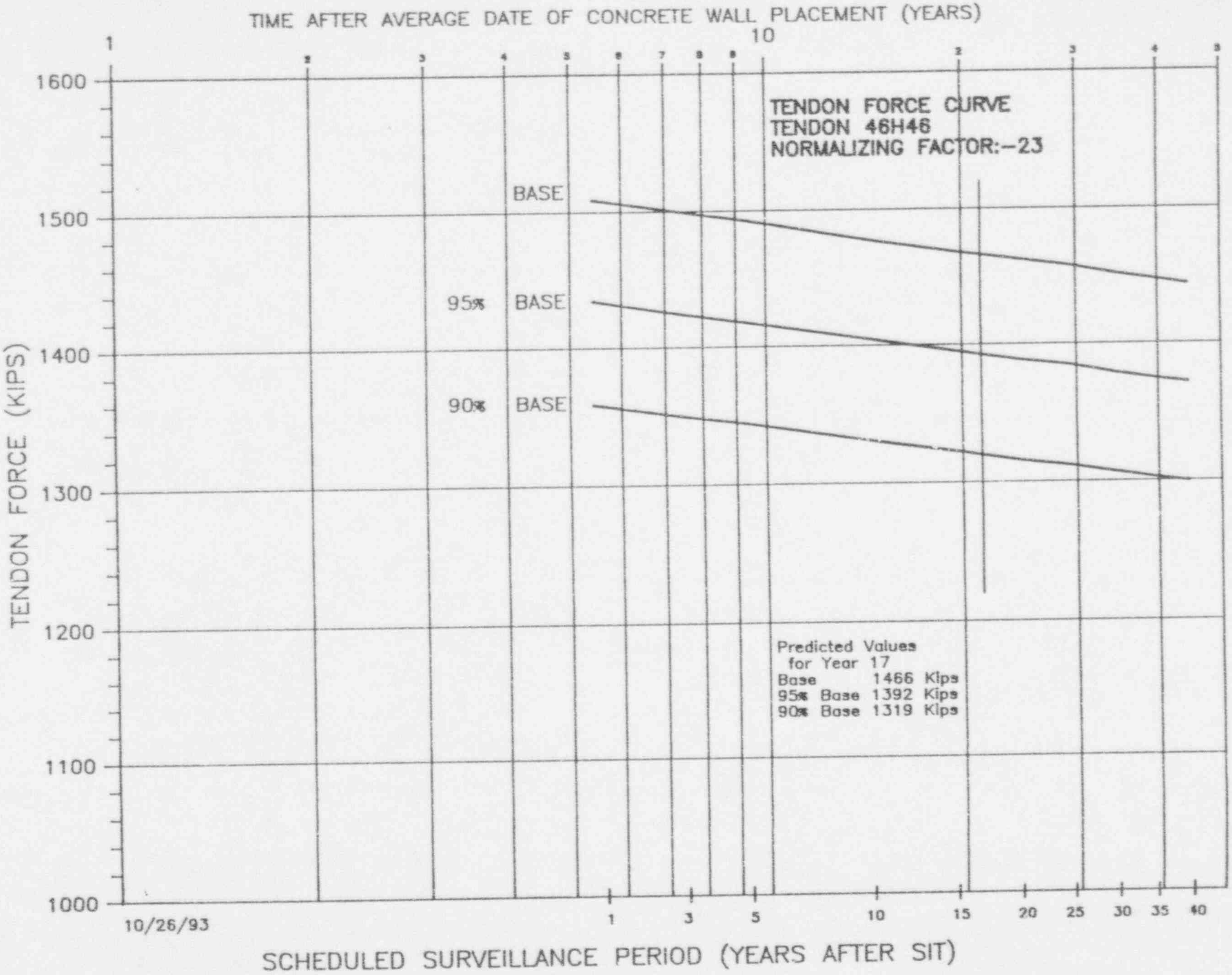

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H28
NORMALIZING FACTOR:-77
1559 K RETENSIONED
1375 LIFTOFF
Predicted Values
for Year 17
Base 1521 Kips
95% Base 1445 Kips
90% Base 1369 Kips
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
1700
1600
1500
1400
1300
1200
1100
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)
1
3
5
10
15
20
25
30
35
40

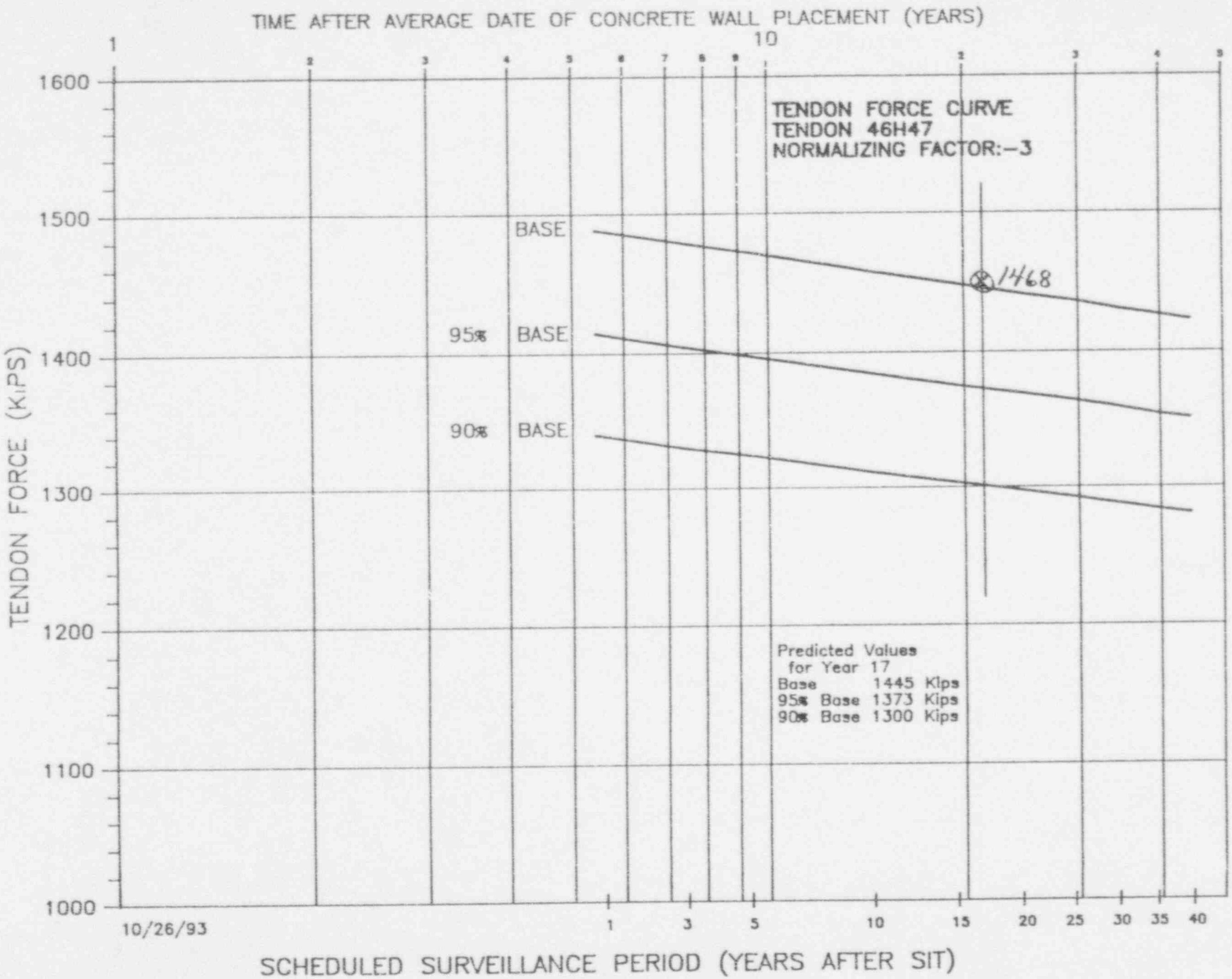

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H29
NORMALIZING FACTOR:-32
(163 EFF. WIRES)
BASE
95% BASE
90% BASE
1466
RETENSIONED
1300
LIFTOFF
Predicted Values
for Year 17
Base 1476 Kips
95% Base 1402 Kips
90% Base 1328 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

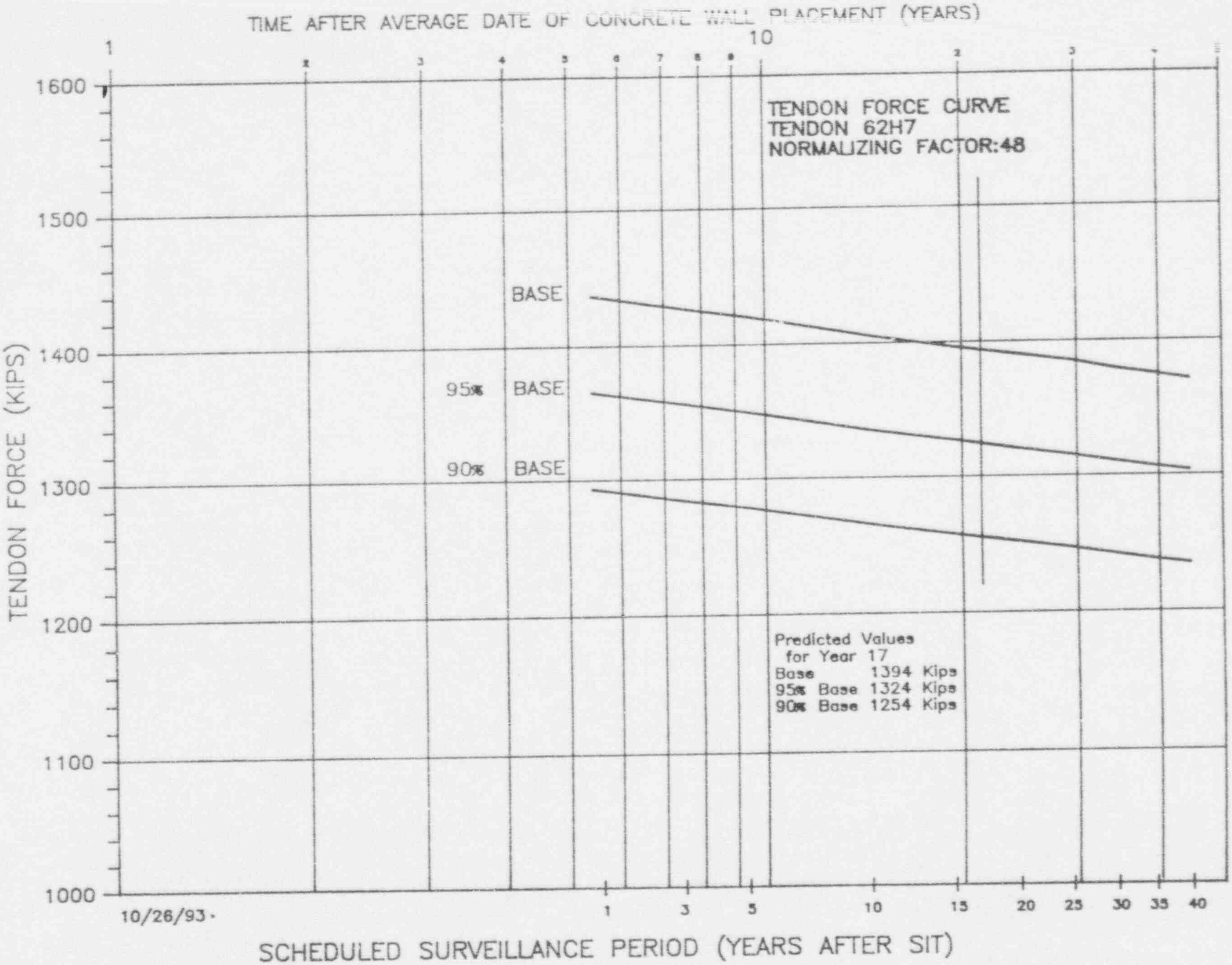

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H29
NORMALIZING FACTOR: 8
(159 EFF. WIRES)
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
* REVISED CURVE TO REPRESENT 4 REMOVED WIRES FROM 5TH SURVEILLANCE
Predicted Values for Year 17
Base 1436 Kips
95% Base 1364 Kips
90% Base 1293 Kips
12/13/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

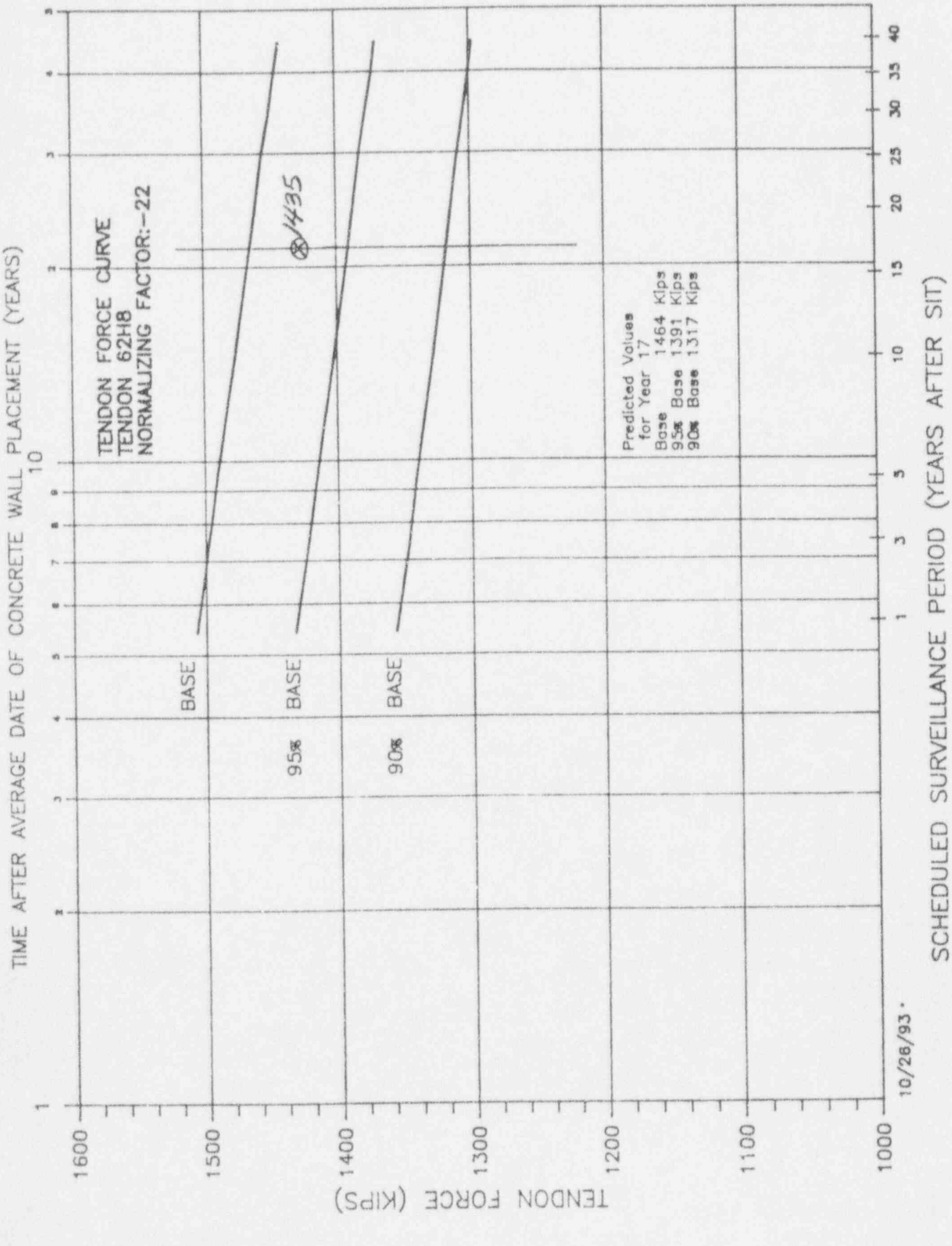

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H30
NORMALIZING FACTOR:-7
1382
Predicted Values
for Year 17
Base 1450 Kips
95% Base 1378 Kips
90% Base 1305 Kips
BASE
95% BASE
90% BASE
1600
1500
1400
1300
1200
1100
1000
TENDON FORCE (KIPS)
1
2
3
4
5
6
7
8
9
10
1
3
5
10
15
20
25
30
35
40
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

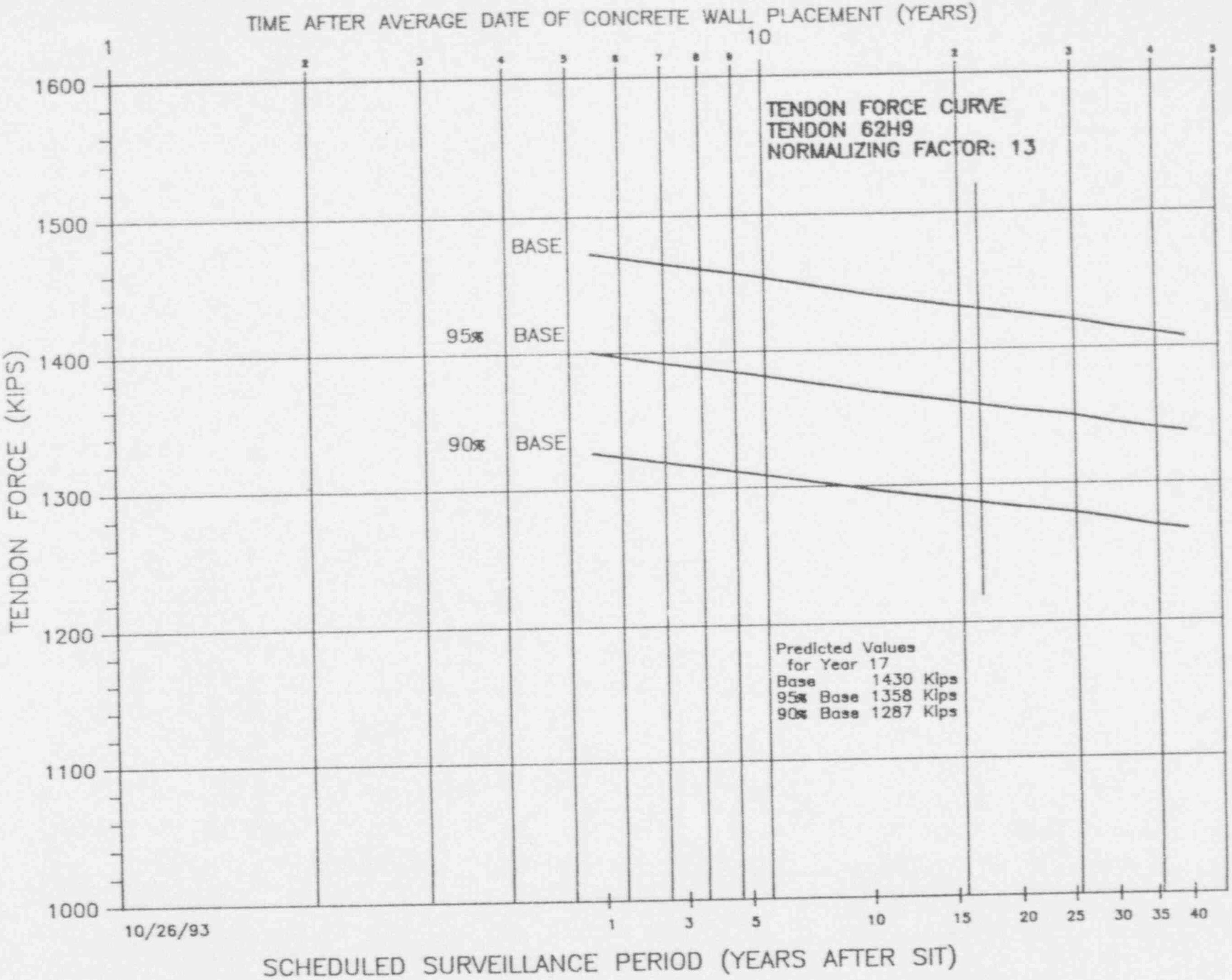

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H45
NORMALIZING FACTOR:-14
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
Predicted Values
for Year 17
Base 1456 Kips
95% Base 1383 Kips
90% Base 1311 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

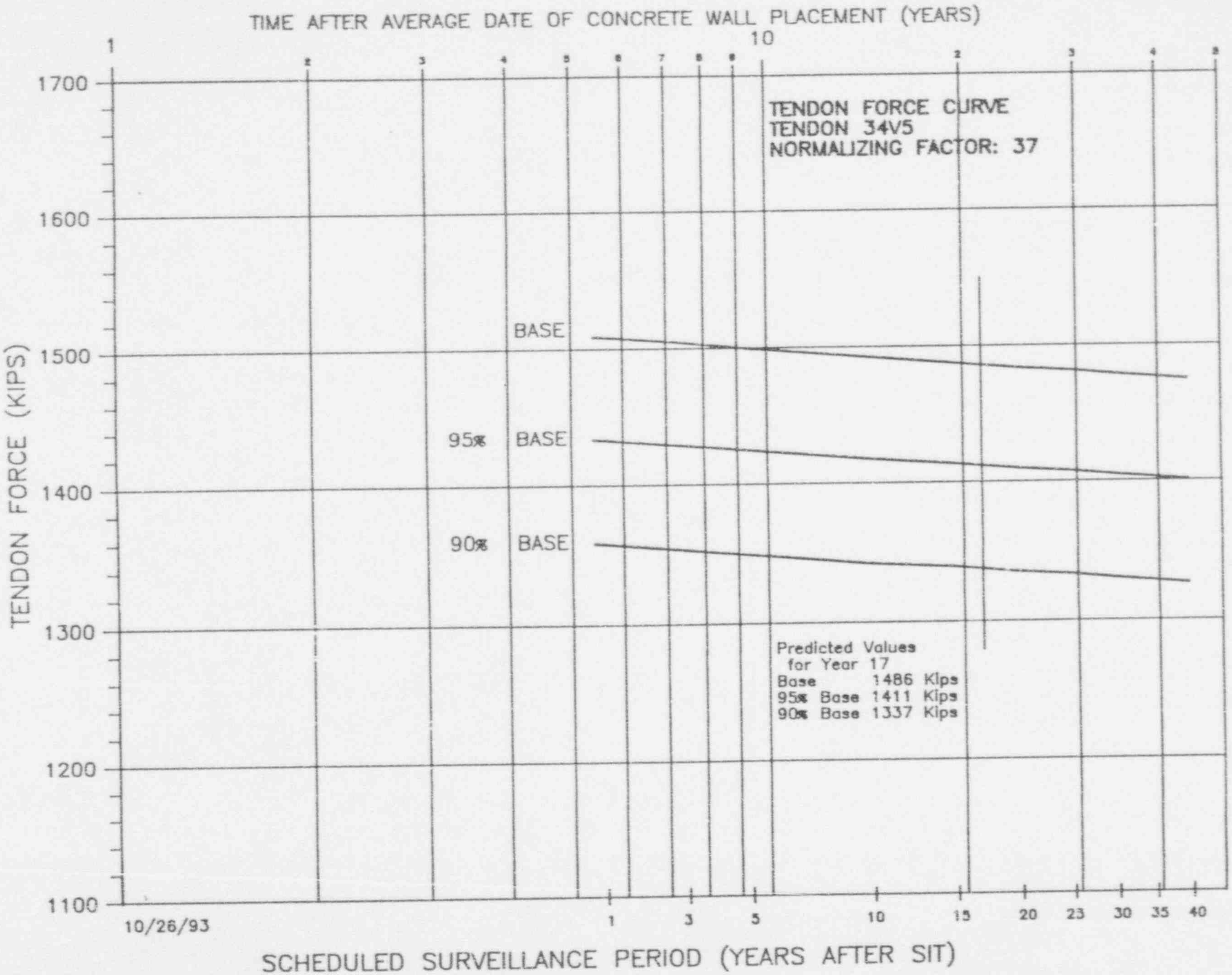

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
1
10
1600
1500
1400
1300
1200
1100
1000
TENDON FORCE CURVE
TENDON 46H46
NORMALIZING FACTOR:-23
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
Predicted Values
for Year 17
Base 1466 Kips
95% Base 1392 Kips
90% Base 1319 Kips
10/26/93
1
3
5
10
15
20
25
30
35
40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 46H47
NORMALIZING FACTOR:-3
BASE
95% BASE
90% BASE
1468
Predicted Values for Year 17
Base 1445 Kips
95% Base 1373 Kips
90% Base 1300 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

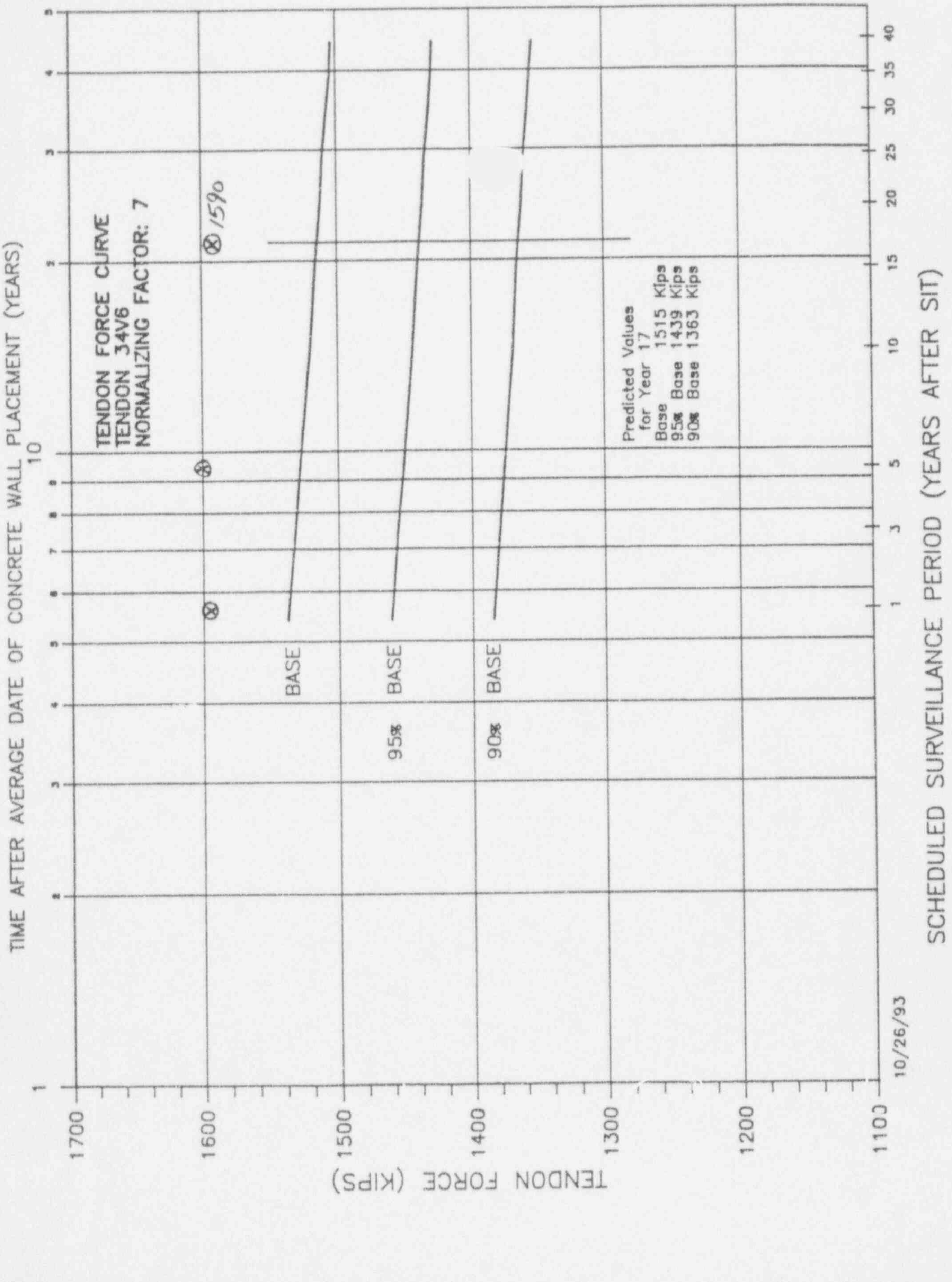

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 62H7
NORMALIZING FACTOR:48
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
1600
1500
1400
1300
1200
1100
1000
1
10
Predicted Values
for Year 17
Base 1394 Kips
95% Base 1324 Kips
90% Base 1254 Kips
1 3 5 10 15 20 25 30 35 40
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

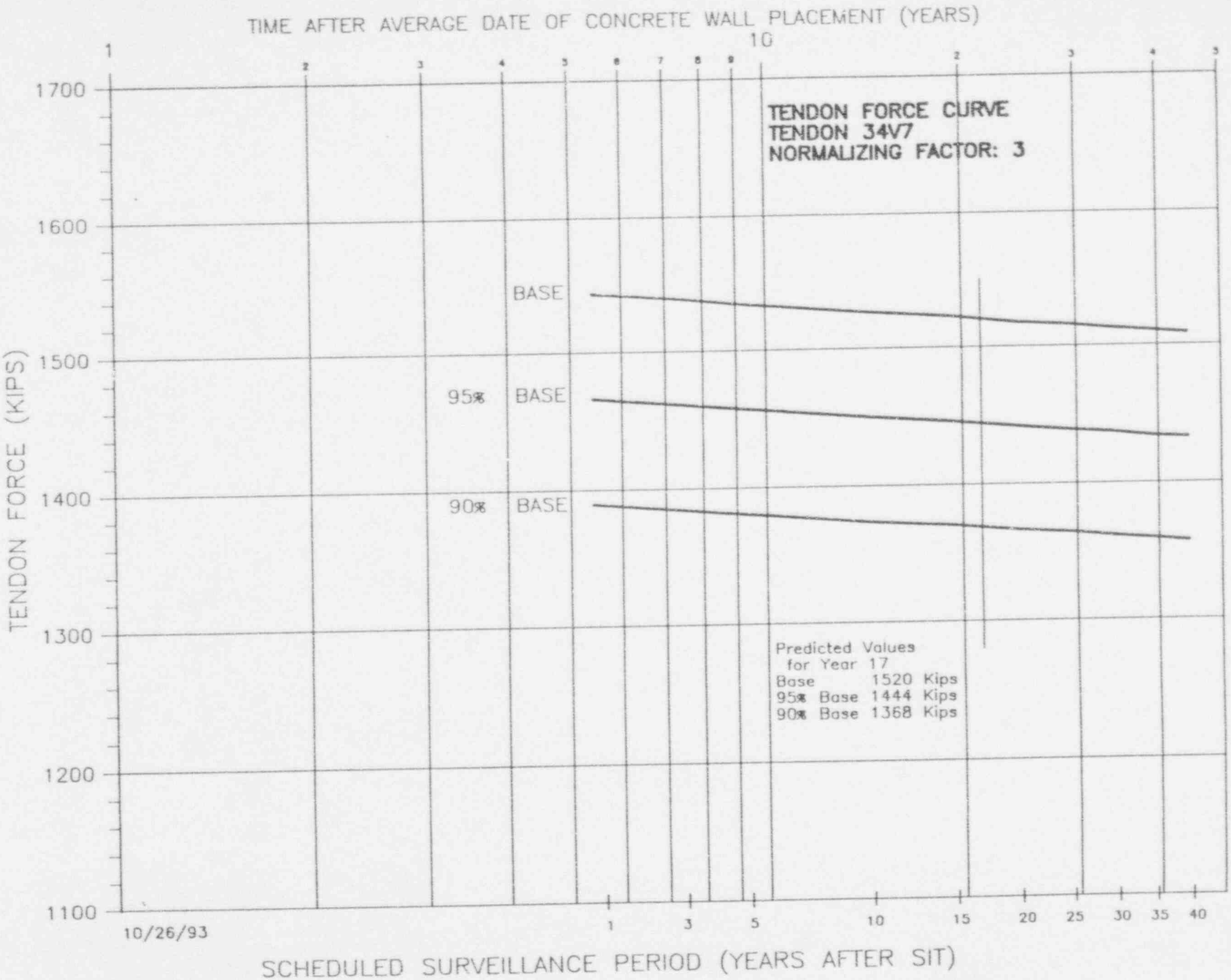

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 62H8
NORMALIZING FACTOR:-22
1435
Predicted Values
for Year 17
Base 1464 Kips
95% Base 1391 Kips
90% Base 1317 Kips
BASE
95% BASE
90% BASE
1600
1500
1400
1300
1200
1100
1000
TENDON FORCE (KIPS)
1
10
1
3
5
10
15
20
25
30
35
40
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 62H9
NORMALIZING FACTOR: 13
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1430 Kips
95% Base 1358 Kips
90% Base 1287 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

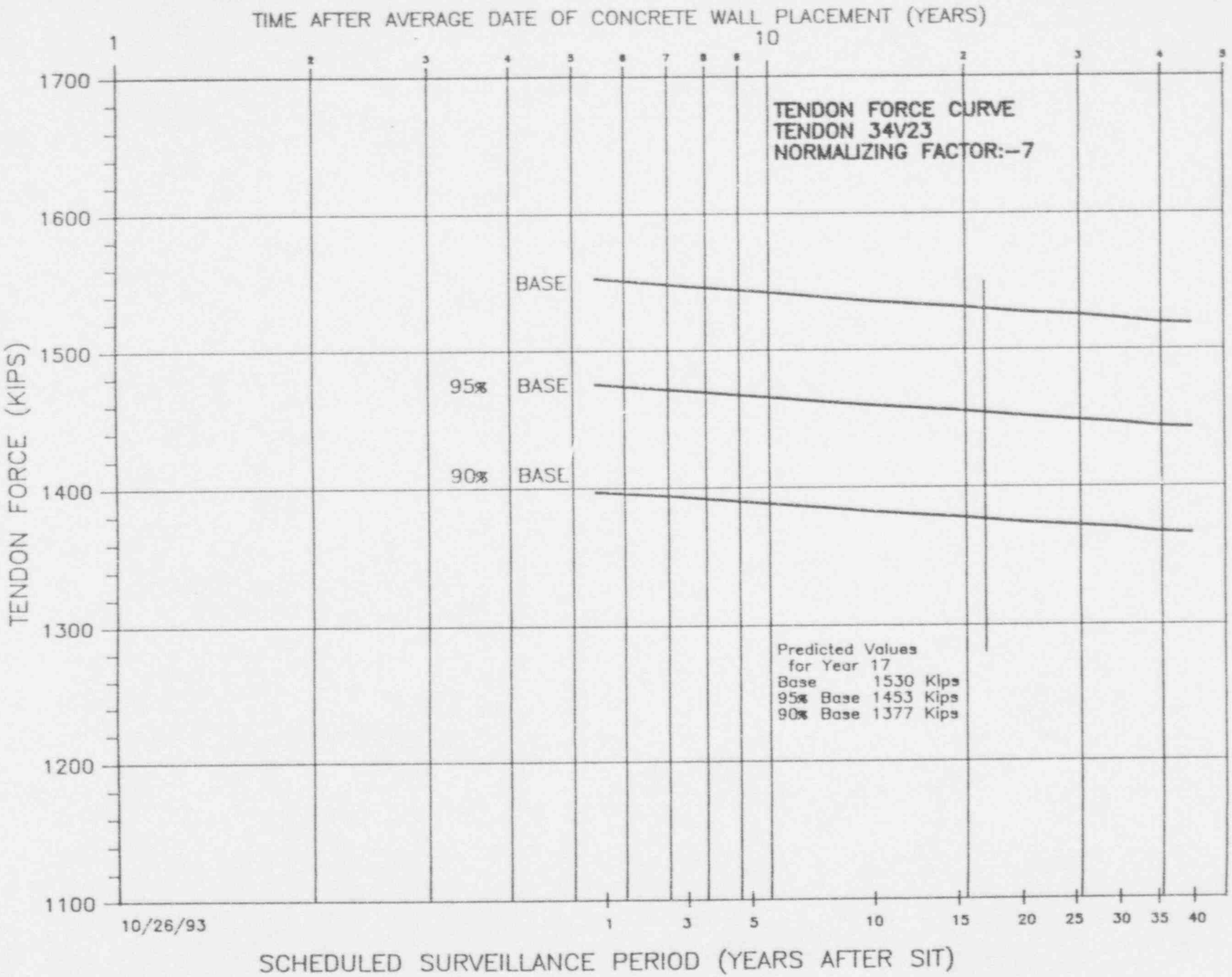


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
1
10
TENDON FORCE CURVE
TENDON 34V5
NORMALIZING FACTOR: 37
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1486 Kips
95% Base 1411 Kips
90% Base 1337 Kips
TENDON FORCE (KIPS)
1700
1600
1500
1400
1300
1200
1100
10/26/93
1
3
5
10
15
20
23
30
35
40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

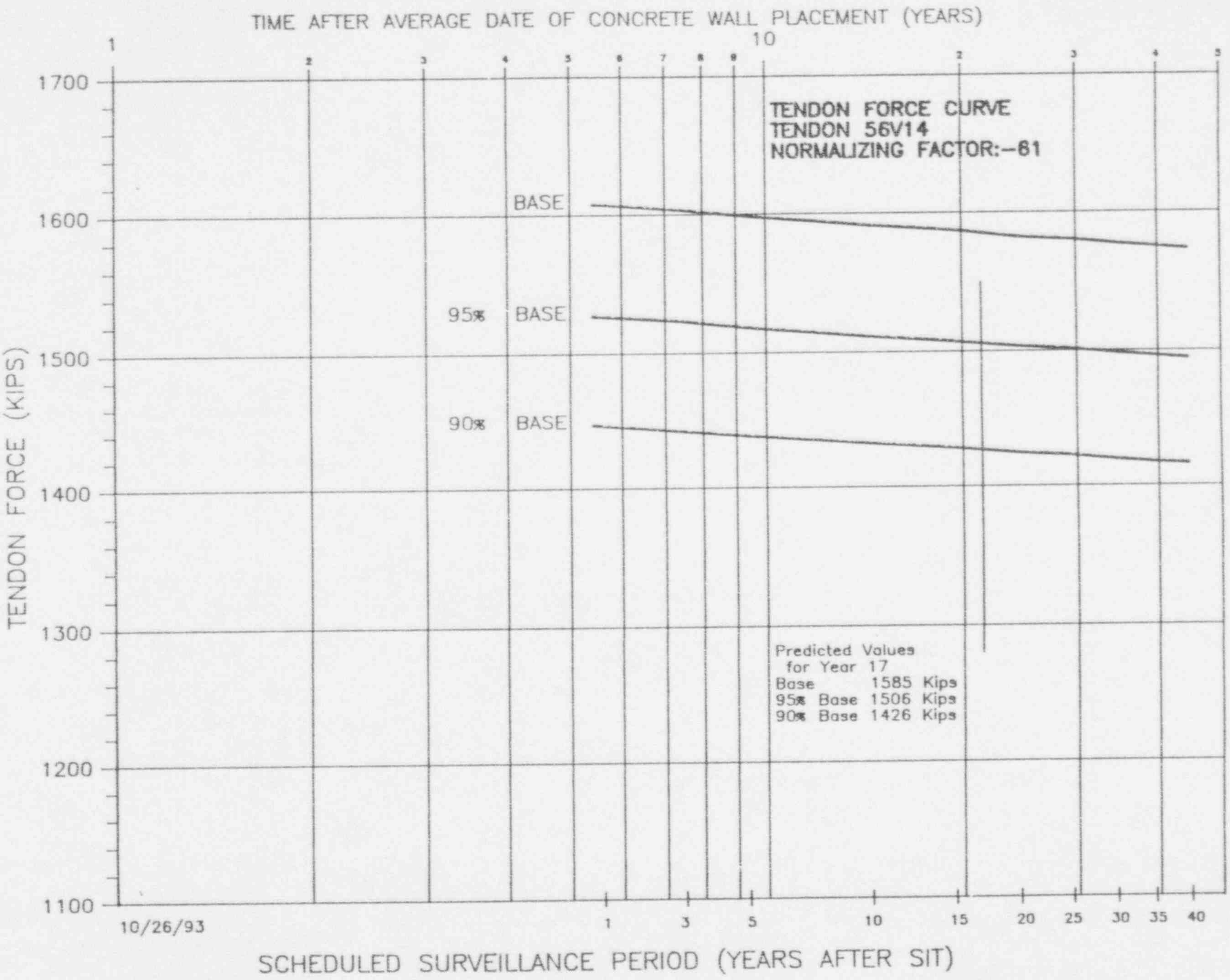

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 34V6
NORMALIZING FACTOR: 7
1590
Predicted Values
for Year 17
Base 1515 Kips
95% Base 1439 Kips
90% Base 1363 Kips
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
1700
1600
1500
1400
1300
1200
1100
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)
1
3
5
10
15
20
25
30
35
40
10/26/93

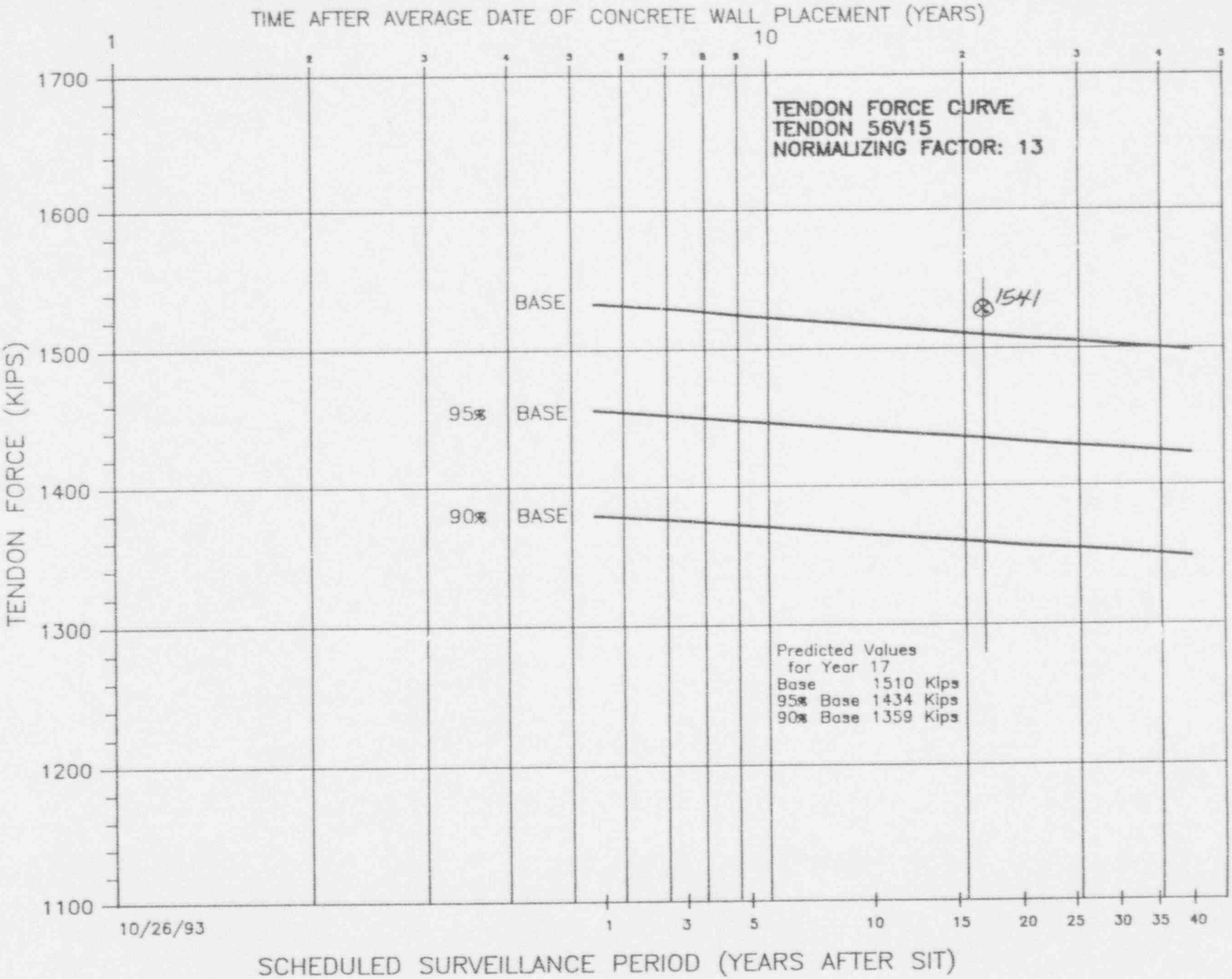


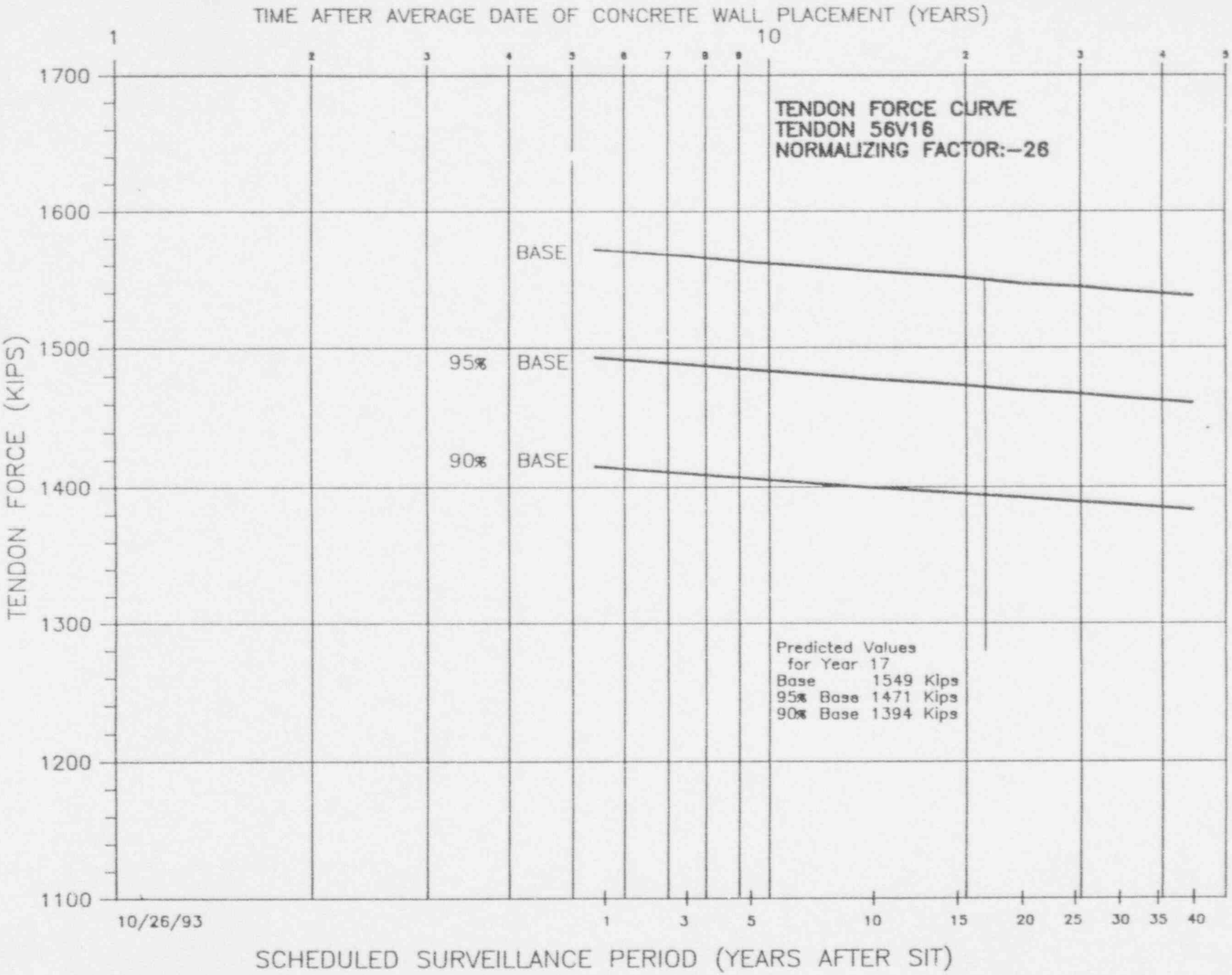
TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 34V7
NORMALIZING FACTOR: 3
TENDON FORCE (KIPS)
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1520 Kips
95% Base 1444 Kips
90% Base 1368 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

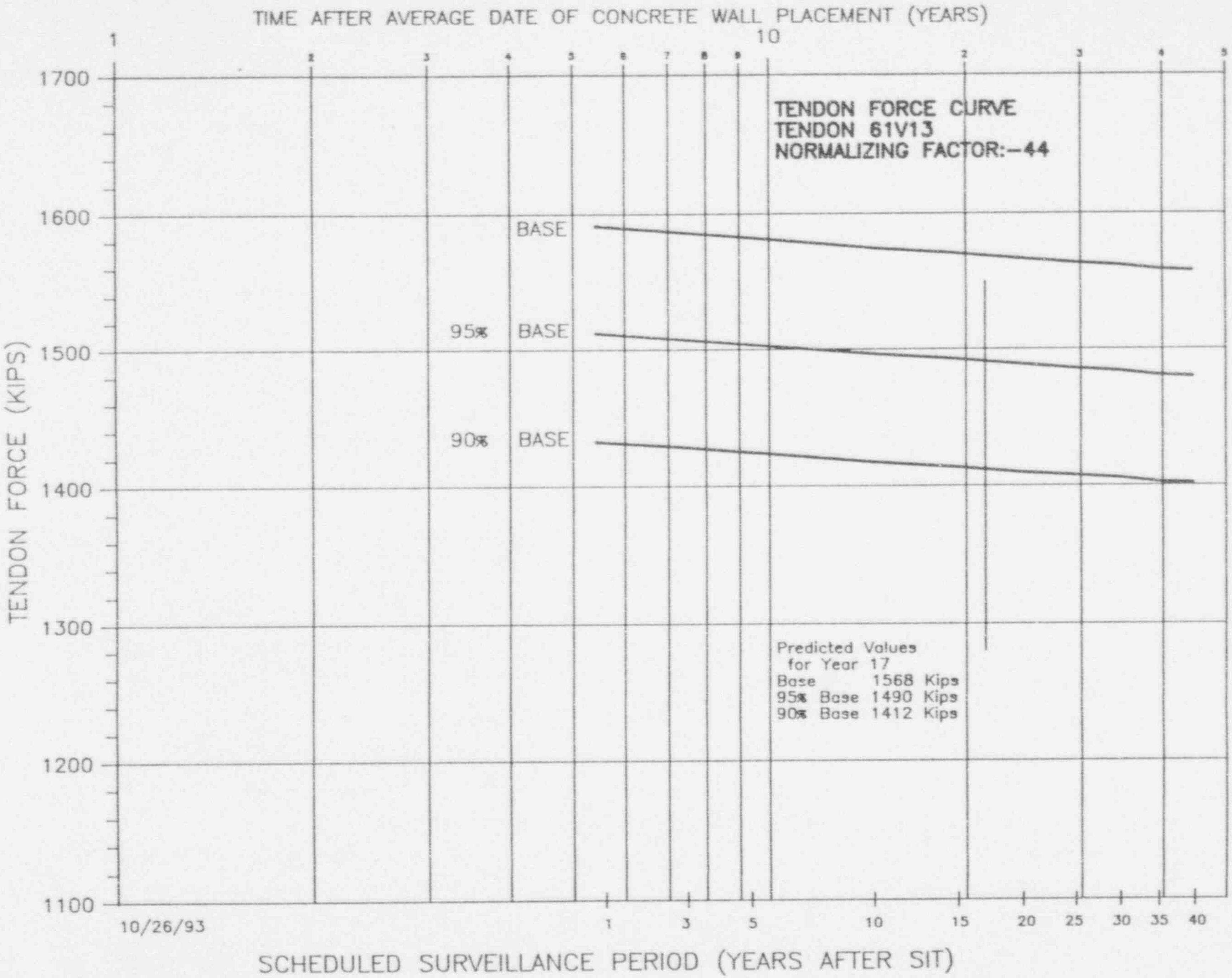


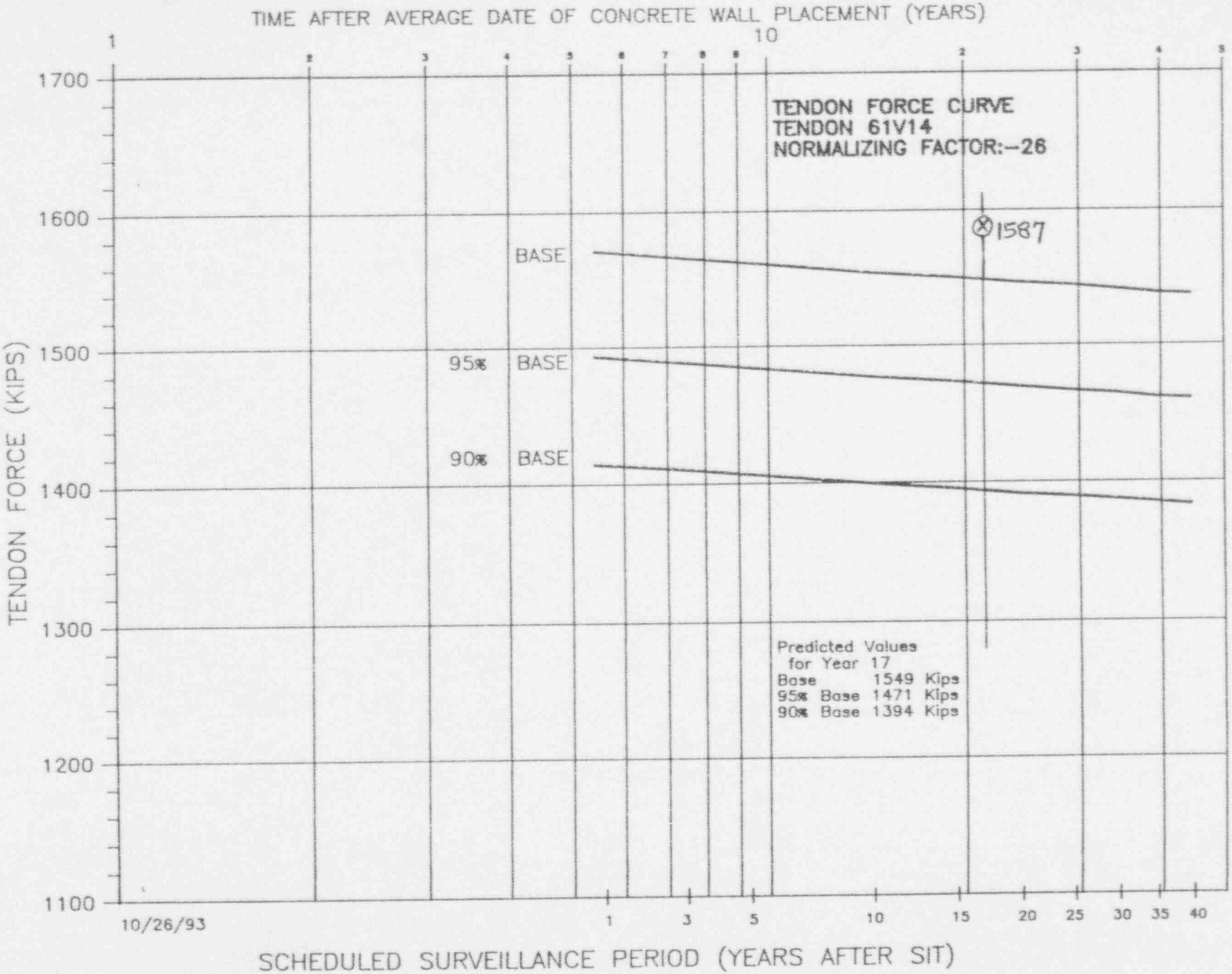
TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 34V23
NORMALIZING FACTOR:-7
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1530 Kips
95% Base 1453 Kips
90% Base 1377 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

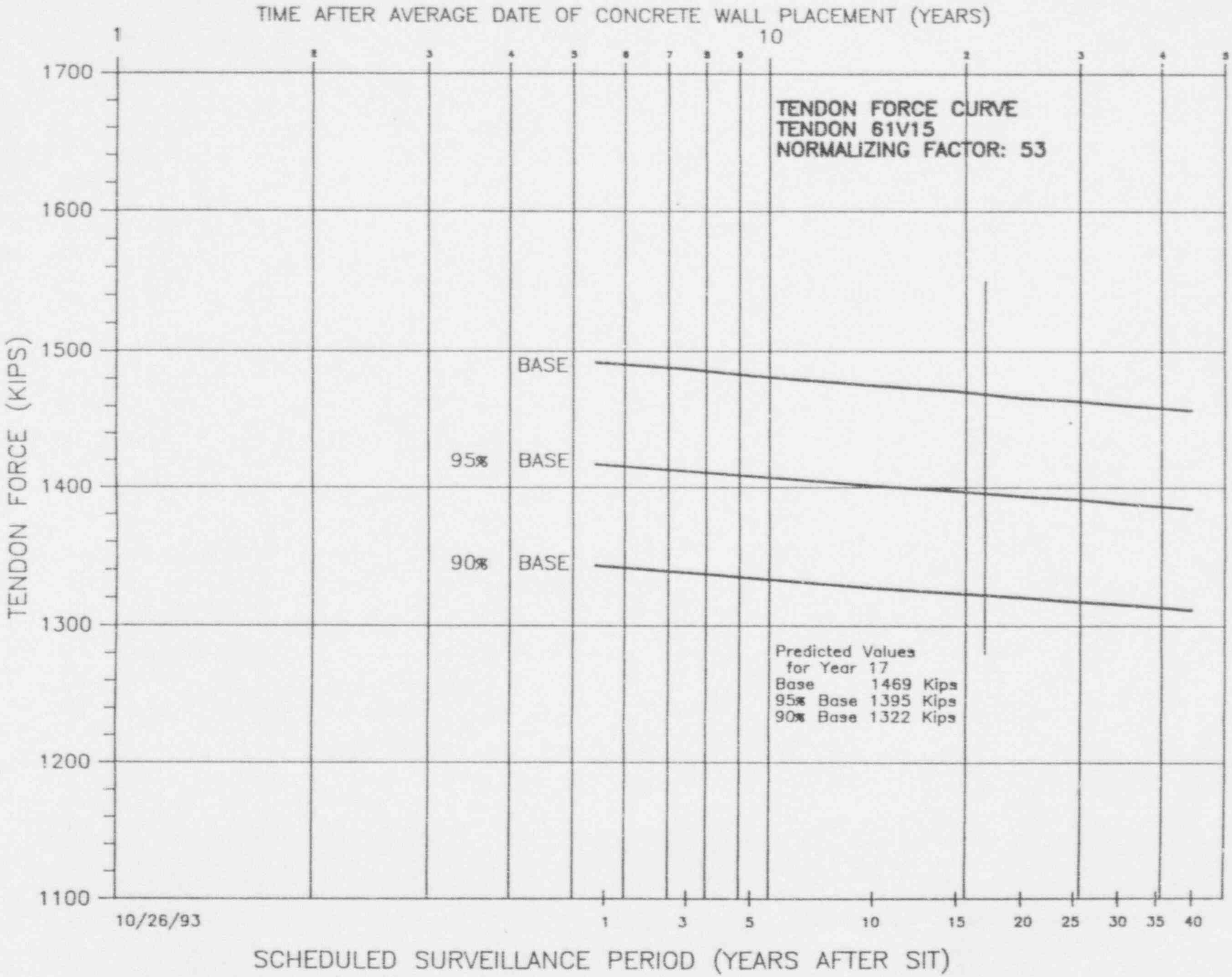

TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 56V14
NORMALIZING FACTOR:-61
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
Predicted Values
for Year 17
Base 1585 Kips
95% Base 1506 Kips
90% Base 1426 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 56V15
NORMALIZING FACTOR: 13
TENDON FORCE (KIPS)
BASE
95% BASE
90% BASE
1541
Predicted Values
for Year 17
Base 1510 Kips
95% Base 1434 Kips
90% Base 1359 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 56V16
NORMALIZING FACTOR:-26
BASE
95% BASE
90% BASE
TENDON FORCE (KIPS)
Predicted Values
for Year 17
Base 1549 Kips
95% Base 1471 Kips
90% Base 1394 Kips
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 61V13
NORMALIZING FACTOR:-44
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1568 Kips
95% Base 1490 Kips
90% Base 1412 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 61V14
NORMALIZING FACTOR:-26
1587
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1549 Kips
95% Base 1471 Kips
90% Base 1394 Kips
TENDON FORCE (KIPS)
10/26/93
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)


TIME AFTER AVERAGE DATE OF CONCRETE WALL PLACEMENT (YEARS)
TENDON FORCE CURVE
TENDON 61V15
NORMALIZING FACTOR: 53
TENDON FORCE (KIPS)
1700
1600
1500
1400
1300
1200
1100
BASE
95% BASE
90% BASE
Predicted Values
for Year 17
Base 1469 Kips
95% Base 1395 Kips
90% Base 1322 Kips
10/26/93
1 3 5 10 15 20 25 30 35 40
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)

*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:

| Tendon | NF in SP-182 Rev 11 | Corrected NF |
|---|---|---|
| 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

**Dome Tendons****

| Tendon ID | (1) Lift Off Force | (2)* Normalizing Factor (NF) | (3) Normalized Lift Off (1)+(2) | (4) Acceptance Yes No |
|---|---|---|---|---|
| 1. D215 | 1518 | 27 | 1545 | |
| 2. D224 | 1425 | 17 | 1442 | |
| 3. D231 | 1335 | 39 | 1374 | (Average equal to or greater than 1215 kips) |
| 4. N/A | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| | | Total | ~~[illegible]~~ 4361 | |
| | | Average | 1454 | YES ✓ |

**Vertical Tendons****

| Tendon ID | (1) Lift Off Force | (2)* Normalizing Factor (NF) | (3) Normalized Lift Off (1)+(2) | (4) Acceptance Yes No |
|---|---|---|---|---|
| 1. 34V6 | 1590 | 7 | 1597 | |
| 2. 61V14 | 1537 | -26 | 1561 | |
| 3. 56V15 | 1541 | 13 | 1554 | (Average equal to or greater than 1149 kips) |
| 4. N/A | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |
| | | Total | 4712 | |
| | | Average | 1571 | YES ✓ |

**Hoop Tendons****

CORRECTED 5/17/94 M.M.

| Tendon ID | (1) Lift Off Force | (2)* Normalizing Factor (NF) | (3) Normalized Lift Off (1)+(2) | (4) Acceptance Yes No |
|---|---|---|---|---|
| 1. 35H1 | 1572 | 19 | 1591 | |
| 2. 42H1 | 1560 | ~~11~~ 12 | ~~1571~~ 1572 | |
| 3. 46H47 | 1468 | -3 | 1465 | (Average equal to or greater than 1252 kips) |
| 4. 62H8 | 1435 | ~~-31~~ -22 | ~~[illegible]~~ 1413 | |
| 5. 46H29 | 1300 | -32 | 1268 | |
| ADJACENT 6. 46H28 | 1375 | -77 | 1298 | |
| ADJACENT 7. 46H30 | 1382 ~~1254~~ | -7 | ~~1247~~ 1375 | |
| 8. 46H21 | 1425 | -12 | 1413 | |
| 9. N/A | | | | |
| 10. | | | | |
| 11. | | | | |
| 12. | | | | |
| | | Total | 11395 ~~[illegible]~~ | |
| | | Average | ~~1405~~ 1424 | YES ✓ |

* See Enclosure 42 for Normalizing Factors
** Include adjacent tendons, if any, in the above tendon list.

Contract Reviewed By: David M. McC[signature] Date: 1/5/94

FPC Approval By: [signature] Date: 1/10/94

ENCLOSURE 42

TENDON NORMALIZING FACTORS

| Tendon No. | NF | Tendon No. | NF | Tendon No. | NF |
|---|---|---|---|---|---|
| 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 BROKEN 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:

| Tendon Group | Max/Tendon | Max/10 Tendons | Max/Group |
|---|---|---|---|
| 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 UNTI 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

| TENDON NO. | EFF. WIRES | INEFF. WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
|---|---|---|---|---|---|
| D 101 ** | 162 | 1 | | 9 | |
| D 102 | 163 | 0 | | 8 | |
| D 103 | 163 | 0 | | 8 | |
| D 104 | 157 | 6 | | 8 | |
| D 105 | 162 | 1 | | 3 | |
| D 106 | 162 | 1 | | 2 | |
| D 107 | 163 | 0 | | 2 | |
| D 108 | 163 | 0 | | 2 | |
| D 109 ** | 163 | 0 | | 2 | |
| D 110 | 163 | 0 | | 2 | |
| D 111 | 163 | 0 | | 2 | |
| D 112 | 163 | 0 | | 3 | |
| D 113 | 163 | 0 | | 3 | |
| D 114 | 162 | 1 | | 4 | |
| D 115 | 163 | 0 | | 3 | |
| D 116 | 162 | 1 | | 3 | |
| D 117 ** | 163 | 0 | | 2 | |
| D 118 | 163 | 0 | | 2 | |
| D 119 | 163 | 0 | | 6 | |
| D 120 | 163 | 0 | | 8 | |
| D 121 | 162 | 1 | | 8 | |
| D 122 | 163 | 0 | | 9 | |
| D 123 | 162 | 1 | | 10 | |
| D 124 | 163 | 0 | | 12 | |
| D 125 ** | 163 | 0 | | 13 | |
| D 126 | 163 | 0 | | 14 | |
| D 127 | 163 | 0 | | 15 | |
| D 128 | 159 | 4 | | 22 | |
| D 129 | 161 | 2 | | 19 | |
| D 130 | 163 | 0 | | 17 | |
| D 131 | 161 | 2 | | 17 | |
| D 132 | 162 | 1 | | 15 | |
| D 133 ** | 160 | 3 | | 15 | |
| D 134 | 162 | 1 | | 12 | |
| D 135 | 162 | 1 | | 11 | |
| D 136 | 162 | 1 | | 16 | |
| D 137 | 156 | 7 | | 16 | |
| D 138 | 162 | 1 | | 10 | |
| D 139 | 163 | 0 | | 9 | |
| D 140 | 163 | 0 | | 9 | |
| D 141 ** | 163 | 0 | | 9 | |
| TOTAL | 6647 | 36 | OK | | |
| MAXIMUM 2% / GROUP | | 134 | | | |

### D200 GROUP

| TENDON NO. | EFF. WIRES | INEFF. WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
|---|---|---|---|---|---|
| D 201 ** | 163 | 0 | | 10 | |
| D 202 | 162 | 1 | | 11 | |
| D 203 | 163 | 0 | | 11 | |
| D 204 | 161 | 2 | | 11 | |
| D 205 | 160 | 3 | | 11 | |
| D 206 | 163 | 0 | | 8 | |
| D 207 | 161 | 2 | | 8 | |
| D 208 | 161 | 2 | | 22 | |
| D 209 ** | 163 | 0 | | 25 | |
| D 210 | 163 | 0 | | 25 | |
| D 211 | 162 | 1 | | 27 | |
| D 212 | 162 | 1 | | 27 | |
| D 213 | 163 | 0 | | 26 | |
| D 214 | 161 | 2 | | 26 | |
| D 215 | 163 | 0 | | 26 | |
| D 216 | 163 | 0 | | 30 | |
| D 217 ** | 147 | 16 | * | 30 | |
| D 218 | 158 | 5 | | 14 | |
| D 219 | 163 | 0 | | 9 | |
| D 220 | 161 | 2 | | 9 | |
| D 221 | 162 | 1 | | 7 | |
| D 222 | 163 | 0 | | 10 | |
| D 223 | 163 | 0 | | 10 | |
| D 224 | 161 | 2 | | 22 | |
| D 225 ** | 159 | 4 | | 21 | |
| D 226 | 163 | 0 | | 18 | |
| D 227 | 163 | 0 | | 19 | |
| D 228 | 163 | 0 | | 19 | |
| D 229 | 163 | 0 | | 19 | |
| D 230 | 163 | 0 | | 19 | |
| D 231 | 159 | 4 | | 19 | |
| D 232 | 163 | 0 | | 19 | |
| D 233 ** | 151 | 12 | * | 19 | |
| D 234 | 162 | 1 | | 8 | |
| D 235 | 162 | 1 | | 7 | |
| D 236 | 162 | 1 | | 8 | |
| D 237 | 163 | 0 | | 10 | |
| D 238 | 163 | 0 | | 10 | |
| D 239 | 163 | 0 | | 12 | |
| D 240 | 163 | 0 | | 14 | |
| D 241 ** | 159 | 4 | | 14 | |
| TOTAL | 6616 | 67 | OK | | |
| MAXIMUM 2% / GROUP | | 134 | | | |

### D300 GROUP

| TENDON NO. | EFF. WIRES | INEFF. WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
|---|---|---|---|---|---|
| D 301 ** | 162 | 1 | | 19 | |
| D 302 | 156 | 7 | | 18 | |
| D 303 | 161 | 2 | | 11 | |
| D 304 | 163 | 0 | | 9 | |
| D 305 | 160 | 3 | | 11 | |
| D 306 | 161 | 2 | | 9 | |
| D 307 | 163 | 0 | | 7 | |
| D 308 | 160 | 3 | | 7 | |
| D 309 ** | 163 | 0 | | 6 | |
| D 310 | 162 | 1 | | 6 | |
| D 311 | 163 | 0 | | 8 | |
| D 312 | 163 | 0 | | 8 | |
| D 313 | 163 | 0 | | 10 | |
| D 314 | 161 | 2 | | 12 | |
| D 315 | 162 | 1 | | 10 | |
| D 316 | 163 | 0 | | 10 | |
| D 317 ** | 163 | 0 | | 10 | |
| D 318 | 161 | 2 | | 10 | |
| D 319 | 163 | 0 | | 8 | |
| D 320 | 160 | 3 | | 9 | |
| D 321 | 163 | 0 | | 7 | |
| D 322 | 161 | 2 | | 9 | |
| D 323 | 161 | 2 | | 9 | |
| D 324 | 163 | 0 | | 10 | |
| D 325 ** | 162 | 1 | | 11 | |
| D 326 | 163 | 0 | | 14 | |
| D 327 | 163 | 0 | | 14 | |
| D 328 | 163 | 0 | | 14 | |
| D 329 | 162 | 1 | | 15 | |
| D 330 | 162 | 1 | | 17 | |
| D 331 | 161 | 2 | | 16 | |
| D 332 | 161 | 2 | | 16 | |
| D 333 ** | 160 | 3 | | 15 | |
| D 334 | 162 | 1 | | 19 | |
| D 335 | 159 | 4 | | 20 | |
| D 336 | 163 | 0 | | 16 | |
| D 337 | 163 | 0 | | 19 | |
| D 338 | 162 | 1 | | 21 | |
| D 339 | 160 | 3 | | 20 | |
| D 340 | 163 | 0 | | 20 | |
| D 341 ** | 161 | 2 | | 20 | |
| TOTAL | 6631 | 52 | OK | | |
| MAXIMUM 2% / GROUP | | 134 | | | |

** REDUCED FORCE TENDONS
MAXIMUM WIRES PER GROUP = 41 X 163 = 6683

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNTI 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.WK3

**13HXX GROUP**

| TENDON NO. | EFF WIRES | INEFF WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
|---|---|---|---|---|---|
| 13H 1 | 161 | 2 | | 4 | |
| 13H 2 | 163 | 0 | | 2 | |
| 13H 3 | 163 | 0 | | 2 | |
| 13H 4 | 163 | 0 | | 2 | |
| 13H 5 | 163 | 0 | | 2 | |
| 13H 6 | 163 | 0 | | 2 | |
| 13H 7 | 163 | 0 | | 4 | |
| 13H 8 | 163 | 0 | | 4 | |
| 13H 9 | 161 | 2 | | 7 | |
| 13H 10 | 163 | 0 | | 7 | |
| 13H 11 | 163 | 0 | | 8 | |
| 13H 12 | 163 | 0 | | 13 | |
| 13H 13 | 163 | 0 | | 13 | |
| 13H 14 | 163 | 0 | | 13 | |
| 13H 15 | 163 | 0 | | 13 | |
| 13H 16 | 161 | 2 | | 13 | |
| 13H 17 | 163 | 0 | | 11 | |
| 13H 18 | 160 | 3 | | 11 | |
| 13H 19 | 161 | 2 | | 8 | |
| 13H 20 | 162 | 1 | | 8 | |
| 13H 21 | 158 | 5 | | 7 | |
| 13H 22 | 163 | 0 | | 2 | |
| 13H 23 | 163 | 0 | | 3 | |
| 13H 24 | 163 | 0 | | 4 | |
| 13H 25 | 163 | 0 | | 4 | |
| 13H 26 | 163 | 0 | | 6 | |
| 13H 27 | 163 | 0 | | 9 | |
| 13H 28 | 163 | 0 | | 10 | |
| 13H 29 | 161 | 2 | | 11 | |
| 13H 30 | 163 | 0 | | 10 | |
| 13H 31 | 163 | 0 | | 11 | |
| 13H 32 | 162 | 1 | | 11 | |
| 13H 33 | 162 | 1 | | 10 | |
| 13H 34 | 163 | 0 | | 10 | |
| 13H 35 | 161 | 2 | | 10 | |
| 13H 36 | 160 | 3 | | 9 | |
| 13H 37 | 162 | 1 | | 6 | |
| 13H 38 | 162 | 1 | | 5 | |
| 13H 39 | 162 | 1 | | 6 | |
| 13H 40 | 162 | 1 | | 5 | |
| 13H 41 | 163 | 0 | | 4 | |
| 13H 42 | 163 | 0 | | 4 | |
| 13H 43 | 162 | 1 | | 4 | |
| 13H 44 | 163 | 0 | | 3 | |
| 13H 45 | 162 | 1 | | 3 | |
| 13H 46 | 163 | 0 | | 2 | |
| 13H 47 | 163 | 0 | | 4 | |
| TOTAL | 7629 | 32 | OK | | |
| MAXIMUM 2% / GROUP | | 153 | | | |

**35HXX GROUP**

| TENDON NO. | EFF WIRES | INEFF WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
|---|---|---|---|---|---|
| 35H 1 | 161 | 2 | | 14 | |
| 35H 2 | 162 | 1 | | 18 | |
| 35H 3 | 161 | 2 | | 17 | |
| 35H 4 | 161 | 2 | | 17 | |
| 35H 5 | 160 | 3 | | 15 | |
| 35H 6 | 163 | 0 | | 12 | |
| 35H 7 | 162 | 1 | | 12 | |
| 35H 8 | 161 | 2 | | 11 | |
| 35H 9 | 163 | 0 | | 9 | |
| 35H 10 | 162 | 1 | | 10 | |
| 35H 11 | 157 | 6 | | 9 | |
| 35H 12 | 163 | 0 | | 4 | |
| 35H 13 | 161 | 2 | | 4 | |
| 35H 14 | 163 | 0 | | 2 | |
| 35H 15 | 163 | 0 | | 3 | |
| 35H 16 | 163 | 0 | | 4 | |
| 35H 17 | 163 | 0 | | 4 | |
| 35H 18 | 163 | 0 | | 4 | |
| 35H 19 | 162 | 1 | | 4 | |
| 35H 20 | 163 | 0 | | 7 | |
| 35H 21 | 162 | 1 | | 7 | |
| 35H 22 | 163 | 0 | | 6 | |
| 35H 23 | 163 | 0 | | 6 | |
| 35H 24 | 162 | 1 | | 6 | |
| 35H 25 | 162 | 1 | | 5 | |
| 35H 26 | 163 | 0 | | 4 | |
| 35H 27 | 163 | 0 | | 4 | |
| 35H 28 | 163 | 0 | | 4 | |
| 35H 29 | 159 | 4 | | 4 | |
| 35H 30 | 163 | 0 | | 5 | |
| 35H 31 | 163 | 0 | | 5 | |
| 35H 32 | 163 | 0 | | 5 | |
| 35H 33 | 163 | 0 | | 5 | |
| 35H 34 | 163 | 0 | | 6 | |
| 35H 35 | 163 | 0 | | 6 | |
| 35H 36 | 163 | 0 | | 6 | |
| 35H 37 | 163 | 0 | | 6 | |
| 35H 38 | 163 | 0 | | 6 | |
| 35H 39 | 158 | 5 | | 8 | |
| 35H 40 | 163 | 0 | | 4 | |
| 35H 41 | 163 | 0 | | 6 | |
| 35H 42 | 163 | 0 | | 8 | |
| 35H 43 | 162 | 1 | | 11 | |
| 35H 44 | 163 | 0 | | 10 | |
| 35H 45 | 163 | 0 | | 11 | |
| 35H 46 | 163 | 0 | | 13 | |
| 35H 47 | 163 | 0 | | 13 | |
| TOTAL | 7625 | 36 | OK | | |
| MAXIMUM 2% / GROUP | | 153 | | | |

**51HXX GROUP**

| TENDON NO. | EFF WIRES | INEFF WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
|---|---|---|---|---|---|
| 51H 1 | 163 | 0 | | 11 | |
| 51H 2 | 163 | 0 | | 11 | |
| 51H 3 | 163 | 0 | | 11 | |
| 51H 4 | 162 | 1 | | 15 | |
| 51H 5 | 163 | 0 | | 14 | |
| 51H 6 | 161 | 2 | | 14 | |
| 51H 7 | 162 | 1 | | 13 | |
| 51H 8 | 160 | 3 | | 12 | |
| 51H 9 | 161 | 2 | | 11 | |
| 51H 10 | 161 | 2 | | 9 | |
| 51H 11 | 163 | 0 | | 7 | |
| 51H 12 | 163 | 0 | | 7 | |
| 51H 13 | 159 | 4 | | 7 | |
| 51H 14 | 163 | 0 | | 3 | |
| 51H 15 | 163 | 0 | | 3 | |
| 51H 16 | 162 | 1 | | 4 | |
| 51H 17 | 163 | 0 | | 3 | |
| 51H 18 | 161 | 2 | | 5 | |
| 51H 19 | 163 | 0 | | 3 | |
| 51H 20 | 163 | 0 | | 3 | |
| 51H 21 | 163 | 0 | | 4 | |
| 51H 22 | 163 | 0 | | 7 | |
| 51H 23 | 163 | 0 | | 8 | |
| 51H 24 | 163 | 0 | | 8 | |
| 51H 25 | 162 | 1 | | 8 | |
| 51H 26 | 163 | 0 | | 7 | |
| 51H 27 | 161 | 2 | | 8 | |
| 51H 28 | 163 | 0 | | 8 | |
| 51H 29 | 163 | 0 | | 9 | |
| 51H 30 | 162 | 1 | | 9 | |
| 51H 31 | 160 | 3 | | 8 | |
| 51H 32 | 162 | 1 | | 5 | |
| 51H 33 | 163 | 0 | | 5 | |
| 51H 34 | 163 | 0 | | 7 | |
| 51H 35 | 163 | 0 | | 8 | |
| 51H 36 | 162 | 1 | | 9 | |
| 51H 37 | 161 | 2 | | 8 | |
| 51H 38 | 162 | 1 | | 7 | |
| 51H 39 | 163 | 0 | | 6 | |
| 51H 40 | 163 | 0 | | 6 | |
| 51H 41 | 163 | 0 | | 6 | |
| 51H 42 | 162 | 1 | | 7 | |
| 51H 43 | 161 | 2 | | 6 | |
| 51H 44 | 162 | 1 | | 6 | |
| 51H 45 | 162 | 1 | | 6 | |
| 51H 46 | 163 | 0 | | 8 | |
| 51H 47 | 162 | 1 | | 10 | |
| TOTAL | 7625 | 36 | OK | | |
| MAXIMUM 2% / GROUP | | 153 | | | |

MAXIMUM WIRES PER GROUP = 47 X 163 = 7661

FLORIDA POWER CORPORATION
CRYSTAL RIVER UNTI 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 ?
FILE: HWIRE2.WK3

| 42HXX GROUP | | | | | |
|---|---|---|---|---|---|
| TENDON NO. | EFF WIRES | INEFF WIRES | * IF GREATER THAN 8 | TOTAL INEFF. WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
| 42H 1 | 160 | 3 | | 8 | |
| 42H 2 | 160 | 3 | | 5 | |
| 42H 3 | 163 | 0 | | 2 | |
| 42H 4 | 162 | 1 | | 3 | |
| 42H 5 | 163 | 0 | | 3 | |
| 42H 6 | 163 | 0 | | 3 | |
| 42H 7 | 162 | 1 | | 3 | |
| 42H 8 | 163 | 0 | | 2 | |
| 42H 9 | 163 | 0 | | 2 | |
| 42H 10 | 163 | 0 | | 2 | |
| 42H 11 | 163 | 0 | | 2 | |
| 42H 12 | 163 | 0 | | 3 | |
| 42H 13 | 162 | 1 | | 4 | |
| 42H 14 | 162 | 1 | | 4 | |
| 42H 15 | 163 | 0 | | 3 | |
| 42H 16 | 163 | 0 | | 3 | |
| 42H 17 | 163 | 0 | | 3 | |
| 42H 18 | 163 | 0 | | 3 | |
| 42H 19 | 163 | 0 | | 3 | |
| 42H 20 | 163 | 0 | | 3 | |
| 42H 21 | 162 | 1 | | 3 | |
| 42H 22 | 162 | 1 | | 2 | |
| 42H 23 | 162 | 1 | | 1 | |
| 42H 24 | 163 | 0 | | 0 | |
| 42H 25 | 163 | 0 | | 3 | |
| 42H 26 | 163 | 0 | | 4 | |
| 42H 27 | 163 | 0 | | 4 | |
| 42H 28 | 163 | 0 | | 4 | |
| 42H 29 | 163 | 0 | | 4 | |
| 42H 30 | 163 | 0 | | 4 | |
| 42H 31 | 163 | 0 | | 5 | |
| 42H 32 | 163 | 0 | | 6 | |
| 42H 33 | 163 | 0 | | 6 | |
| 42H 34 | 166 | 3 | | 6 | |
| 42H 35 | 162 | 1 | | 3 | |
| 42H 36 | 163 | 0 | | 2 | |
| 42H 37 | 163 | 0 | | 2 | |
| 42H 38 | 163 | 0 | | 5 | |
| 42H 39 | 163 | 0 | | 8 | |
| 42H 40 | 162 | 1 | | 11 | |
| 42H 41 | 162 | 1 | | 10 | |
| 42H 42 | 163 | 0 | | 10 | |
| 42H 43 | 163 | 0 | | 10 | |
| 42H 44 | 163 | 0 | | 10 | |
| 42H 45 | 163 | 0 | | 11 | |
| 42H 46 | 163 | 0 | | 11 | |
| 42H 47 | 160 | 3 | | 11 | |
| TOTAL | 7639 | 22 | OK | | |
| MAXIMUM 2% / GROUP | | 153 | | | |

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

| 62HXX GROUP | | | | | |
|---|---|---|---|---|---|
| TENDON NO. | EFF WIRES | INEFF WIRES | * IF GREATER THAN 8 | TOTAL INEFF WIRES IN NEXT 10 TENDONS | * IF GREATER THAN 49 (3%) |
| 62H 1 | 162 | 1 | | 11 | |
| 62H 2 | 163 | 0 | | 12 | |
| 62H 3 | 163 | 0 | | 12 | |
| 62H 4 | 161 | 2 | | 12 | |
| 62H 5 | 159 | 4 | | 10 | |
| 62H 6 | 163 | 0 | | 6 | |
| 62H 7 | 162 | 1 | | 6 | |
| 62H 8 | 161 | 2 | | 5 | |
| 62H 9 | 163 | 0 | | 3 | |
| 62H 10 | 162 | 1 | | 5 | |
| 62H 11 | 161 | 2 | | 5 | |
| 62H 12 | 163 | 0 | | 4 | |
| 62H 13 | 163 | 0 | | 4 | |
| 62H 14 | 163 | 0 | | 4 | |
| 62H 15 | 163 | 0 | | 4 | |
| 62H 16 | 163 | 0 | | 6 | |
| 62H 17 | 163 | 0 | | 6 | |
| 62H 18 | 163 | 0 | | 6 | |
| 62H 19 | 161 | 2 | | 6 | |
| 62H 20 | 162 | 1 | | 5 | |
| 62H 21 | 162 | 1 | | 4 | |
| 62H 22 | 163 | 0 | | 3 | |
| 62H 23 | 163 | 0 | | 3 | |
| 62H 24 | 163 | 0 | | 4 | |
| 62H 25 | 161 | 2 | | 5 | |
| 62H 26 | 163 | 0 | | 4 | |
| 62H 27 | 163 | 0 | | 4 | |
| 62H 28 | 163 | 0 | | 5 | |
| 62H 29 | 162 | 1 | | 5 | |
| 62H 30 | 163 | 0 | | 5 | |
| 67H 31 | 163 | 0 | | 5 | |
| 62H 32 | 163 | 0 | | 5 | |
| 62H 33 | 162 | 1 | | 5 | |
| 62H 34 | 162 | 1 | | 6 | |
| 62H 35 | 162 | 1 | | 5 | |
| 62H 36 | 163 | 0 | | 5 | |
| 62H 37 | 162 | 1 | | 5 | |
| 62H 38 | 163 | 0 | | 7 | |
| 62H 39 | 162 | 1 | | 8 | |
| 62H 40 | 163 | 0 | | 7 | |
| 62H 41 | 163 | 0 | | 7 | |
| 62H 42 | 163 | 0 | | 9 | |
| 62H 43 | 161 | 2 | | 13 | |
| 62H 44 | 163 | 0 | | 11 | |
| 62H 45 | 162 | 1 | | 12 | |
| 62H 46 | 163 | 0 | | 13 | |
| 62H 47 | 160 | 3 | | 13 | |
| TOTAL | 7630 | 31 | OK | | |
| MAXIMUM 2% / GROUP | | 153 | | | |

MAXIMUM WIRES PER GROUP = 47 X 163 = 7661

# FLORIDA POWER CORPORATION
## CRYSTAL RIVER UNTI 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: VWIRE1.WK3

| 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 UNTI 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°)

| 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 | |
| 56V 2 | 162 | 1 | | 9 | |
| 56V 3 | 163 | 0 | | 8 | |
| 56V 4 | 162 | 1 | | 9 | |
| 56V 5 | 162 | 1 | | 8 | |
| 56V 6 | 162 | 1 | | 10 | |
| 56V 7 | 161 | 2 | | 11 | |
| 56V 8 | 161 | 2 | | 9 | |
| 56V 9 | 162 | 1 | | 7 | |
| 56V 10 | 163 | 0 | | 9 | |
| 56V 11 | 163 | 0 | | 9 | |
| 56V 12 | 163 | 0 | | 11 | |
| 56V 13 | 162 | 1 | | 13 | |
| 56V 14 | 163 | 0 | | 12 | |
| 56V 15 | 160 | 3 | | 12 | |
| 56V 16 | 161 | 2 | | 11 | |
| 56V 17 | 163 | 0 | | 9 | |
| 56V 18 | 163 | 0 | | 10 | |
| 56V 19 | 160 | 3 | | 11 | |
| 56V 20 | 163 | 0 | | 8 | |
| 56V 21 | 161 | 2 | | 9 | |
| 56V 22 | 161 | 2 | | 13 | |
| 56V 23 | 163 | 0 | | 11 | |
| 56V 24 | 163 | 0 | | 11 | |
| 45V 1 | 161 | 2 | | 13 | |
| 45V 2 | 163 | 0 | | 11 | |
| 45V 3 | 162 | 1 | | 11 | |
| 45V 4 | 162 | 1 | | 11 | |
| 45V 5 | 163 | 0 | | 11 | |
| 45V 6 | 162 | 1 | | 11 | |
| 45V 7 | 157 | 6 | | 11 | |
| 45V 8 | 163 | 0 | | 6 | |
| 45V 9 | 163 | 0 | | 7 | |
| 45V 10 | 161 | 2 | | 9 | |
| 45V 11 | 163 | 0 | | 9 | |
| 45V 12 | 163 | 0 | | 10 | |
| TOTAL | 5832 | 36 | OK | | |
| MAXIMUM 2% / GROUP | | 117 | | | |

### 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%) |
|---|---|---|---|---|---|
| 45V 13 | 163 | 0 | | 4 | |
| 45V 14 | 163 | 0 | | 4 | |
| 45V 15 | 163 | 0 | | 5 | |
| 45V 16 | 163 | 0 | | 5 | |
| 45V 17 | 163 | 0 | | 6 | |
| 45V 18 | 163 | 0 | | 9 | |
| 45V 19 | 163 | 0 | | 12 | |
| 45V 20 | 161 | 2 | | 12 | |
| 45V 21 | 162 | 1 | | 10 | |
| 45V 22 | 162 | 1 | | 9 | |
| 45V 23 | 163 | 0 | | 10 | |
| 45V 24 | 162 | 1 | | 10 | |
| 34V 1 | 163 | 0 | | 9 | |
| 34V 2 | 162 | 1 | | 9 | |
| 34V 3 | 160 | 3 | | 9 | |
| 34V 4 | 160 | 3 | | 10 | |
| 34V 5 | 163 | 0 | | 8 | |
| 34V 6 | 163 | 0 | | 9 | |
| 34V 7 | 163 | 0 | | 11 | |
| 34V 8 | 161 | 2 | | 11 | |
| 34V 9 | 163 | 0 | | 9 | |
| 34V 10 | 163 | 0 | | 13 | |
| 34V 11 | 163 | 0 | | 13 | |
| 34V 12 | 162 | 1 | | 14 | |
| 34V 13 | 159 | 4 | | 13 | |
| 34V 14 | 162 | 1 | | 9 | |
| 34V 15 | 162 | 1 | | 9 | |
| 34V 16 | 161 | 2 | | 8 | |
| 34V 17 | 163 | 0 | | 6 | |
| 34V 18 | 163 | 0 | | 6 | |
| 34V 19 | 159 | 4 | | 6 | |
| 34V 20 | 163 | 0 | | 2 | |
| 34V 21 | 162 | 1 | | 2 | |
| 34V 22 | 163 | 0 | | 1 | |
| 34V 23 | 163 | 0 | | 3 | |
| 34V 24 | 162 | 1 | | 4 | |
| TOTAL | 5839 | 29 | OK | | |
| 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

| TENDON | NET DUCT VOLUME (GAL.) | NET GREASE ADDED (GAL.) | % GREASE ADDED |
|---|---|---|---|
| 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 $20^{\circ}$ F change in temperature. Initial filling temperature of the grease averaged $140^{\circ}$F. During the subject tendon surveillance the ambient temperature of insitu grease was about 80 $^{\circ}$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 y 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.

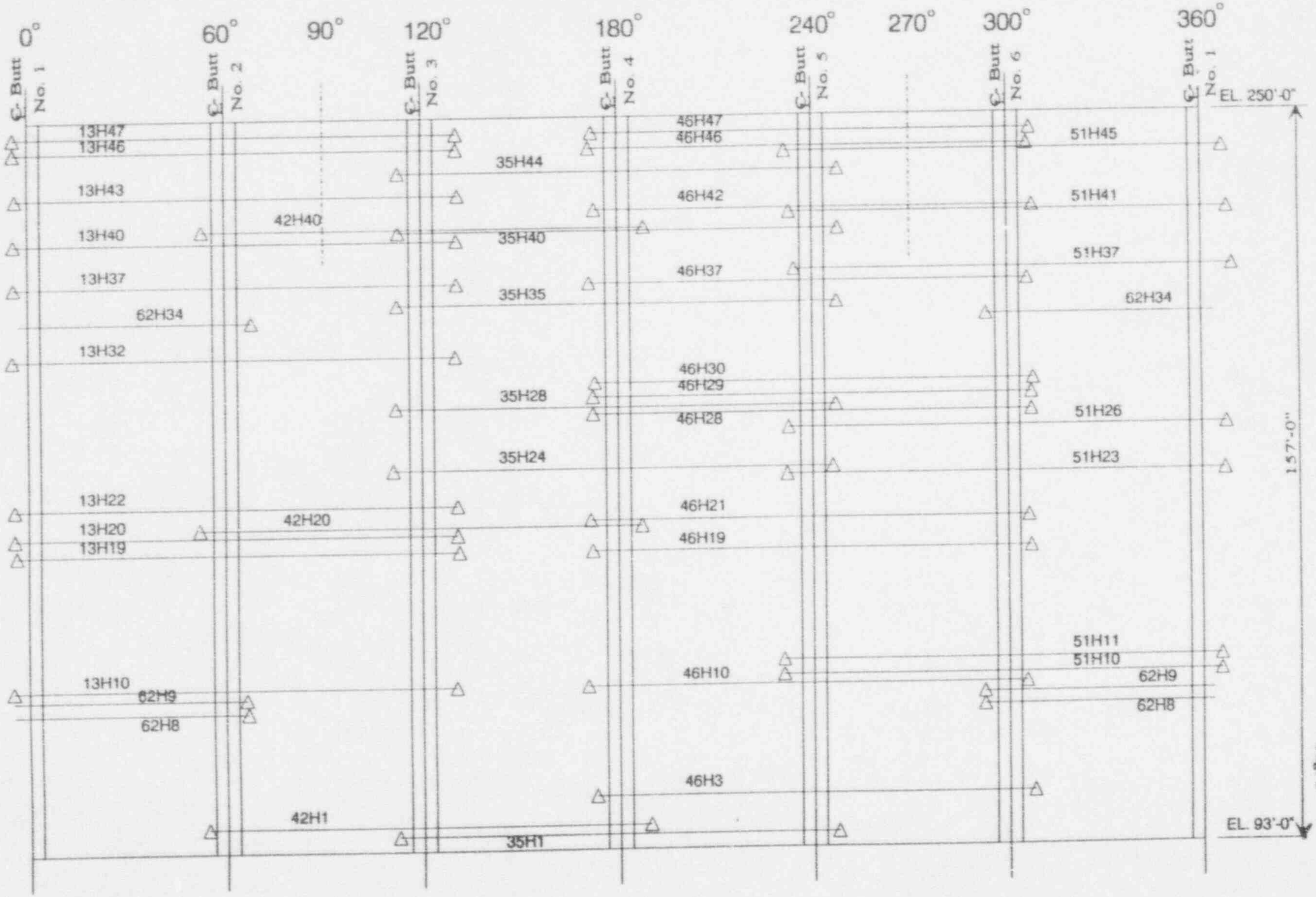
*APPENDIX E*

*LOCATION PLOTS OF HOOP TENDONS*

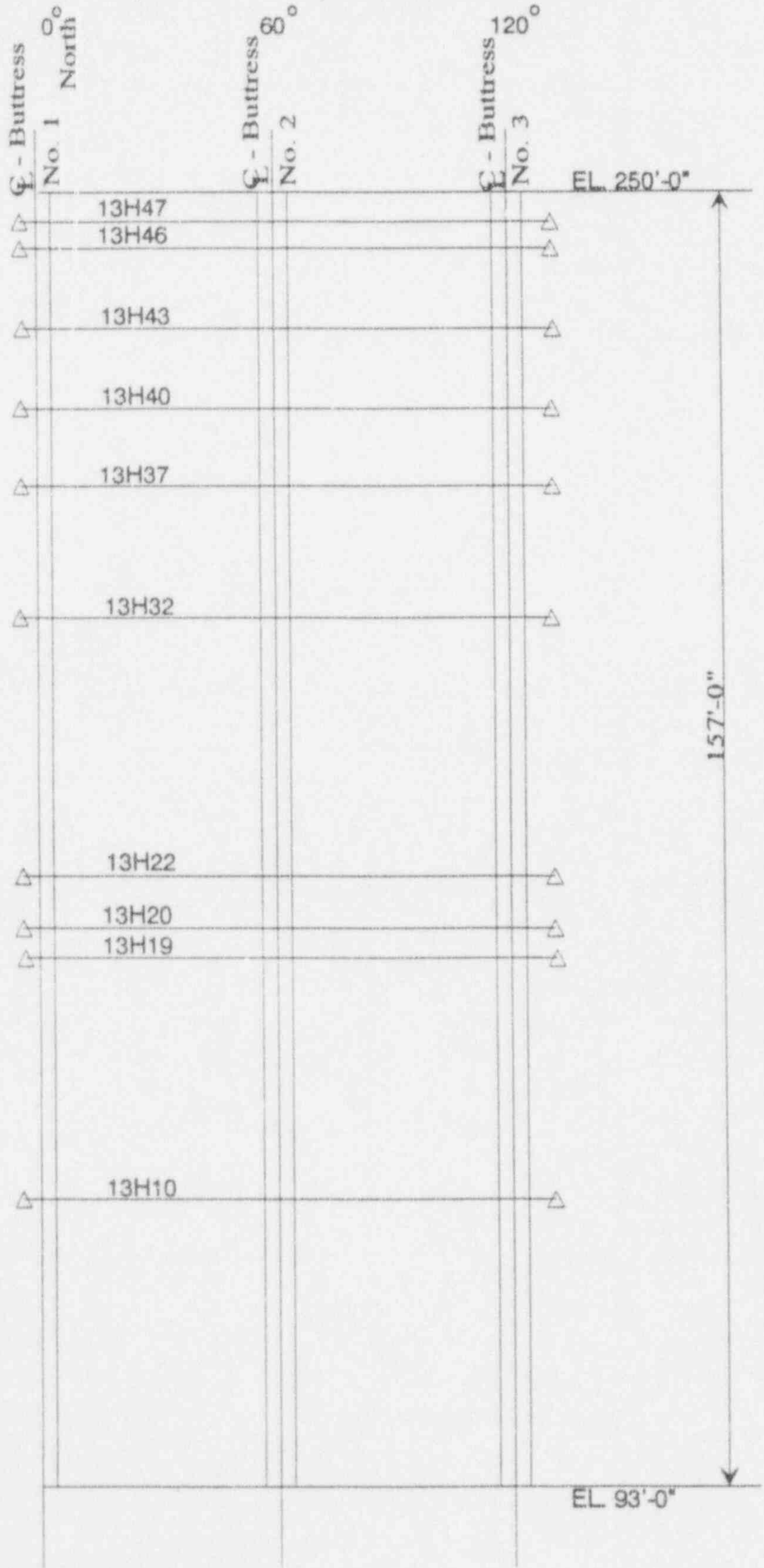
*INSPECTED IN ALL SURVEILLANCES*

**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.

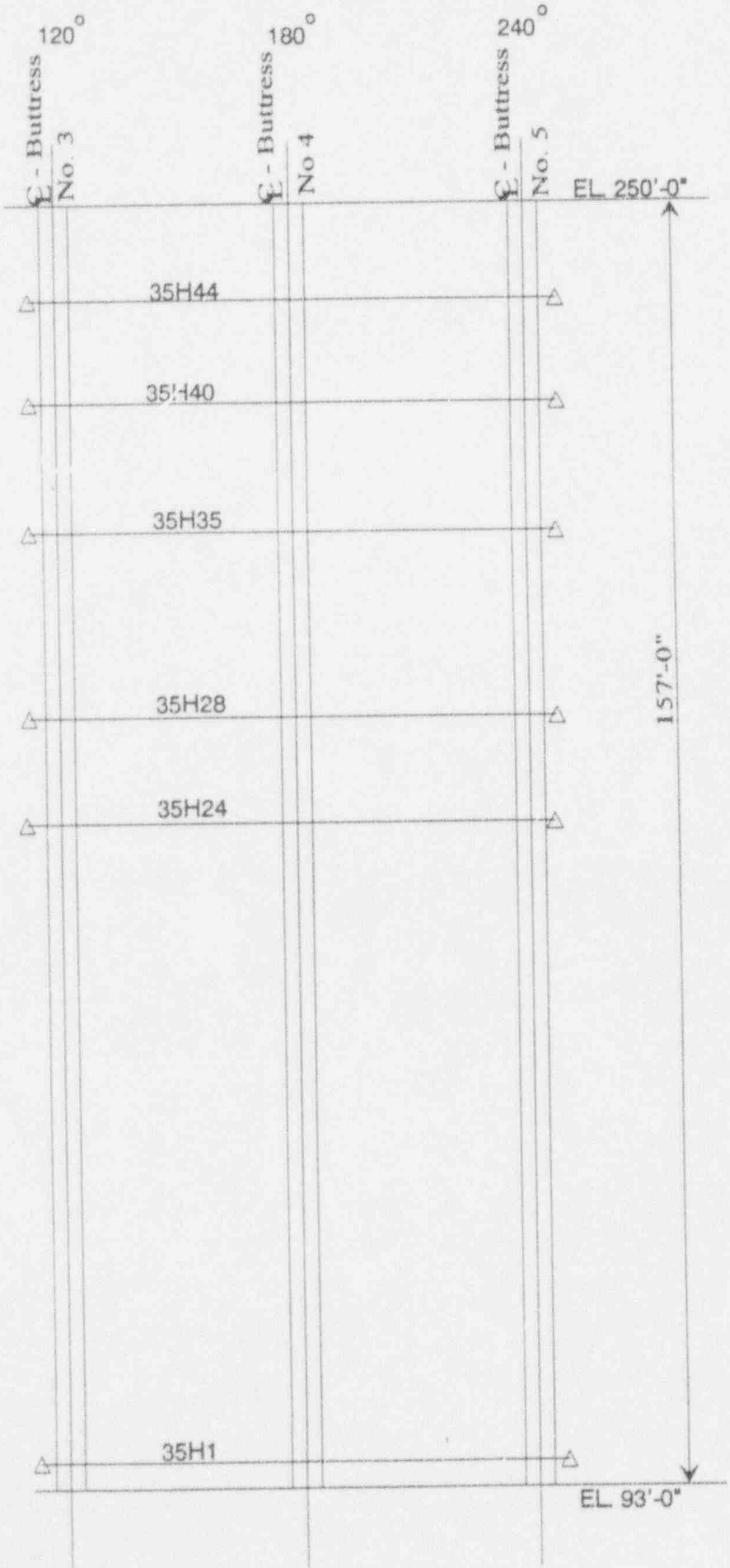
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Layout
Tendons Inspected up to 5th Surveillance



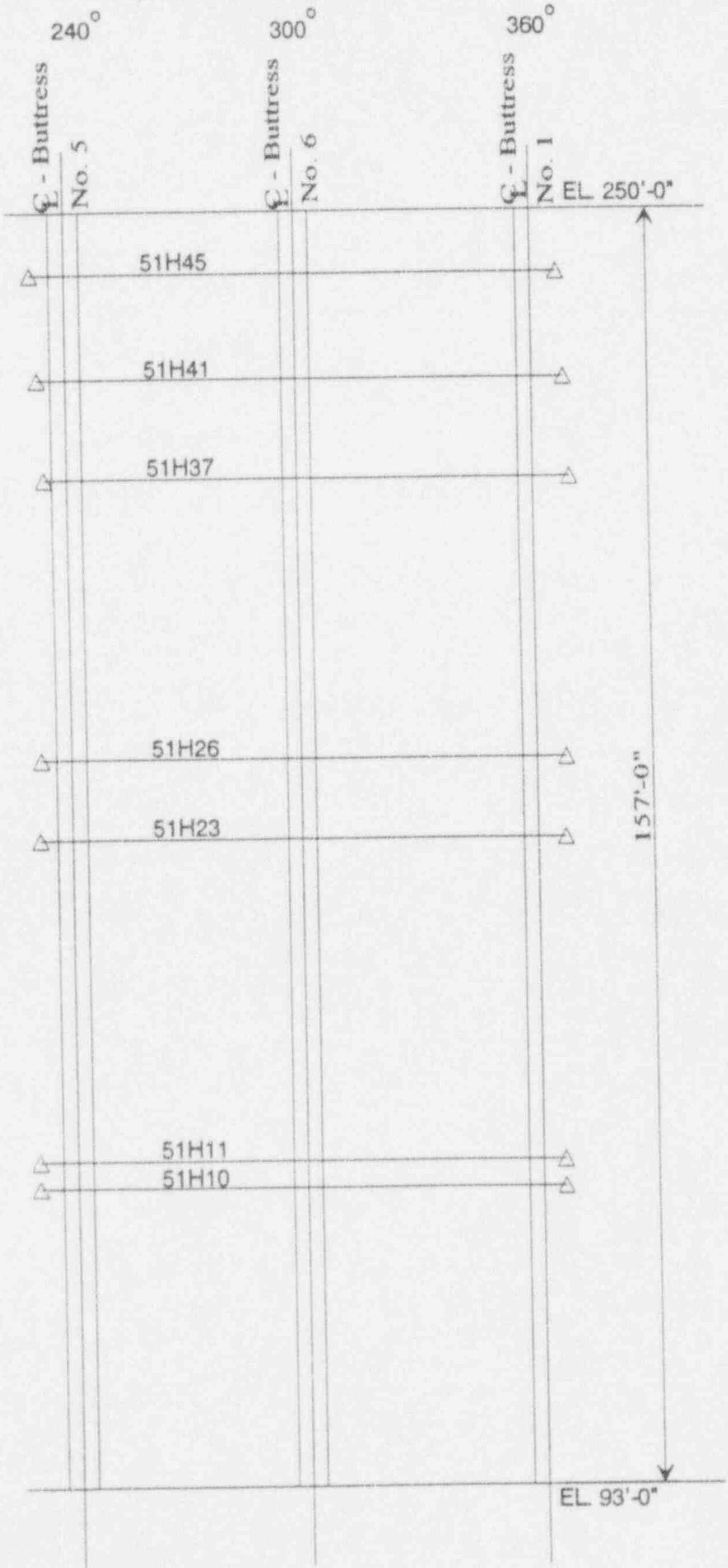
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



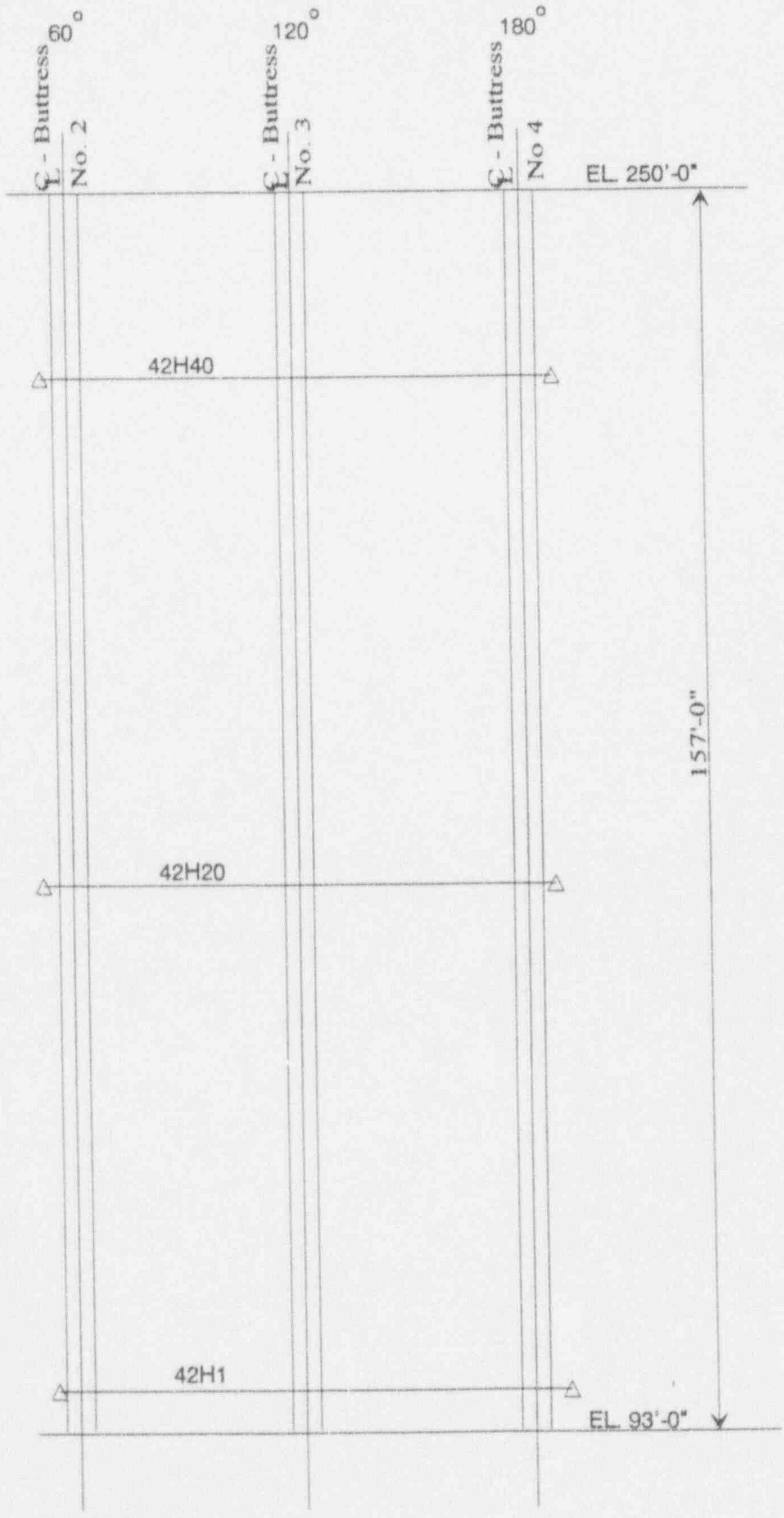
Crystal River Unit #3
Tendon Surveillance Program
Hoop Tendons Inspected to the 5th Surveillance



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



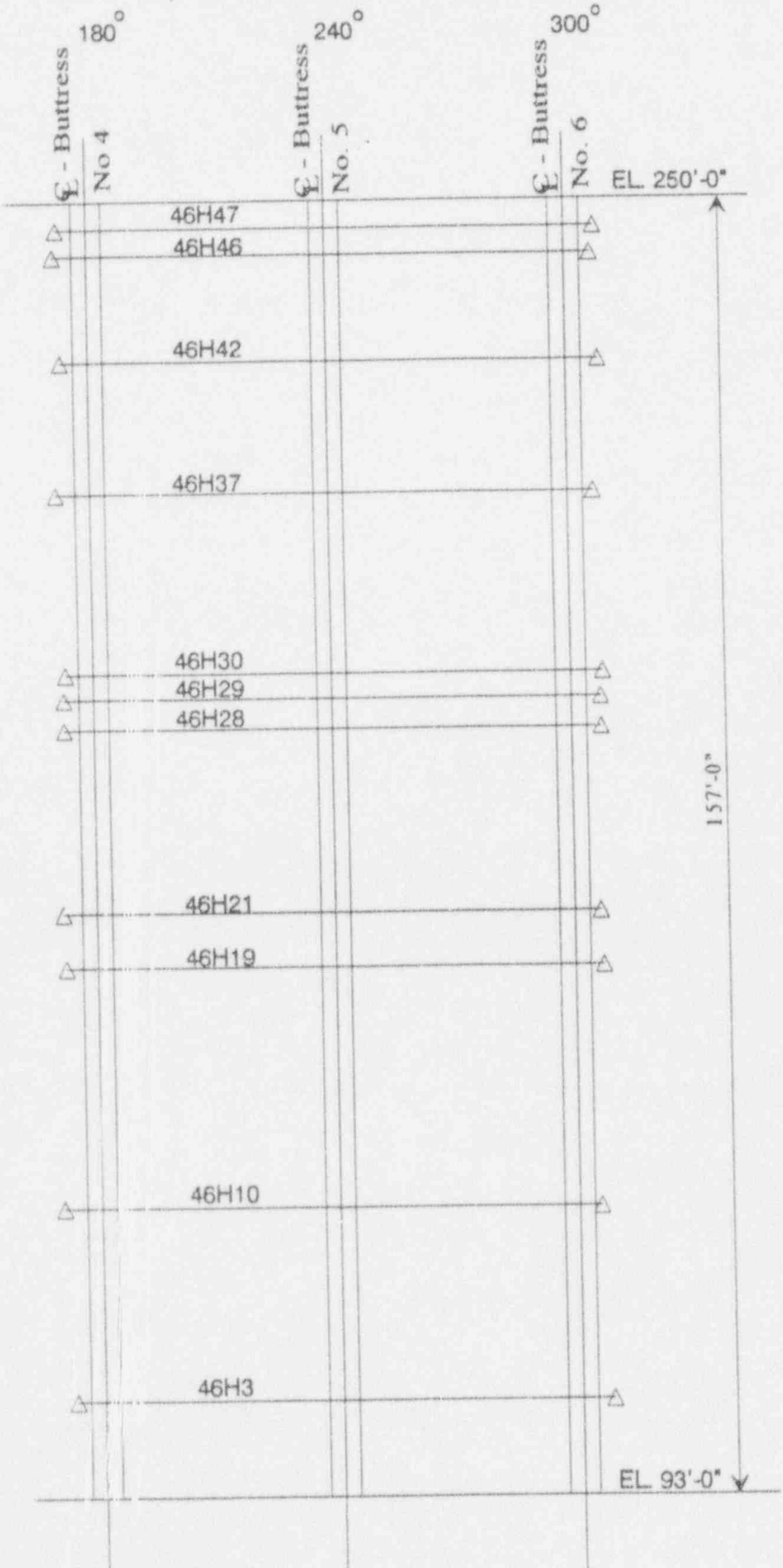
# Crystal River Unit #3
## Tendon Surveillance Program
## Hoop Tendons Inspected to the 5th Surveillance



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