AmerGen

Three Mile Island Unit No.1

30TH YEAR REACTOR BUILDING TENDON SURVEILLANCE (PERIOD 8)

Topical Report No. 183
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1. PURPOSE AND INTRODUCTION

This topical report documents the results of the 30th Year (Period 8) Reactor Building In-Service Inspection. This in-service inspection (ISI), also referred to herein as a surveillance, is performed at 5 year intervals to demonstrate the continuing structural integrity of the reactor building, or, containment.

This topical report also serves as the Engineering Evaluation Report required by 10CFR50.55a and the ASME Boiler and Pressure Vessel Code, Section XI, Sub-Section IWL, Par. IWL-3310. The ISI Summary Report and the NIS-1 and NIS-2 forms identified in Sub-Section IWA, Article IWA-6000 and required by 10CFR50.55a, are separate documents.

The ISI, performed per Technical Specification 4.4.2.1, meets the requirements of USNRC Regulation 10CFR50.55a and, as referenced in that regulation, the requirements of the 1992 Edition (with 1992 Addenda) of the, ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWL. The ISI, also referred to as a surveillance, meets the requirements described in the FSAR and is performed in accordance with TMI-1 Surveillance Procedure 1301-9.1.

The ISI is comprised of the measurements, examinations, tests and related activities identified in Section 2 below.

Measurements, examinations and tests on randomly selected tendons have been done on a regular basis throughout the life of the plant.. Complete examination of the containment exterior as specified in Sub-Section IWL, examination of tendon end anchorage caps and tendon force trend extrapolation commenced with the Period 7 surveillance (performed in mid-2000) in accordance with requirements introduced in a 1996 amendment to 10CFR50.55a. The Period 8 surveillance is the second to be conducted per 10CFR50.55a and Sub-Section IWL. The first, the Period 7 surveillance, is documented in Topical Report No. 136.

The remainder of this topical report is divided into the following sections.

Section 2, Summary of Work Performed and Inspection Results, is a synopsis of ISI activities and findings.

Section 3, Post-Tensioning System Examinations and Tests, describes all measurements, tests examinations performed on post-tensioning system components (except bearing plate examinations performed as a part of the overall containment exterior examination), tabulates results, provides a detailed development of tendon force trend extrapolation and includes evaluations of conditions that do not meet acceptance criteria. Post-tensioning system examinations and tests performed to satisfy the Topical Report 136 commitments are also covered in this section.

Section 4, Containment Surface Examinations, describes the examination process, discusses examination findings and includes photographs and evaluations of conditions that do not meet acceptance criteria. Containment surface examinations performed to satisfy the Topical Report 136 commitments are also covered in this section.

Section 5, Repairs and Follow-Up Examinations, is a summary list of all required repair work and all damage / deteriorated area re-examinations to be done during the 35th year surveillance.

Section 6, Conclusions, summarizes overall conclusions regarding containment integrity as demonstrated by the ISI.

Section 7, References, identifies the documents that govern the performance of the ISI and that are otherwise cited in this report.

Section 8, Tables and Figures, includes all tables and figures referenced in preceding sections of the report.

Section 9, Attachment, is the detailed report submitted by the ISI contractor. This report includes all field data sheets.

2. SUMMARY OF WORK PERFORMED AND INSPECTION RESULTS

The work performed during the 30^{th} year surveillance and the results of these examinations and tests are summarized in 2.1 and 2.2 below.

2.1 Work Performed

The 30^{th} year surveillance consisted of testing and visual examination of a randomly selected sample of post-tensioning tendons and visual examination of the accessible containment exterior.

2.1.1 Post-Tensioning System Testing and Examination

The following tendons, except as noted, were randomly selected for testing and examination. Tendons V-32, H62-26 and D225, identified as control tendons, are included in successive surveillance samples. The initial size, nominally 2% of the tendons in each group (vertical, hoop, dome) or 5 tendons, whichever is less (but at least 3 tendons), meets the requirements of Sub-Section IWL, Par. IWL-2521. Vertical tendons V-137 and V-141 were added to the initial sample when the elongations of V-140 exceeded the acceptance limit. Dome tendon D342 was an initial random selection, which, for safety reasons, could not be fully examined with the plant in operation. Tendon D213 was substituted for D342 per IWL-2521.1.

- Vertical Tendons: V-32, V-53, V-66, V-137, V-140, V-141
- Hoop Tendons: H13-11, H35-49, H46-25, H62-18, H62-26
- Dome Tendons: D213, D225, D230, D342

Examinations and tests consisted of the following activities, with exceptions as noted. All examinations and tests were performed in accordance with Surveillance Procedure 1301-9.1, which incorporates the applicable requirements of the 1992 Edition (with 1992 Addenda) of the ASME Boiler and Pressure Vessel Code, Section XI, Sub-Section IWL and the additional requirements specified in 10CFR50.55a, Par. (b)(2)(viii). The surveillance procedure also incorporates all applicable requirements of the FSAR.

- Collection of corrosion protection medium (CPM) samples from each end of each tendon (no samples taken from the ends of V-137 and V-141) and laboratory tests on these to determine water content, concentration of corrosive ions and reserve alkalinity.

- Visual examination of end anchorage hardware (button heads, anchor heads, shims and bearing plates) and concrete within 2 ft. of the bearing plate.
- Measurement of end anchorage force using the feeler gage pull out procedure described in Surveillance Procedure 1301-9.1.
- De-tensioning of one tendon in each group and extraction of a specimen wire for visual examination and tensile tests.
- Re-tensioning of the de-tensioned tendons with measurement of elongations at several loads.
- Refilling tendon ducts and end caps with CPM (quantities of CPM removed and replaced measured and documented).

In addition, corrosion protection medium samples taken from the lower ends of tendons V-86 and V-164 were tested. This was done to satisfy a commitment made in Topical Report No. 136.

Also, all tendon end anchorage covers were examined for damage and CPM leakage in accordance with the requirements of 10CFR50.55a, Par. (b)(2)(viii)(A).

2.1.2 Containment Surface Examination

The entire accessible concrete surface of the containment was visually examined using the VT-3C procedure defined in Sub-Section IWL, Par. IWL-2310. This examination was performed directly (without optical aide) and remotely using both binoculars and a theodolite. Tendon end anchorage bearing plates were examined at the same time.

The concrete was examined for evidence of cracking, spalling, efflorescence and other types of damage / deterioration as identified in ACI 202.1R. This examination was also focused, as specified in 10CFR50.55a, Par. (b)(2)(viii)(D)(3), on CPM seepage through the concrete.

Bearing plates were examined for detached or missing coatings and corrosion.

Topical Report No. 136, Section 4, specifies that detailed examinations of previously identified concrete surface conditions be performed during the 30th year ISI. These were performed using the VT-1C detailed visual examination procedure defined in IWL-2310.

2.2 Inspection Results

The results of the 30th Year (Period 8) Reactor Building In-Service Inspection are summarized below.

2.2.1 Post-Tensioning System

The results of post-tensioning system examinations, measurements and tests generally met prescriptive acceptance criteria and the few exceptions were shown to be acceptable by evaluation. A listing of specific results follows.

- All tendon forces were above 95% of the predicted values.
- Vertical, hoop and dome tendon normalized group mean forces were all above the minimum required levels.
- Vertical and hoop tendon force trends projected to the latest date for completion of the 35th year ISI were above the minimum required levels for those groups. The unadjusted dome tendon projection was below the minimum required level; the result of a small sample statistical anomaly. A projection using forces adjusted for the mean normalization factor met the acceptance criterion. The dome tendon projection was accepted by evaluation.
- Elongations measured during re-tensioning of de-tensioned dome and hoop tendons were within 10% of previously measure values. The elongation of V-140 exceeded the 10% limit, a condition attributed to anchor head rotation observed during the re-tensioning process. As a result, tendons V-137 and V-141 (like V-140, these curve around the equipment opening) were added to the surveillance sample, de-tensioned and re-tensioned. Since the elongations of these additional sample tendons met the acceptance criterion, since the V-140 anchor head experienced a large rotation during the initial re-tensioning and since the elongation of V-140 met the acceptance criteria during the second re-tensioning, the excess elongation of V-140 was accepted by evaluation.
- End anchorage hardware was free of active corrosion, cracking and distortion.
- With two exceptions, button head condition was as documented during construction. One exception was a single button head protruding about 0.1 in that was not previously documented. Since such a small protrusion could have been easily missed by the construction examinations, this was accepted without further question. Four button heads protruded from the lower anchor head of V-140 both before de-tensioning and after re-tensioning. Since the vertical tendons are tensioned at the top end only, it was concluded that

protruding button heads at the lower end could have been overlooked at the time of construction. On this basis, the condition was accepted by evaluation.

- The tensile strength and elongation (at failure) of all wire test samples were above the minimum required values.

- Water content, corrosive ion concentration and reserve alkalinity of all corrosion protection medium samples (including those collected at the lower ends of V-86 and V-164) met acceptance criteria.

- No free water was found at tendon anchorages.

- Concrete adjacent to end anchorages was free of cracks over 0.01 in. wide.

- All end anchorage covers (grease caps) were free of damage; only a few showed any signs of CPM leakage and the leakage observed was deemed to be insignificant.

2.2.2 Containment Surface

Concrete and tendon anchorage bearing plates were generally free of damage / deterioration other than that previously documented. Three exceptions, listed below, will be restored to acceptable condition.

- Water seeping under three embedded plates on the dome has resulted in some minor leaching of the concrete. These plates extend out from a point close to the dome apex toward the general area of the vent stack on the west side of the containment. This condition will be corrected by sealing the concrete to embed interface area with a caulking compound to prevent further entry of water.

- Grout patches have detached from dome surface at two locations leaving depressions that can accumulate water. One location is alongside an embed on the west side of the dome. The other is on the west side of the dome close to the crane rail. These depressions will be filled with epoxy grout to prevent ponding and the consequent possibility of progressive freeze-thaw damage.

- The coating has detached from significantly large areas on several vertical tendon upper end bearing plates. Some of these areas are heavily rusted. All areas with detached coating will be cleaned to bright metal, primed and painted to prevent further corrosion.

The above activities do not fall under the purview of Section XI and will be done as routine maintenance tasks rather than under a Section XI Repair / Replacement program. The work will be examined during the 35^{th} year surveillance.

Containment surface areas with previously documented damage / deterioration were re-examined as specified in Section 4 of Topical Report No. 136. In all cases, the conditions previously recorded were found to be effectively stable. However, in several of these areas it was determined that repair / restorative work is necessary to ensure against further deterioration. The repair and restoration work will be completed at the earliest reasonable opportunity, but definitely by the end of September 2006. All such work will be examined during the 35^{th} year surveillance.

With one exception, the repairs, which are identified in Sections 4 and 5, consist of minor restorative work on the concrete surface or sealing against water intrusion. These are not subject to Section XI Repair / Replacement requirements. The exception is the application of protective coating in the areas where reinforcing steel is exposed on the vertical face of the ring girder. This work falls under the purview of Section XI since the first layer of reinforcing is exposed.

As previously documented, there is some seepage of CPM through the lower containment wall. This condition is being addressed under the Repetitive Task program and is no longer considered a reactor building ISI issue.

3. POST-TENSIONING SYSTEM TESTS AND EXAMINATIONS

The following tests and examinations were performed to assess the continuing quality and integrity of the post-tensioning system.

- Measurement of tendon end anchorage force.
- Measurement of tendon elongation during re-tensioning.
- Measurement of wire test specimen strength and elongation at failure.
- Chemical analysis to determine corrosion protection medium test specimen water content, reserve alkalinity and concentration of corrosive ions.
- Visual examination of post-tensioning system components, as well as concrete adjacent to bearing plates, to detect accumulation of free water, corrosion, deformation, cracking, wire breakage and wire button head failure.
- Visual examination of tendon end anchorage covers (grease caps) to detect damage and corrosion protection medium leakage.

All but the last of the above tests and examinations involved a small sample of the total tendon population. All tendon end anchorage covers were examined.

Tendons initially selected for tests and examinations were randomly picked from a population that included all tendons not examined during a prior surveillance. These tendons, identified in Surveillance Procedure 1301-9.1, Enclosure 2, are listed below.

Vertical Tendons: V32, V53, V66 and V140

Hoop Tendons: H13-11, H35-49, H46-25, H62-18 and H62-26

Dome Tendons: D213, D225, D230 and D342 (limited scope examination[1])

[1] Tendon D342 was randomly selected for examination during Surveillance 8. Since one end of this tendon is located over the main steam safety and dump valve discharge piping, safety considerations limit the scope of the examination that can be performed while the plant is operating. Another dome tendon (one of the remaining 3) was added to maintain the necessary sample size. During this surveillance, per ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWL requirements, the end of tendon D342 that is not over the discharge piping was visually examined; also, a corrosion protection medium test specimen was collected. Tendon D342 will be subject to a full set of tests and examinations during Surveillance 9, which will be performed during a refueling outage.

One tendon in each group (vertical, hoop, dome) was selected for de-tensioning and removal of a specimen wire for testing.

Vertical tendons V-137 and V-141 were added to the sample when the elongation measured during re-tensioning of V140 exceeded the acceptance limit. V-137 and V-141 were de-tensioned and re-tensioned to determine elongations; no wire test specimen was removed from these tendons.

Additional limited examinations and tests were performed on specified tendons in accordance with commitments made in the 25th year surveillance report (Topical Report No. 136). These are covered under the applicable topic headings in Sections 3.1 through 3.8 below, which present and discuss the results of post-tensioning system tests and examinations, and summarized in Section 3.9.

3.1 Tendon End Anchorage Forces

Tendon end anchorage forces were measured using the liftoff technique described in Surveillance Procedure 1301-9.1. Forces were measured at both ends of hoop and dome tendons and at only the upper ends of vertical tendons.

Acceptance criteria cover individual tendon forces, current group mean forces and projected group mean forces. These forces and the associated criteria are discussed in the following paragraphs.

3.1.1 Individual Tendon Forces

Table 3-1 lists measured end anchorage forces, tendon mean end forces (for hoop and dome tendons, the average of individual end anchorage measurements) and lower acceptance limits[2]. The acceptance limits are equal to 95% of the forces predicted for the individual tendons. Predictions are documented in Calculation DC-5390-225.01-SE.

As shown in the table, all tendon forces (mean end forces) are above the lower acceptance limits. Furthermore, the forces in all tendons except V-140 are above the predicted levels. The force in V-140 is at 97.4% of the predicted level.

In addition, all measured end anchorage forces are below 1394 kip (0.7 GUTS).

[2] There is no stated upper limit; however, no measured force exceeded the implicit upper limit of 0.7 GUTS (Guaranteed Ultimate Tensile Strength), which is the stated upper limit on re-tensioning force. For the tendons examined during the 30th year surveillance, all of which have 169 effective wires, 0.7 GUTS equates to 1394 kip.

3.1.2 Group Mean Forces

The mean of the forces in each group of tendons must be equal to or greater than the minimum required force for the group as stated in Par. 9.3.1 of Surveillance Procedure 1301-9.1. The minimum required force values are:

Vertical Tendons: 1033 kip

Hoop Tendons: 1108 kip

Dome Tendons: 1064 kip

During construction of the containment, individual tendons were tensioned to anchorage forces between lower and upper acceptance limits of about 0.70 and 0.74 GUTS. Tendons were tensioned in sequence. The force in any tendon falls (elastic shortening loss) during subsequent tensioning of tendons in the same group.

Surveillance samples are quite small, nominally 2% of the tendons in each group. For this reason, there is a relatively high probability that the samples will consist of tendons initially tensioned to the high end or the low end of the acceptance range and / or tendons tensioned close to the beginning of the sequence or end of the sequence. Therefore, a sample mean force calculated using measured end anchorage forces has a high probability of deviating significantly from the true group mean.

To account for this probable deviation, measured tendon forces are adjusted (normalized) to account for initial tensioning force and stressing sequence. Calculation DC-5390-225.01-SE describes the normalization procedure and lists the adjustments for each tendon selected for (or added to) surveillance samples.

Table 3-2 lists tendon forces (from Table 3-1), adjustments, normalized forces and group mean normalized forces. All group mean normalized forces are well above the minimum required levels as summarized below.

Tendon Group	Mean Normalized Force, kip	Minimum Required Mean, kip
Vertical	1184	1033
Hoop	1153	1108
Dome	1161	1064

3.1.3 Projected Group Mean Forces

10 CFR 50.55a requires, in Par. (b)(2)(viii)(B), projecting the trends of tendon forces to determine whether or not group means are not expected to remain above minimum required levels until the time of the subsequent surveillance.

Topical Report No. 136, which documents the results of the 25th year surveillance, develops the procedure used to extrapolate tendon force trends. As explained in that report, the projection uses the tendon force data acquired during the 10th year and later surveillances. It does not use data from the 1st, 3rd and 5th year surveillances for two reasons. First, the trends of the forces measured during those early surveillances appear to differ significantly from the trends established by the data recorded during the later surveillances. Second, the later (10th year forward) surveillances are more completely documented, which ensures that the correct force values are used in trend development.

As discussed in Topical Report No. 136, the force data for all three groups exhibit a considerable degree of scatter. As a result, fitted lines or curves do not provide meaningful representations of force trends. Therefore, forecast force levels are not determined as the ordinates of regression curves. Rather, these are reported as the 95% lower confidence levels computed for postulated log-linear relationships between force and time. The basis for using the confidence level approach is extensively discussed in the cited topical report.

Tables 3-3, 3-4 and 3-5 list, for each of the three tendon groups, the forces measured during the 10th, 15th, 20th, 25th and 30th year surveillances. All values except those listed for the 30th year are extracted from Tables 7, 8 and 9 in Topical Report No. 136. Forces listed are measured values rather than normalized values. Measured values are used in the trend projections since the quantity of data is normally considered sufficient (but see subsequent discussion and treatment of dome tendon forces) to average out over time the effects of initial tensioning force and tensioning sequence. The 'Time since SIT' figure in the tables is determined as the number of months, converted to equivalent years, from March 1974 (SIT date) to the month in which the mid-point of the surveillance falls.

Figures 3-1, 3-2 and 3-3 are log-linear plots of vertical, hoop and dome group tendon forces measured during the 10th year and later surveillances. The data scatter, which is typical, is evident in the plots. The plots include log-linear trend lines for reference. However, the magnitude of the scatter is such that these fitted trends cannot be considered meaningful (that the hoop tendon trend shows force increasing with time).

The tendon forces listed in Tables 3-3, 3-4 and 3-5 (and plotted in Figures 3-1 through 3-3) were used to compute 95% lower confidence limits on group means projected to March 2010 (36 years after the SIT and the latest date for the completion of Surveillance 9). These limits were computed using the following procedure as developed in most engineering statistics texts[3].

$$LCL(X) = a + b \times X - t_{0.05} \times s_e \times \sqrt{[1/n + n \times (X - X_m)^2 / S_{xx}]}$$

where (with all summations from 1 to n):

$LCL(X)$ = Lower confidence limit on Y at an abscissa value of X
$a = Y_m - b \times X_m$ is the intercept of the least squares fit trend line
$Y_m = (\Sigma Y_i) / n$
$X_m = (\Sigma X_i) / n$
X_i, Y_i are data sets with $X_i = Log_{10}(t_i)$ and Y_i = tendon force in kip
t_i is time in years since the SIT
$b = S_{xy} / S_{xx}$ is the slope of the slope of the least squares fit trend line
$t_{0.05}$ is Student's t statistic for a 95% confidence level and (n-2) degrees of freedom
$s_e = \sqrt{\{[S_{xx} \times S_{yy} - (S_{xy})^2] / [n \times (n - 2) \times S_{xx}]\}}$ is the standard error of estimate
n is the number of data sets used in the LCL calculation
$S_{xx} = n \times \Sigma X_i^2 - (\Sigma X_i)^2$
$S_{yy} = n \times \Sigma Y_i^2 - (\Sigma Y_i)^2$
$S_{xy} = n \times \Sigma (X_i \times Y_i) - (\Sigma X_i) \times (\Sigma Y_i)$

These lower confidence limits (LCL's) on group means and the corresponding minimum required group means are listed below.

Group	95% LCL on Group Mean, kip	Minimum Required Group Mean, kip
Vertical	1162	1033
Hoop	1113	1108
Dome	1031	1064

The LCL's on the projected means for the vertical and hoop groups are above the minimum required values which provides a significant degree of confidence that the true means will, in fact, be above these levels in March 2010.

[3] The procedure shown is that presented in *Probability and Statistics for Engineers* by Irwin Miller and John E. Freund, Prentice-Hall, 1965.

The LCL on the projected mean for the dome group is below the minimum required value. This is the result of an unexpected skew in the dome tendon samples rather than excessive force loss.

The mean normalization factors for the 25th and 30th year surveillance samples are listed in the following table.

Tendon Group	Mean Normalization Factors and (Number of Sample Tendons)		
	Surveillance Year 25	Surveillance Year 30	Weighted Mean
Vertical	-5.8 (4)	-9.7 (6)	-8.1
Hoop	+1.2 (5)	-0.4 (5)	+0.2
Dome	+27.3 (3)	+40.0 (3)	+33.6

The vertical and hoop tendon normalization factors average out to reasonably small values as expected. The dome tendon factors do not. This is a consequence of random sample selection and the small number of dome tendons in the samples. Of five sample tendons (one, D225, with the relatively large factor of +45 kip, is a control, or common, tendon), all have significant positive factors ranging from +8 kip to +67 kip. In contrast, the vertical and hoop tendon factors range from –46 kip to +25 kip and –54 kip to +51 kip, respectively. Also, the control vertical tendon, V-32, has a relatively small factor of –7 kip and the control hoop, H62-26, has a miniscule factor of +2 kip. Since the control tendon factors figure twice in the above weighted means, the magnitudes of these factors are doubly significant.

A more reasonable LCL results if the 25th and 30th year dome tendon forces are increased by 33.6 kip. Uniformly increasing the forces, rather than normalizing, preserves the scatter and ensures that the standard error of estimate is not grossly affected. The LCL determined for the higher forces is 1068 kip, which is above the minimum required value of 1064 kip.

To preserve consistent treatment of data, the vertical tendon LCL was recomputed using forces for the for 25th and 30th years that are reduced by the mean normalization factor of 8.1 kip. The LCL determined for the reduced force levels is 1152 kip. This is 10 kip below the previously computed LCL but still well above the 1033 kip minimum required mean force.

Based on the above computations and evaluations, it is concluded that mean vertical, hoop and dome tendon anchorage forces will remain above minimum required levels through March 2010, by which time the 35th year surveillance must be complete.

3.1.4 Control Tendon Force Trends

One tendon in each group is designated as a control tendon and is, barring exceptional circumstances, included in each consecutive surveillance sample to provide information on the time dependent behavior of individual post-tensioning elements. Control tendons are not de-tensioned. The control tendons and consecutively measured (not normalized) forces are listed in the table below.

Control Tendon Forces, kip					
Tendon	Surveillance Year				
	10th	15th	20th	25th	30th
V-32	1196	N/A	1210	1193	1190
H62-26	1145	1128	1161	1136	1120
D225	1125	N/A	1120	1104	1120

There is no clear trend to the above forces. The forces appear to fluctuate in a more or less random manner over a relatively narrow range. The fluctuations, which probably result from temperature changes, tendon force redistribution and small measurement errors, tend to mask the expected trend (a slow, linear decrease with the logarithm of time).

The measured forces, measured force trend line (log-linear fit to the force data) and predicted force trend line are shown for each of the control tendons in Figures 3-4 through 3-6. These plots exhibit three consistent features.

- Trend lines fitted to the measured forces all have flatter slopes than the predicted force trend lines and, as expected, all fitted trend lines have negative slopes.
- 30th year surveillance measured forces and fitted trend line ordinates at time = 30.6 years are all above predicted force trend line ordinates.
- Measured force trend lines and predicted force trend lines all intersect some time before the time of the 25th year surveillance (the dome control tendon intersection is off of the plot area).

These plots provide a positive indication that tendon forces are currently decreasing at a lower than expected rate and, support the conclusion that mean tendon forces will remain above minimum required levels at least until the latest date for completion of the 35th year surveillance.

3.2 Tendon Elongations and Re-Tensioning

One tendon in each group was de-tensioned to allow removal of a wire for testing. In addition, 2 more vertical tendons were de-tensioned as discussed below. Elongations were measured during subsequent re-tensioning and compared to original construction values to verify that tendons were intact and that there were no obstructions to tendon motion within the ducts. Following the elongation measurements at OSF (nominal 80% of ultimate strength), each tendon was seated, in accordance with Sub-Section IWL requirements, at force between that predicted for the time of the surveillance and 70% of ultimate strength

Tendons V-140, H46-25 and D230 were de-tensioned for test wire removal. Elongation measured during re-tensioning of V-140 exceeded the upper acceptance limit. Therefore, it was decided to de-tension and re-tension 2 additional tendons randomly selected from those that, like V-140, are curved to clear the equipment opening. Tendons V-137 and V-141 were drawn in the random selection process.

3.2.1 Elongations

Elongations measured at a nominal ram pressure of 1000 psi (PTF) and a nominal force of 80% GUTS (OSF) are used to compute a normalized elongation rate expressed as inches elongation per kip force per effective wire. Normalizing construction and surveillance values in this manner allows direct comparison of elongations regardless of differences in PTF values, OSF values and numbers of wires. PTF values depend on the characteristics of the jack used but are all on the order of 200 kip.

Elongations measured in the field during construction were corrected by INRYCO as reported in the post-tensioning system vendor manual, VM-TM-2485. The corrected values reported in the vendor manual, rather than those documented on the field stressing cards are used in the following computations. The fractional difference in rates shown for each tendon is equal to the rate difference (re-tensioning rate less original stressing rate) divided by the original stressing rate. This value is acceptable if it is between –0.1 and +0.1.

Pertinent data documented for initial construction tensioning for 30th year surveillance re-tensioning are tabulated for each of the sample tendons (including V-137 and V-141) below. These tabulations also list the calculated normalized elongation rates. Original stressing data are as listed on the tendon stressing cards completed during construction and maintained in permanent plant records.

- Tendon V-137

Original Stressing:	OSF	1593 kip
	PTF	210 kip
	Net Force	1383 kip
	Elongation	11.9 in.
	No. of Wires	169
	Rate	1.45
Re-Tensioning:	OSF	1551 kip
	PTF	212 kip
	Net Force	1339 kip
	Elongation	11.6 in.
	No. of Wires	169
	Rate	1.46
Fractional Difference in Rates		+0.01

Four wires were documented on the surveillance data sheets as unseated following re-tensioning; these were conservatively classified as ineffective for the purpose of providing pre-stressing force in the concrete. However, there is no evidence that the unseated wires are not intact. Therefore, these do affect elongation rate (force transfer to the unseated wires is by friction in the wire bundle rather than bearing at the button head). For this reason, the re-tensioning rate is based on 169 effective wires rather than 165. The rate listed above, 1.46, is, therefore, greater than the 1.43 value reported on the V-137 re-tensioning data sheet.

- Tendon V-140

Tendon V-140 was re-tensioned twice as discussed in a subsequent paragraph. The results of both trials are reported below.

	Initial Trial	
Original Stressing:	OSF	1548 kip
	PTF	210 kip
	Net Force	1338 kip
	Elongation	12.0 in.
	No. of Wires	169
	Rate	1.52

Re-Tensioning:	OSF	1578 kip
	PTF	212 kip
	Net Force	1366 kip
	Elongation	14.55 in.
	No. of Wires	168
	Rate	1.79
Fractional Difference in Rates		+0.18

Second Trial

Original Stressing:		Same as above
Re-Tensioning:	OSF	1578 kip
	PTF	212 kip
	Net Force	1366 kip
	Elongation	13.15 in.
	No. of Wires	168
	Rate	1.62
Fractional Difference in Rates		+0.07

- Tendon V-141

Tendon V-141 was re-tensioned twice as discussed in a subsequent paragraph. The results of both trials are reported below.

Initial Trial

Original Stressing:	OSF	1517 kip
	PTF	210 kip
	Net Force	1307 kip
	Elongation	11.9 in.
	No. of Wires	169
	Rate	1.54
Re-Tensioning:	OSF	1587 kip
	PTF	212 kip
	Net Force	1375 kip
	Elongation	13.4 in.
	No. of Wires	169
	Rate	1.65
Fractional Difference in Rates		+0.07

Second Trial

Original Stressing:		Same as above
Re-Tensioning:	OSF	1578 kip
	PTF	212 kip
	Net Force	1366 kip
	Elongation	13.0 in.
	No. of Wires	168
	Rate	1.60
Fractional Difference in Rates		+0.04

- Tendon H46-25

Original Stressing:	Mean OSF	1564 kip
	Mean PTF	210 kip
	Net Force	1354 kip
	Elongation	9.7 in.
	No. of Wires	169
	Rate	1.21
Re-Tensioning:	Mean OSF	1576 kip
	Mean PTF	196 kip
	Net Force	1380 kip
	Elongation	10.4 in.
	No. of Wires	168
	Rate	1.27
Fractional Difference in Rates		+0.05

- Tendon D230

Original Stressing:	Mean OSF	1528 kip
	Mean PTF	210 kip
	Net Force	1318 kip
	Elongation	10.3 in.
	No. of Wires	169
	Rate	1.32
Re-Tensioning:	Mean OSF	1572 kip
	Mean PTF	192 kip
	Net Force	1380 kip
	Elongation	10.1 in.
	No. of Wires	168
	Rate	1.23
Fractional Difference in Rates		-0.07

The fractional differences in elongation rates are summarized below.

Tendon	Original and Re-Tensioning Elongation Rate Fractional Difference
V-137	+0.01
V-140	+0.18 (First trial)
V-140	+0.07 (Second trial)
V-141	+0.07 (First trial)
V-141	+0.04 (Second trial)
H46-25	+0.05
D230	-0.07

With the exception of that listed for the first V-140 trial, all of the above elongation rate fractional differences are within the –0.1 to +0.1 acceptance band.

During the initial re-tensioning of V-140, the anchor head rotated by a significant amount (1 turn). Tendons are twisted during fabrication to equalize wire stresses in curved ducting. Twisting shortens a tendon and subsequent rotation during tensioning, if any, increases the length. The amount of length increase depends not only on the amount of rotation but also on the distribution of the twist. If twist is uniformly distributed along a tendon, the length change due to rotation is relatively small. If it is concentrated at one end, length change can be significant[4]. It is likely that a substantial part of the twist in V-140 was concentrated near the upper end. In this case, rotation during re-tensioning would explain the large measured elongation. For reference, documented rotations of all de-tensioned tendons are tabulated below.

Tendon	Location	Rotation, Turns		
		Initial Lift-Off	De-Tensioning	Re-Tensioning
V-137	Top	0	¼ CCW	¼ CCW
V-140 (Trial 1)	Top	1 CW	1 CW	1 CW
V-140 (Trial 2)	Top	N/A	1 CW	1 CW
V-141 (Trial 1)	Top	0	1 CW	½ CW
V-141 (Trial 2)	Top	N/A	¾ CW	½ CW
D230	Shop	0	0	0
D230	Field	0	0	0
H46-25	Shop	0	0	0
H46-25	Field	0	0	0

[4] Length change resulting from twisting a bundle of parallel wires is determined by the cosine of the rate of twist per unit length. The cosine function varies non-linearly with angle. As a result, length change increases if total twist is concentrated over a short segment of the bundle.

During the initial re-tensioning the V-141 and V-140 anchor heads rotated by essentially the same amount. However, the effect on elongation rate difference was much less in the case of V-141. This is reasonable if the twist in V-141 was more uniformly distributed than that in V-140.

To ensure that the large elongation of V-140 was a singular event, two additional vertical tendons (V-137 and V-141) that also curve around the equipment opening were added to the surveillance sample as previously discussed. Elongations of both additional tendons are acceptable as shown in the above tabulations.

After the initial re-tension of V-141, the top shim stack would not clear the end cap. Also during the initial re-tensioning, one top end button head detached at some point during the loading cycle. The tendon was de-tensioned, a 2 in. shim was added at the bottom end and the tendon was re-tensioned a second time without incident. The difference in elongation between the first and second re-tensioning trials was relatively minor (0.4 in. with a nominal 13 in. elongation).

During re-tensioning, elongations were measured not only at PTF and OSF, but also at two equally spaced intermediate forces. The elongations measured at each of these four points are plotted in Figures 3-7 through 3-13. For consistency, all jacking forces are reduced by PTF and all elongations are referenced to the PTF value.

All plots except that shown for the first V-140 trial are essentially linear, as expected. The initial three elongations shown for the first V-140 trial (Figure 3-8) are almost identical to those shown for the second trial in Figure 3-9. However, the OSF elongation measured during the first trial is significantly higher than that measured during the subsequent trial. This difference can be explained by the observed anchor head rotation.

3.2.2 Re-Tensioning

After elongations at OSF were measured, tendons were reseated at forces between those predicted for the time of the surveillance and 70% of ultimate strength as specified in Sub-Section IWL, Paragraph 2523.3. Final lock-off forces as documented in Surveillance Procedure 1301-9.1 are listed below with the applicable lower and upper limits.

Tendon	Predicted Force, kip	Lock-Off Force, kip	70% GUTS, kip
V-137	1185	1239	1361
V-140	1174	1356	1385
V-141	1225	1307	1385
H46-25	1063	1312	1385
D230	1111	1345	1385

The 70% GUTS figure for V-137 is based on 165 effective wires . As discussed earlier, four wires were unseated at lock-off. Since no load is transferred to unseated wires at the button heads, these are not effective for purposes of determining wire stress at the anchor head.

Specimen test wires were removed from V-140, H46-25 and D230. And, as previously noted, one button head detached during V-141 re-tensioning. Therefore, the 70% GUTS figure listed for these tendons is based on 168 effective wires.

As shown above, all final lock-off forces are between the specified limits.

3.3 End Anchorage Condition

Sample tendon end anchorages, except as subsequently noted, were visually examined for evidence of corrosion, physical damage, missing button heads and unseated button heads. In addition, concrete surrounding the anchorage was examined out to a distance of 2 ft. beyond the bearing plate edge to detect cracks >0.01 in. in width, spalls and other indications of damage / deterioration. As previously noted, examination of the V-137 and V-141 anchorages was limited to button head condition. Also, as previously noted, only the field end anchorage of of D342 was examined.

These examinations uncovered no indication of unacceptable conditions. Examination results and acceptance criteria are listed below.

3.3.1 Corrosion

- Acceptance Criterion

  No evidence of active corrosion

- Examination Results

  No active corrosion was found on wires[5], button heads, stressing washers, shims or bearing plates (but, see Section 4 for discussion of corrosion on other bearing plates found during containment surface visual examinations). Observed corrosion was limited to light, dry, tightly adhering rust on anchor heads, shims and bearing plates; no rust was observed on button heads).

3.3.2 Physical Damage

- Acceptance Criterion

  No cracks or deformations in anchor heads, shims or bearing plates.

- Examination Results

  No cracks or deformations were found.

3.3.3 Missing Button Heads

- Acceptance Criterion

  No missing button heads not previously documented (no specific criterion set for button heads that detach during surveillance operations).

- Examination Results

  No missing button heads were found during examinations performed prior to lift-off measurements. One button head detached during the initial re-tensioning of V-141. This singular incident is considered acceptable as it affects only one of more than 1,000 vertical tendon wires examined.

3.3.4 Unseated Button Heads

- Acceptance Criterion

  No unseated button heads not previously documented (no specific criterion set for button heads that are unseated following re-tensioning).

[5] Short segments of some wires were visible when tendons were de-tensioned for specimen wire removal.

- Examination Results

  Four unseated button heads, not previously documented, were found during the bottom end anchorage examination performed prior to the V-137 lift-off. The same four were unseated following the completion of re-tensioning. As there is no evidence wire breakage, it is concluded that these wires were tightly bound in the bundle at a point relatively close to the bottom anchorage and that full load transfer to the wires was by friction rather than button head bearing. Since the condition is at the bottom anchorage and the vertical tendons are tensioned only from the top, it is likely that it was missed during examinations performed at the time of initial stressing. Therefore, the condition is considered to be acceptable.

  In addition, one button head, not previously documented, at the field end of H62-18 protrudes on the order of 0.1 in. As there is no evidence of wire breakage the cause is probably that discussed in the above paragraph. This small protrusion was probably missed during examinations performed at the time of initial stressing. It is considered to be acceptable.

3.3.5 Concrete Within Two Feet of bearing Plate

- Acceptance Criterion

  No concrete cracks wider than 0.01 in.

- Examination Results

  No cracks wider than 0.01 in. were found. There is a minor spall, documented as 12 in. long x 2 in. wide x ¼ in. deep, in the concrete adjacent to the bearing plate at the shop (Buttress 6) end of tendon H62-26. With a depth of only ¼ in., this spall is relatively insignificant and acceptable without further evaluation.

3.4 Specimen Wire Test Results

A specimen wire for examination and testing was removed from one tendon in each group. Each wire was visually examined over its entire length for corrosion, pitting, and physical damage. Test samples (100 in. in length) were cut from near each end and near the middle of each specimen wire. These were tested to determine tensile strength and elongation at failure.

The visual examinations, as documented Surveillance Procedure 1301-9.1, Enclosure 4, showed that all three specimen wires were free of corrosion, pitting and physical damage. As a result eliminated the need to cut an additional test specimen from the most corroded section of wire as specified in the surveillance procedure.

Tensile strengths of all 9 test specimens exceeded the specified lower limit of 240 ksi (Guaranteed Ultimate Tensile Strength, or, GUTS). Also, the elongations at failure all exceeded the lower limit of 4%. The results of the tests are tabulated below.

Tendon	Test Sample Location	Tensile Strength, ksi	Elongation at Failure, %
V-140	Top End	259.2	5.40
	Middle	256.3	5.25
	Bottom End	257.6	5.20
H46-25	Buttress 6 End	260.6	5.65
	Middle	259.0	5.30
	Buttress 4 End	258.3	5.35
D230	Shop End	256.0	4.65
	Middle	257.3	4.05
	Field End	261.4	4.75

3.5 Corrosion Protection Medium Test Results

Samples of corrosion protection medium (CPM) were collected from each end of each original sample tendon[6], from the field end of D342[7], and from several other tendon ends in accordance with various commitments that addressed findings during prior surveillances. Laboratory tests were performed on these samples to determine the characteristics listed (with acceptance limits) below. Enclosure 3 of Surveillance Procedure 1301-9.1 identifies the processes and standardized tests used in the laboratory analyses.

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[6] No samples were collected from V-137and V-141 since these tendons were added to the sample only for the purpose of checking end anchorage forces and elongations during re-tensioning.

[7] D342 was initially selected as one of the three dome tendons to be examined during the 30^{th} year surveillance. The shop end of D342 is close to the main steam atmospheric dump and relief valve discharge stacks and cannot be safely examined while the plant is operating. D213 was added as a substitute sample tendon and the field end of D342 was examined in accordance with the requirements of Sub-Section IWL, Par. IWL-2521.1(c).

Characteristic	Acceptance Limit
Water Content	Not to Exceed 10% by weight
Water Soluble Chlorides	Not to Exceed 10 ppm
Water Soluble Nitrates	Not to Exceed 10 ppm
Water Soluble Sulfides	Not to Exceed 10 ppm
Reserve Alkalinity (Base Number)[8]	≥0 for originally installed CPM ≥17.5 for Visconorust 2090-P4

Table 3-6 lists the laboratory test results. The table also lists the acceptance criterion for reserve alkalinity since this is not the same for all samples. As shown in the table, all test results meet the acceptance criteria.

3.6 Corrosion Protection Medium Removal / Replacement

When CPM was removed from tendon sheath, quantity removed and the quantity later replaced were documented. The difference in these quantities provides the information to assess the acceptability of both the level of CPM fill prior to removal and the level following replacement. If the amount replaced is significantly less than the amount removed, the level is low and must be increased. If the amount replaced is significantly greater than the amount removed the reason for the difference (initial under fill or leakage over time) must be determined and the situation corrected. Per Surveillance Procedure 1301-9.1, the difference is acceptable if it does not exceed the TMI-1 administrative limit of 4 gallons, a quantity significantly less than the 10% of the net duct volume limit specified in 10CFR50.55a, Par. (b)(2)(viii)(D)(2).

Quantities of CPM removed and replaced during the 30th year surveillance are shown in Table 3-7. All differences (absolute values) are below the 4 gallon limit and are, therefore acceptable.

[8] The corrosion protection product installed at the time of construction had a nominal base number of 5 or less. In accordance with Sub-Section IWL, Table IWL-2525-1, Note 3, the acceptance limit for this material is 0. Over time, many tendons were refilled, or topped off at one end, with Visconorust 2090-P4. The P4 formulation has a specified minimum base number of 35. Again in accordance Table IWL-2525-1, Note 3, the acceptance limit for this material is one half the initial value of 35, or 17.5.

3.7 Free Water Accumulation

End anchorages (only the field end anchorage of D342 as previously explained) were examined for evidence of free water accumulation. No free water was found at any of the anchorages examined.

3.8 Tendon End Anchorage Cover Examination

Tendon end anchorage cover were examined as specified in 10CFR50.55a Par. (b)(2)(viii)(A) for damage / deformations and CPM leakage.

All covers examined were in sound condition and free of deformations. No evidence of CPM leakage was noted at either hoop tendon anchorages or vertical tendon top end anchorages. Some oil residue was found on various vertical tendon bottom end covers but there is no evidence of ongoing CMP leakage. Also, there was oil residue on the containment wall directly below the ends of several dome tendons but, again, no evidence ongoing leakage. The oil residue on the containment wall was removed.

The examinations demonstrated that all end anchorage covers are in acceptable condition and that CPM leakage, if any, is of a very minor nature and, therefore, acceptable.

3.9 Topical Report No. 136 Examination and Test Commitments

Topical Report No. 136 specified that the following post-tensioning system examinations and tests be performed during the 30th year surveillance. Containment surface examination requirements identified in that topical report are covered in Section 4 below.

Par. 4.6 (mentioned here for reference only) specifies continued monitoring of tendon anchorage covers for corrosion protection medium leakage. This work is performed a part of Repetitive Maintenance Task No. 9641 and is not a containment ISI activity. End anchorage cover examination as mandated in 10CFR50.55a is a separate matter and is discussed in 3.8

Par. 4.7 specified re-examination of a 0.013 in. wide crack in the concrete adjacent to the bearing plate of tendon H46-37. Results of this examination, which, for procedural reasons, was performed as a containment surface examination activity, are discussed in Section 4 below.

Par. 4.8 specified collecting corrosion protection medium samples from the bottom end of tendon V-164 and performing tests to ensure an acceptable nitrate level. Samples were collected and subject to the full battery of CPM tests. All test results, which are summarized in Section 3.5 above and listed in Table 3-6, are acceptable.

Par. 4.9 specified checking the level of CPM at the top end of tendon V-86. This was done; the level was verified to be within 2 in. of the top of the anchorage cover. In addition, CPM samples were collected at the bottom end of this tendon and tested. All test results, which are summarized in Section 3.5 above and listed in Table 3-6, are acceptable.

4. CONTAINMENT SURFACE EXAMINATIONS

The accessible exterior surface of the containment was visually examined as specified in Sub-Section IWL. The examination was performed using VT-3C and, as applicable, VT-1C criteria in accordance with Par. IWL-2310. The examinations covered both the concrete surface and the tendon anchorage bearing plates. Bearing plates other than those included in the post-tensioning system examinations discussed in Section 3 above, are not specifically addressed in IWL. These are included in the examination scope to ensure that significant corrosion, if any, is identified during the surveillance.

Limited concrete damage / degradation was observed at several locations on the containment during prior surveillances. The areas and the conditions of concern are identified in Topical Report No. 136, Paragraphs 4.1 through 4.5. In accordance with the commitments stated in that topical report, detailed examinations were performed in these areas to ensure that the conditions previously observed are stable.

4.1 Overall Concrete Surface Condition

The VT-3C visual examination of the containment concrete surface uncovered only two recordable conditions (tendon anchorage bearing plate corrosion is discussed in Section 4.3) that had not been previously identified. Other than these two conditions and those reported in Topical Report No. 136, no damage or deterioration was found on the concrete surface. The surface, except in those areas just noted, was free cracks exceeding 0.015 in. in width (threshold recording criteria as adopted from ACI 349.3R), spalling and other indications of potential damage / deterioration. Previously identified recordable conditions are discussed in Section 4.2. The conditions first documented during the 30th year surveillance are discussed below. These are on the dome.

a. Water Seepage Under Dome Embeds

- Condition

  There is an occasional seepage of water along the undersides of three embedded plates that extend west from the dome apex to the vent stack area. The water seeps in to the gaps between the plate edges and concrete during rains or when snow / ice melt and resurfaces at lower points. There is some efflorescence (whitish mineral deposit) where the water surfaces. Figure 4-1, a photograph of a typical efflorescing area, shows both mineral deposit and moist areas.

- Evaluation

  This condition does not currently have any deleterious effect on structural integrity. However, continued seepage of water between the embedded plate and the concrete, coupled with freeze-thaw cycles could eventually lead to the development of significant cracking and spalling.

- Corrective Action

  The interface between the embedded plates and concrete will be sealed with a caulking compound to prevent further water intrusion. Since concrete surface coating and sealing is outside the scope of Section XI, this work will be done as a routine maintenance task rather than a Section XI Repair / Replacement activity.

b. Grout Patch Loss

- Condition

  Grout patches have detached from the underlying concrete at two locations on the west side of the dome, one alongside an embedded plate and another adjacent to the inner crane rail. The first has approximate dimensions of 7 in. x 4 in. x ½ in. deep. Figure 4-2 is a photograph of the second, which is about 4 in. in diameter by about ½ in. deep.

- Evaluation

  These conditions do not currently have any deleterious effect on structural integrity. However, the depressions left by the detached grout can accumulate water which, coupled with freeze-thaw cycles, could eventually initiate the development of significant cracking and spalling.

- Corrective Action

  The depressions in the concrete surface will be filled with epoxy grout. Since the depressions do not extend to the first layer of reinforcing steel, this work will be done as a routine maintenance task rather than a Section XI Repair / Replacement activity.

4.2 Previously Documented Conditions

Recordable concrete conditions have been documented during prior surveillances. Detailed VT-1C examinations of the concrete areas in question are performed during subsequent surveillances for evidence of on-going deterioration. The previously documented conditions and the areas where these are located are summarized in Section 4 of Topical Report No. 136. Conditions documented during the 30th year surveillance, evaluations of these and corrective actions to be taken, if any, are discussed in the following paragraphs.

a. Efflorescence On Tendon Gallery Wall

- Condition

  There are whitish mineral deposits (efflorescence) on the tendon gallery wall. Figure 4-3 is a photograph of a typical deposit.

- Evaluation

  This condition is the result of ground water seepage through the joints between the bottom of the base mat and the tops of the gallery walls. Since the water is seeping through a joint rather than through a concrete mass, the deposits are unlikely to be leached concrete materials. Rather, these are minerals dissolved in the ground water during its passage through the outside soil. There is no evidence of seepage through the base mat concrete. Neither is there evidence of gallery wall concrete loss, which this is not an issue since the gallery is not a part of the pressure retaining containment structure. As a result, it is concluded that this condition has no structural significance.

- Corrective Action

  No corrective action is needed. The condition will be examined again during the 35th year surveillance.

b. Exposed Reinforcing On Underside of Base Mat

- Condition

  Small areas of reinforcing, or other, steel items are exposed on the tendon gallery ceiling (base mat underside). These are located close to the anchorages of tendons V-89, V-143 and V-149.

- Evaluation

  There is no significant spalling associated with the exposure of the steel surfaces, which were located quite close to the bottom form at the time of concrete placement. The gallery is a sheltered area so ongoing corrosion of the exposed steel is not a major concern. Therefore, the condition has no structural significance.

- Corrective Action

No corrective action is needed. These areas will be examined again during the 35th year surveillance.

c. CPM Leakage Through the Containment Wall

- Condition

Corrosion protection medium has been slowly seeping through vertical cracks the lower part of the containment wall for many years.

- Evaluation

This condition, which has been observed on many other containment structures, results from a combination of the CPM high head in the vertical tendon ducts and relatively high temperature in the concrete. The vertical cracks in the lower wall result from the tensile stress induced by concrete shrinkage following placement and prior to tendon stressing. Shrinkage can induce relatively high hoop tension tensile stresses in the lower part of the wall since the base mat restrains inward movement. The cracks and CPM seepage have no structural significance but loss of CPM from vertical tendon ducts may be significant.

- Corrective Action

This condition is considered to be a routine maintenance item rather than an ISI concern. It is monitored on a regular basis under Repetitive Task No. 9641. During the 25th year surveillance, all associated tendons that communicate with the observed surface cracks were checked for CPM volume and evaluated; CPM was replenished as needed.

d. Concrete / Grout Spalling at Embeds

- Condition

There are several areas where concrete and / or grout has spalled at the edges of embedded plates. Figure 4-4 is a photograph of a typical spalled area adjacent to an embedded plate.

- Evaluation

Spalls are probably the result of cracks initiated by shrinkage and extended over time by thermal expansion of the metallic items and swelling of corrosion products. The spalls have no current structural significance. However, spalling exposes more metal to a corrosive environment, which, in turn, increases corrosion and the attendant swelling; this can result in more extensive spalling that could eventually have structural consequences. Also, excessive corrosion of embedded plates that support drain piping, handrails and other items can create a safety hazard.

- Corrective Action

To ensure against the development of more extensive spalling and future safety hazards, loose corrosion will be removed from the embedded plates in the affected areas and the depressions filled with epoxy grout. Since the depressions left by the spalled concrete do not extend to the first layer of reinforcing steel, this work will be done as a routine maintenance task rather than a Section XI Repair / Replacement activity.

e. Lower Wall Joint Spalls

- Condition

There are two small depressions, the result of spalling at a construction joint, located a short distance clockwise from Buttress 3 at approximately 6 ft. above the top of the base mat. These are about 3 in. long, less than 1 in. wide and about ½ in. deep. Corroded metal is exposed in the depression closer to the buttress.

- Evaluation

These spalls are too small to be of any structural significance. And, since the area is enclosed and protected from weather, continuing corrosion is not a concern. The condition has remained unchanged since at least the time of the 25^{th} year surveillance and is not expected to change significantly in the future.

- Corrective Action

No corrective action is needed at the present time. This area will be examined again during the 35^{th} year surveillance.

f. Wall Cracks Over Fuel Handling Building Roof.

- Condition

There are numerous randomly oriented short cracks in an area of the wall above the Fuel Handling Building roof. Figure 4-5 is a photograph of the area.

- Evaluation

  The cracks appear to be the result of drying shrinkage that occurred at the time of construction and have no structural significance. The appearance of the cracked area is essentially unchanged since at least the time of the 25th year surveillance and is not expected to change significantly in the future.

- Corrective Action

  No corrective action is needed. However, this area will be examined again during the 35th year surveillance.

g, Grout Loss Over Equipment Opening

- Condition

  A grout patch has detached from an area, approximately 2 ft. x 5 ft., above the equipment opening. No reinforcing steel or other metallic items are exposed. Figure 4-6 is a photograph of the area.

- Evaluation

  The grout patch was thin and appears to have been applied for cosmetic reasons. Loss of the grout has no structural significance. The area is on the vertical wall and is well drained; water ponding and consequent freeze-thaw damage are not issues. The appearance of the area is essentially unchanged since at least the time of the 25th year surveillance and is not expected to change significantly in the future.

- Corrective Action

  No corrective action is needed. However, this area will be examined again during the 35th year surveillance.

h. Crack At Corner of H46-33 Bearing Plate

- Condition

  A crack 0.020 to 0.025 in. wide and approximately 18 in. long extends out from the upper right hand corner of the bearing plate at the Buttress 6 end of tendon H46-33.

- Evaluation

  The crack is typical of, although wider than, shrinkage cracks that radiate out from the corners of embedded steel plates. It is relatively short and, therefore, has no structural significance. The size of the crack is essentially unchanged since at least the time of the 25th year surveillance and is not expected to change significantly in the future. However, with a width of up to 0.025 in., it is a possible path for entry of water into the buttress concrete; this could lead to freeze-thaw damage and / or corrosion of reinforcing.

- Corrective Action

  The crack will be filled with caulking material to prevent entry of water. Since concrete surface coating and sealing is outside the scope of Section XI, this work will be done as a routine maintenance task rather than a Section XI Repair / Replacement activity.

i. Crack At Corner of H46-37 Bearing Plate

- Condition

  A crack 0.013 in. wide and approximately 2 ½ in. long extends out from a corner of the bearing plate at the Buttress 6 end of tendon H46-37.

- Evaluation

  The crack is typical of, although slightly wider than, shrinkage cracks that radiate out from the corners of embedded steel plates. It is very short and only 0.003 in. wider than the threshold for recording (0.010 in.). It has no structural significance. The size of the crack is essentially unchanged since at least the time of the 25th year surveillance and is not expected to change significantly in the future. The crack is too small to be a credible path for water intrusion.

- Corrective Action

  No corrective action is needed. The crack will be examined again during the 35th year surveillance.

j. Damaged Grout / Concrete At Dome Handrail Base Plates

- Condition

Grout and concrete are loose or missing at several dome handrail base plates. Figure 4-7 is a photograph of a typical condition.

- Evaluation

The handrail is mounted to the top of a short parapet wall. The parapet wall serves no containment function. Therefore, the spalls are of no structural significance. However, the handrail serves an important safety function. It is important that the handrail be well secured into the concrete so that it can serve that function.

- Corrective Action

Spalled concrete around the handrail base plates will be repaired with epoxy grout to restore the design condition. Since the spalled concrete is not a part of the pressure retaining containment structure, this work will be done as a routine maintenance task and not as a Section XI Repair / Replacement activity.

k. Spalled Concrete At Dome Drain Trench Edge

- Condition

Concrete has spalled at the edge of the drain trench on the west side of the dome. No reinforcing steel is exposed. Figure 4-8 is a photograph of the spall.

- Evaluation

The spall has no structural significance. It is probably due to damage initiated when the grounding cable anchor (shown in the photograph, was installed. The appearance of the area is essentially unchanged since at least the time of the 25th year surveillance and is not expected to change significantly in the future. It is not a likely area for ponding of water and consequent freeze-thaw damage.

- Corrective Action

The spalled area will be filled with epoxy grout to restore the design profile. Since this is a cosmetic repair to an area that does not extend to the first layer of reinforcing, it will be done as a routine maintenance task and not as a Section XI Repair / Replacement activity.

l. Cavity In Wall of Vertical Tendon Trench

- Condition

There is a deep cavity at the bottom of the outer wall of the vertical tendon end anchorage trench. It is located between tendons V-144 and V-145. Figure 4-9 is a photograph of the cavity.

- Evaluation

The cavity appears to have been excavated intentionally at the time of construction. The cavity has no structural significance since the concrete at the outside of the trench performs no pressure retaining function; it serves solely as an outer enclosure for the end anchorages.

- Corrective Action

The cavity will be filled with grout to restore the design profile. Since the outer wall of the trench serves no containment function, this repair will be done as a routine maintenance task and not as a Section XI Repair / Replacement activity.

m. Ring Girder Grout Patch Loss and Reinforcing Steel Corrosion

- Condition

Large areas of the grout patches on the vertical face of the ring girder are missing; reinforcing steel is exposed at some locations and is corroded. Figure 4-10 is a photograph of a typical section of exposed reinforcing.

- Evaluation

The ring girder grout patches were principally cosmetic but did extend to the depth of the first reinforcing steel layer in a few areas. In those areas where no reinforcing is exposed, the loss of the patch has no structural significance and, since the surface of the exposed concrete is vertical, water accumulation with attendant freeze-thaw damage is not an issue. However, the exposed reinforcing steel is severely corroded. Continuing corrosion may result in spalling of concrete with consequent exposure of still more reinforcing steel. The appearance of the concrete on the vertical face of the ring girder has not changed noticeably since the 25th year surveillance. However, it is likely that the exposed reinforcing has continued to corrode.

- Corrective Action

The exposed reinforcing will be cleaned to bare metal by grit blasting or mechanical means, primed and painted. Priming / painting will extend onto the surrounding concrete to ensure that the steel surface is well sealed against moisture. The grout will be replaced. This work will be done as a Section XI Repair / Replacement activity. The grout patch areas will be examined again during the 35th year surveillance.

n. Crack At Ring Girder Construction Joint

- Condition

There is a crack 0.018 in. wide between the D320 NE and D321 NE anchorages at a ring girder construction joint.

- Evaluation

This crack is too short to have structural significance. It is, however, sufficiently wide (in excess of the ACI 349.3R Tier 1 acceptance criterion of 0.015 in.) to be a possible pathway for water intrusion. Since the depth of the crack is unknown, water intrusion has the potential to corrode reinforcing steel. The appearance and width of the crack are essentially unchanged since at least the time of the 25th year surveillance.

- Corrective Action

The crack will be sealed with a caulking material to prevent entry of water. Since concrete surface coating and sealing is outside the scope of Section XI, this work will be done as a routine maintenance task rather than a Section XI Repair / Replacement activity.

4.3 Tendon End Anchorage Bearing Plate Condition

- Condition

Coatings on tendon end anchorage bearing plates were generally intact and the plates were generally free of significant corrosion. However, coatings are detached / missing from large areas on a number of the vertical tendon upper end bearing plates (located in the dome trench). Several of these plates exhibit major corrosion. Figure 4-11, a photograph of the tendon V-54 upper end bearing plate, shows a typical area with missing coating and resulting corrosion.

- Evaluation

Loss of metal in the corroded areas is currently well below the level at which this would be a structural concern. However, the corrosion is on-going and could eventually result significant reduction in plate thickness.

- Corrective Action

Bearing plates with missing, detached or damaged coating will be cleaned to bright metal, primed and painted to stop further corrosion. Since post-tensioning system hardware coatings are outside the scope of Section XI, this work will be done as a routine maintenance task rather than a Section XI Repair / Replacement activity.

5. REPAIRS AND FOLLOW-UP EXAMINATIONS

Several areas on the containment exhibited minor surface damage / deterioration. A number of these conditions probably date from the time of construction and have been essentially stable throughout the life of the plant. Others have developed over the years. In some of the cases, repairs will be made to minimize the possibility of progressive damage / deterioration. All of the affected areas will be re-examined during the 35th year ISI to verify that the observed condition is still stable and / or that the repair work continues to be effective.

5.1 Repairs

The following repairs will be made as stated in the Corrective Action statements in Section 4 above. These repairs will be completed at the earliest possible opportunity but, in any event, by the end of September 2006. As discussed in Section 4, most repairs are to be done as routine maintenance tasks. Those that must be done as Section XI Repair and Replacement activities are so noted.

a. Water Seepage Under Dome Embeds

The interface between the plates and the concrete will be sealed with a caulking compound.

b. Grout Patch Loss

Depressions resulting from dome grout patch loss will be filled with epoxy grout.

c. Concrete / Grout Spallling At Embeds

Loose corrosion will be removed from the embedded steel at the affected locations and the original concrete profiles restored with epoxy grout.

d. Crack At Corner of H46-33 Bearing Plate

The identified crack (0.020 to 0.025 in. wide) will be sealed with a caulking compound.

e. Damaged Grout / Concrete At Dome Handrail Base Plates

Damaged and missing grout / concrete will be replaced by epoxy grout to restore the design profile and ensure solid anchorage for the handrail.

f. Spalled Concrete At Dome Drain Trench Edge

The design profile of the concrete will be restored with epoxy grout.

g. Cavity In Wall of Vertical Tendon Trench

The cavity (located between tendons V-144 and V-145) in the wall of the vertical tendon end anchorage trench will be filled with epoxy grout.

h. Ring Girder Grout Patch Loss and Reinforcing Steel Corrosion

The exposed reinforcing will be cleaned to bare metal by grit blasting or mechanical means, primed and painted. Priming / painting will extend onto the surrounding concrete to ensure that the steel surface is well sealed against moisture. The grout will be replaced. This work will be done as a Section XI Repair / Replacement activity.

i. Crack At Ring Girder Construction Joint

The crack will be sealed with a caulking compound.

j. Tendon End Anchorage Bearing Plate Corrosion.

The vertical tendon upper end bearing plates (located in the trench at the top of the ring girder) with corrosion, or with detached / missing coating, will be cleaned to bright metal, primed and painted.

5.2 Follow-Up Examinations During 35th Year ISI

All of the repairs listed in 5.1 above will be examined in detail (VT-1 or VT-1C) during the 35th year ISI. In addition, all areas previously identified for detailed examination, but not repaired, will be re-examined These are listed in Section 4 and restated below.

a. Tendon Gallery Wall Base Mat Interface

The tendon gallery wall / base mat interface areas will be examined to verify that water seepage is not leaching structural concrete or corroding embedded reinforcing and other steel items.

b. Exposed Reinforcing On Underside of Base Mat

The reinforcing steel exposed at three locations on the underside of the base mat will be examined to verify that there is no progressive corrosion or spalling of concrete.

c. Lower Wall Joint Spalls

The spalled areas at the wall joint just above the base mat will be examined to verify that there is no progressive corrosion (in the one area with exposed steel) or spalling of concrete.

d. Wall Cracks Over Fuel Handling Building Roof

The wall area over the fuel handling building roof will be examined to verify that previously observed crack patterns are stable.

e. Grout Loss Over Equipment Opening

The wall area over the equipment opening will be examined to verify that there is no damage / deterioration of the structural concrete exposed by the loss of grout cover.

f. Crack At Corner of H46-37 Bearing Plate

The identified crack (0.013 in. wide) will be examined to verify that it is stable.

6. CONCLUSIONS

It is concluded, on the basis on the 30th year in-service inspection (ISI) results, that the reactor building is in sound structural condition and is fully capable of performing its intended function with an ample margin of safety. It is further concluded, on the basis of observed trends, that the reactor building will remain in sound condition and will retain an ample margin of safety until well beyond the latest completion date (Mar 2010) specified for the subsequent ISI.

Certain conditions noted during the ISI did not meet specified threshold acceptance criteria. In most cases, these conditions were observed during earlier examinations and are not changing with time. Most such conditions were accepted following an engineering evaluation and will be examined again during the 35th year ISI to verify that there is still no progressive degradation. Other conditions will be restored / repaired to ensure against possible continuing surface damage.

None of the conditions documented during the ISI represents a degradation of containment integrity.

7. REFERENCES

The following documents (applicable sections as noted) were used in the development of this report and / or are specifically referenced herein.

1. United States Code of Federal Regulations, Title 10, Part 50, Sub-Part 50.55a (10CFR50.55a), as amended effective 09 Sep 96.

2. ASME Boiler and Pressure Vessel Code (1992 Edition with Addenda through 1992), Section XI, Sub-Sections IWA and IWL.

3. USNRC Regulatory Guide 1.35.1, *Determining Prestressing Forces for Inspection of Prestressed Concrete Containments*, Jul 90.

4. TMI – Unit 1 FSAR Section 5.7.5, Update 15.

5. TMI – Unit 1 Technical Specification Sections 3.19.1 & 4.4.2.1.

6. TMI – Unit 1 Surveillance Procedure 1301-9.1, *RB Structural Integrity Tendon Surveillance*, Revision 18.

7. TMI – Unit 1 EER JO # 162193, *Rx Building Tendons, Minimum Required Prestressing Forces.*

8. TMI – Unit 1 Calculation C-1101-153-E410-028, *Rx Building Tendons, Minimum Required Prestressing Forces*, Revision 0.

9. Gilbert / Commonwealth Calculation DC-5390-225.01-SE, dated 26 Apr 94.

10. Gilbert / Commonwealth Letter (with attachments) G/C/TMI-1CS/16616, dated 27 Dec 88, Transmitting Tendon Stressing Record Data (ECD C-310055).

11. TMI – Unit 1, *Reactor Containment Building / First Tendon Surveillance Test / One Year After SIT*, GAI Report No. 1880, 29 Sep 75.

12. TMI – Unit 1, *Second Tendon Surveillance Test of Reactor Containment Building / Three Years After SIT*, VSL Corp. Report No. GQL 0204, Dec 77.

13. TMI – Unit 1, *Containment Building Tendon Surveillance Test Report for Third Period (5 Years After SIT), TDR No. 229*, 27 Mar 81.

14. TMI – Unit 1, *Reactor Building Tendon Surveillance Test / Inspection Period 4 (10 Years), TR No. 025*, 27 Aug 85.

15. TMI – Unit 1, *Reactor Building Fifteen Year Tendon Surveillance Test (Inspection Period 5), Topical Report 069*, 2 May 90.

16. TMI – Unit 1, *Reactor Building Twenty Year Tendon Surveillance Test (Inspection Period 6), Topical Report 093*, 22 Mar 95.

17. TMI – Unit 1, *25th Year Reactor Building Tendon Surveillance (Period 7), Topical Report 136*, Revision 1, 31 Jul 01.

18. Miller, Irwin & John E. Freund, *Probability and Statistics for Engineers*, Prentice-Hall, Englewood Cliffs, N. J., 1965.

19. ACI 201.1R-92, *Guide for Making a Condition Survey of Concrete in Service*, Published by the American Concrete Institute.

20. ACI 349.3R-96, *Evaluation of Existing Nuclear Safety-Related Concrete Structures*, Published by the American Concrete Institute.

8. TABLES AND FIGURES

Tables and Figures referenced in the preceding text are included in this section.

8.1 Tables

Tables commence on the following page. Numerical values shown in the tables are extracted from Surveillance Procedure 1301-9.1, Calculation DC-5390-225.01-SE, the data sheets documenting the 30th year surveillance and Topical Reports Nos. 025, 069, 093 & 136.

Table 3-1
Measured End Anchorage Forces and Predicted Forces

Tendon	End	Measured Force, kip	Mean End Force, kip	Predicted Force, kip	95% of Predicted Force, kip
V-32	Top	1190	1190	1186	1126
V-53	Top	1222	1222	1205	1145
V-66	Top	1178	1178	1154	1096
V-137	Top	1218	1218	1185	1126
V-140	Top	1144	1144	1174	1115
V-141	Top	1207	1207	1225	1163
H13-11	B-1	1235	1218	1167	1109
	B-3	1201			
H35-49	B-3	1194	1201	1120	1164
	B-5	1208			
H46-25	B-4	1099	1121	1063	1009
	B-6	1143			
H62-18	B-6	1109	1105	1103	1048
	B-2	1101			
H62-26	B-6	1145	1120	1112	1056
	B-2	1095			
D213	NE	1068	1094	1052	999
	SE	1121			
D225	NW	1120	1120	1074	1020
	SE	1120			
D230	NW	1163	1149	1111	1055
	SE	1135			

Table 3-2
Normalized Tendon Forces and Group Mean Forces

Tendon	Measured Force, kip	Adjustment, kip	Normalized Force, kip
V-32	1190	-7	1183
V-53	1222	-27	1195
V-66	1178	25	1203
V-137	1218	-7	1211
V-140	1144	+4	1148
V-141	1207	-46	1161
Vertical Group - Mean Normalized Force			**1184**
H13-11	1218	-54	1164
H35-49	1201	-7	1194
H46-25	1121	+51	1172
H62-18	1105	+10	1115
H62-26	1120	+2	1122
Hoop Group - Mean Normalized Force			**1153**
D213	1094	+67	1161
D225	1120	+45	1165
D230	1149	+8	1157
Dome Group - Mean Normalized Force			**1161**

Table 3-3
Summary of Vertical Tendon Forces

Surveillance Year	Time Since SIT, Years	Tendon	Force, kip
10	11.2	V-14	1243
		V-30	1193
		V-32	1196
		V-84	1189
		V-160	1192
15	15.6	V-19	1187
		V-21	1196
		V-22	1171
		V-23	1175
		V-50	1213
		V-83	1196
		V-85	1179
20	20.6	V-32	1210
		V-78	1306
		V-126	1209
25	25.5	V-32	1193
		V-40	1202
		V-114	1189
		V-164	1181
30	30.6	V-32	1190
		V-53	1222
		V-66	1178
		V-137	1218
		V-140	1144
		V-141	1207

Table 3-4
Summary of Hoop Tendon Forces

Surveillance Year	Time Since SIT, Years	Tendon	Force, kip
10	11.2	H13-35	1191
		H13-36	1066
		H13-37	1182
		H24-26	1173
		H35-26	1156
		H62-26	1145
		H62-30	1152
15	15.6	H24-29	1072
		H24-30	1139
		H24-31	1114
		H24-51	1142
		H46-34	1177
		H62-13	1088
		H62-26	1128
20	20.6	H24-40	1132
		H35-23	1200
		H35-47	1192
		H62-26	1161
		H62-49	1163
25	25.5	H13-50	1159
		H35-33	1169
		H46-37	1129
		H51-43	1170
		H62-26	1136
30	30.6	H13-11	1218
		H35-49	1201
		H46-25	1121
		H62-18	1105
		H62-26	1120

Table 3-5
Summary of Dome Tendon Forces

Surveillance Year	Time Since SIT, Years	Tendon	Force, kip
10	11.2	D133	1107
		D225	1125
		D314	1290
15	15.6	D145	1220
		D347	1183
20	20.6	D141	1164
		D225	1120
		D248	1202
25	25.5	D102	1280
		D225	1104
		D313	1120
30	30.6	D213	1094
		D225	1120
		D230	1149

Table 3-6 Corrosion Protection Medium Test Results						
Tendon	End	Chlorides, ppm	Nitrates, ppm	Sulfides, ppm	Water Contend, %	Base Number (Lower Limit)
V-32	Shop	<0.50	<0.50	<0.50	0.64	68.1 (17.5)
V-32	Field	<0.50	<0.50	<0.50	<0.10	25.8 (17.5)
V-53	Shop	<0.50	<0.50	<0.50	0.14	42.6 (17.5)
V-53	Field	<0.50	<0.50	<0.50	<0.10	2.91 (0)
V-66	Shop	<0.50	<0.50	<0.50	<0.10	55.7 (17.5)
V-66	Field	<0.50	<0.50	<0.50	<0.10	2.70 (0)
V-86	Field	<0.50	<0.50	<0.50	3.7	41.4 (17.5)
V-140	Shop	<0.50	<0.50	<0.50	0.14	46.7 (17.5)
V-140	Field	<0.50	<0.50	<0.50	<0.10	1.85 (0)
V-164	Field	0.60	<0.50	<0.50	0.19	45.2 (17.5)
H13-11	Shop	1.0	<0.50	<0.50	<0.10	3.09 (0)
H13-11	Field	0.60	<0.50	<0.50	<0.10	4.58 (0)
H35-49	Shop	<0.50	<0.50	<0.50	<0.10	6.17 (0)
H35-49	Field	<0.50	<0.50	<0.50	0.15	3.12 (0)
H46-25	Shop	0.60	<0.50	<0.50	<0.10	1.27 (0)
H46-25	Field	<0.50	<0.50	<0.50	<0.10	1.74
H62-18	Shop	<0.50	<0.50	<0.50	<0.10	6.04 (0)
H62-18	Field	<0.50	<0.50	<0.50	<0.10	2.91 (0)
H62-26	Shop	<0.50	<0.50	<0.50	<0.10	56.6 (17.5)
H62-26	Field	<0.50	<0.50	<0.50	<0.50	59.5 (17.5)
D213	Shop	<0.50	<0.50	<0.50	<0.10	3.23 (0)
D213	Field	<0.50	<0.50	<0.50	<0.10	34.9 (17.5)
D225	Shop	<0.50	<0.50	<0.50	0.31	65.2 (17.5)
D225	Field	<0.50	<0.50	<0.50	0.15	48.9 (17.5)
D230	Shop	<0.50	<0.50	<0.50	<0.10	1.37 (0)
D230	Field	0.60	<0.50	<0.50	<0.10	52.0 (17.5)
D342	Field	<0.50	<0.50	<0.50	<0.10	.0700 (0)

Table 3-7 Corrosion Protection Medium - Quantities Removed / Replaced				
Tendon	Quantity Removed, gal.	Quantity Replaced, gal	Absolute Difference, gal	Difference < 4 gal, Yes / No
V-32	36 ½	37	½	Yes
V-53	75 ½	78 ½	3	Yes
V-66	85 ¼	87 ½	2 ¼	Yes
V-86[a]	½	0	½	Yes
V-137	51 ¼	54	2 ¾	Yes
V-140	84	85 ¾	1 ¾	Yes
V-141	60	62 ¾	2 ¾	Yes
V-164[a]	½	0	½	Yes
H13-11	15	17 ½	2 ½	Yes
H35-49	12 ½	16	3 ½	Yes
H46-25	16 ¼	19 ¼	3	Yes
H62-18	16 ½	17 ¾	1 ¼	Yes
H62-26	13 ½	17	3 ½	Yes
D213	54 ¾	58 ¼	3 ½	Yes
D225	13 ½	15 ¾	2 ¼	Yes
D230	23	19 ¼	3 ¾	Yes
D342	8 ¼	8 ¾	½	Yes

Note a: Two samples, one quart each, taken from the bottom end for testing per commitment in Topical Report No. 136. No further examinations / tests performed on this tendon. No CPM added following samples removal. Also per topical report commitment, level of CPM at top end of V-86 verified acceptable.

8.2 Figures

Figures commence on the following page.

Figure 3-1
Vertical Tendon Force Trend

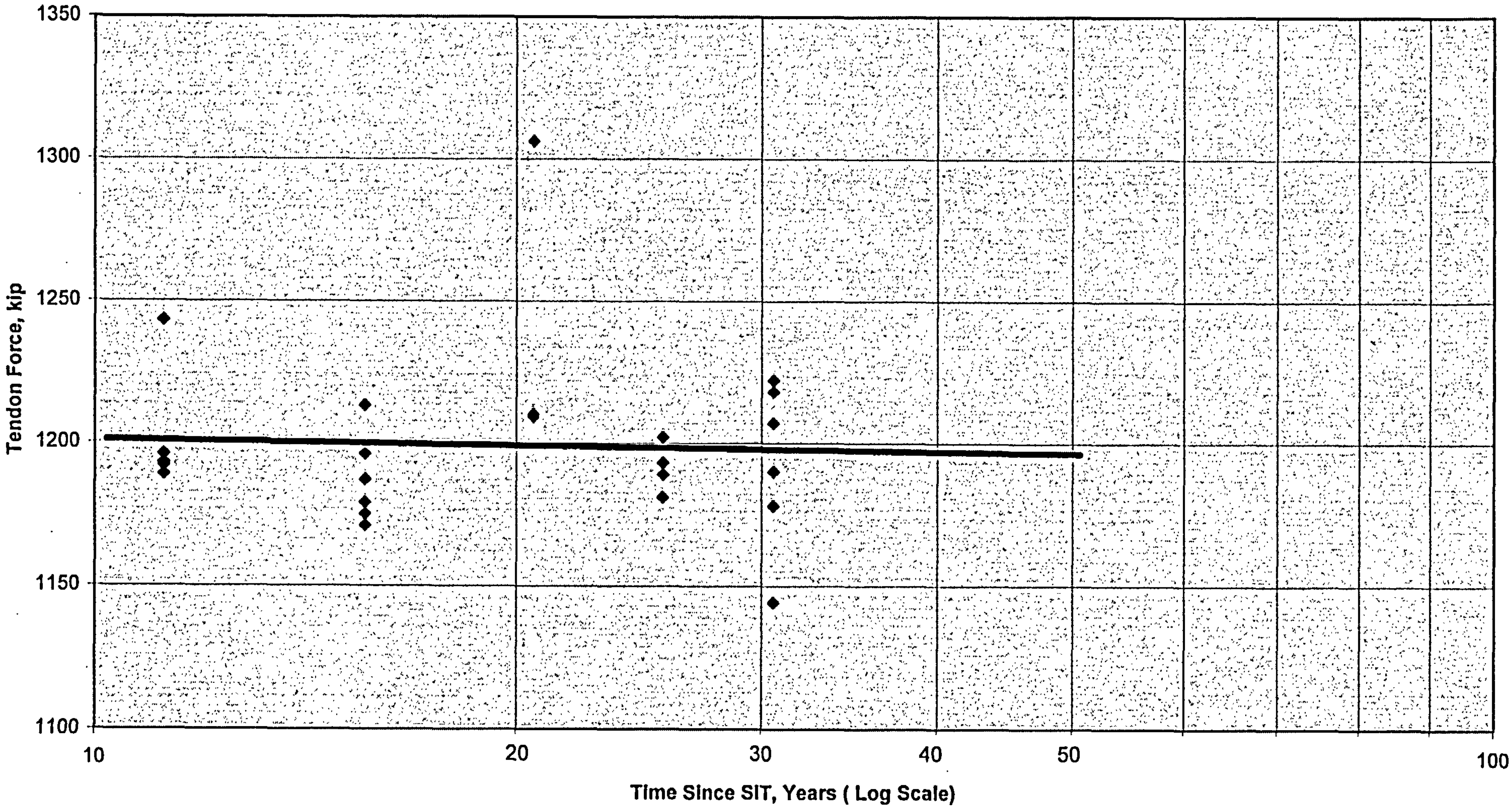


Figure 3-2
Hoop Tendon Force Trend

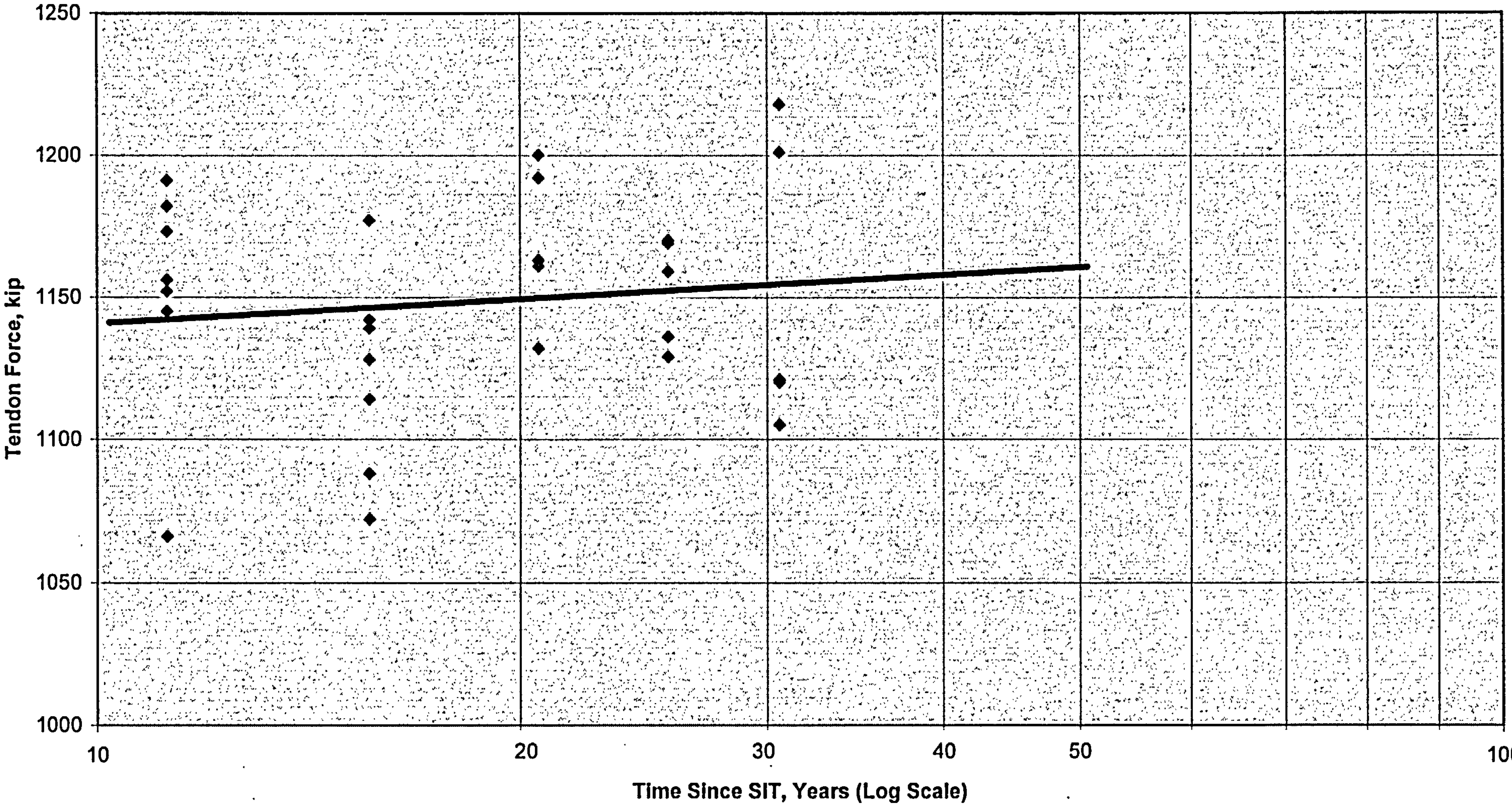


Figure 3-3
Dome Tendon Force Trend

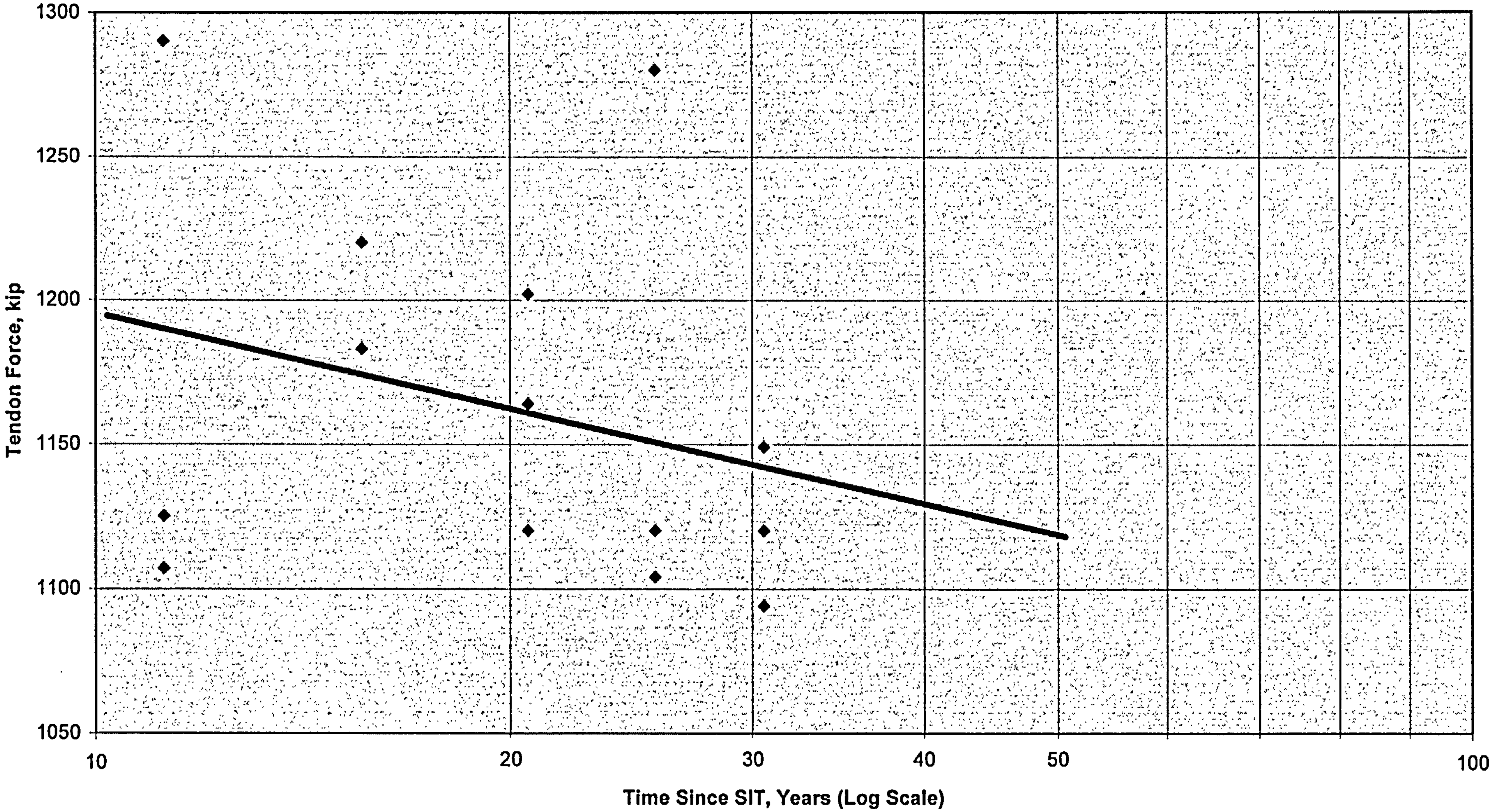


Figure 3-4
Vertical Control Tendon V-32

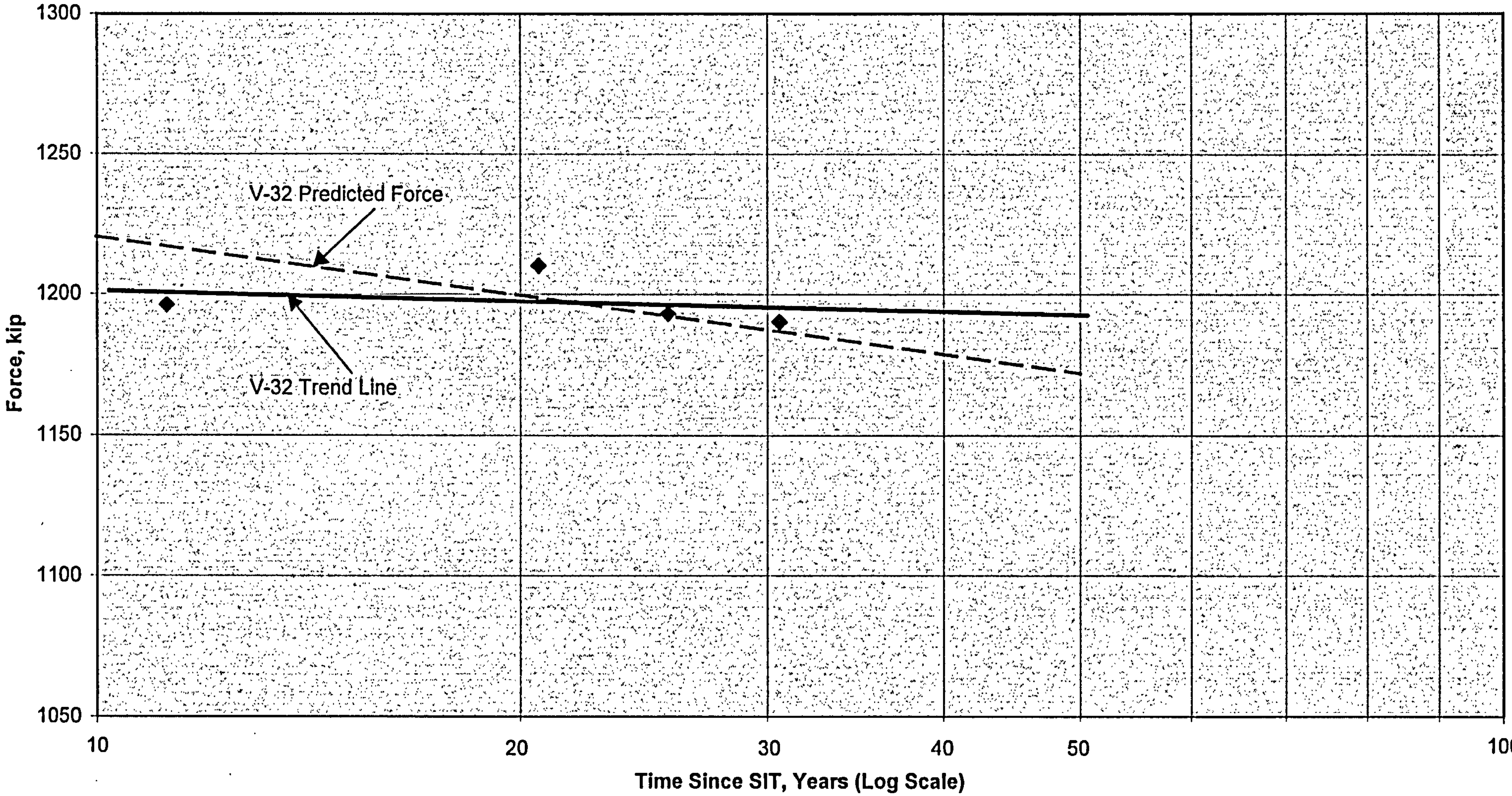


Figure 3-5
Hoop Control Tendon H62-26

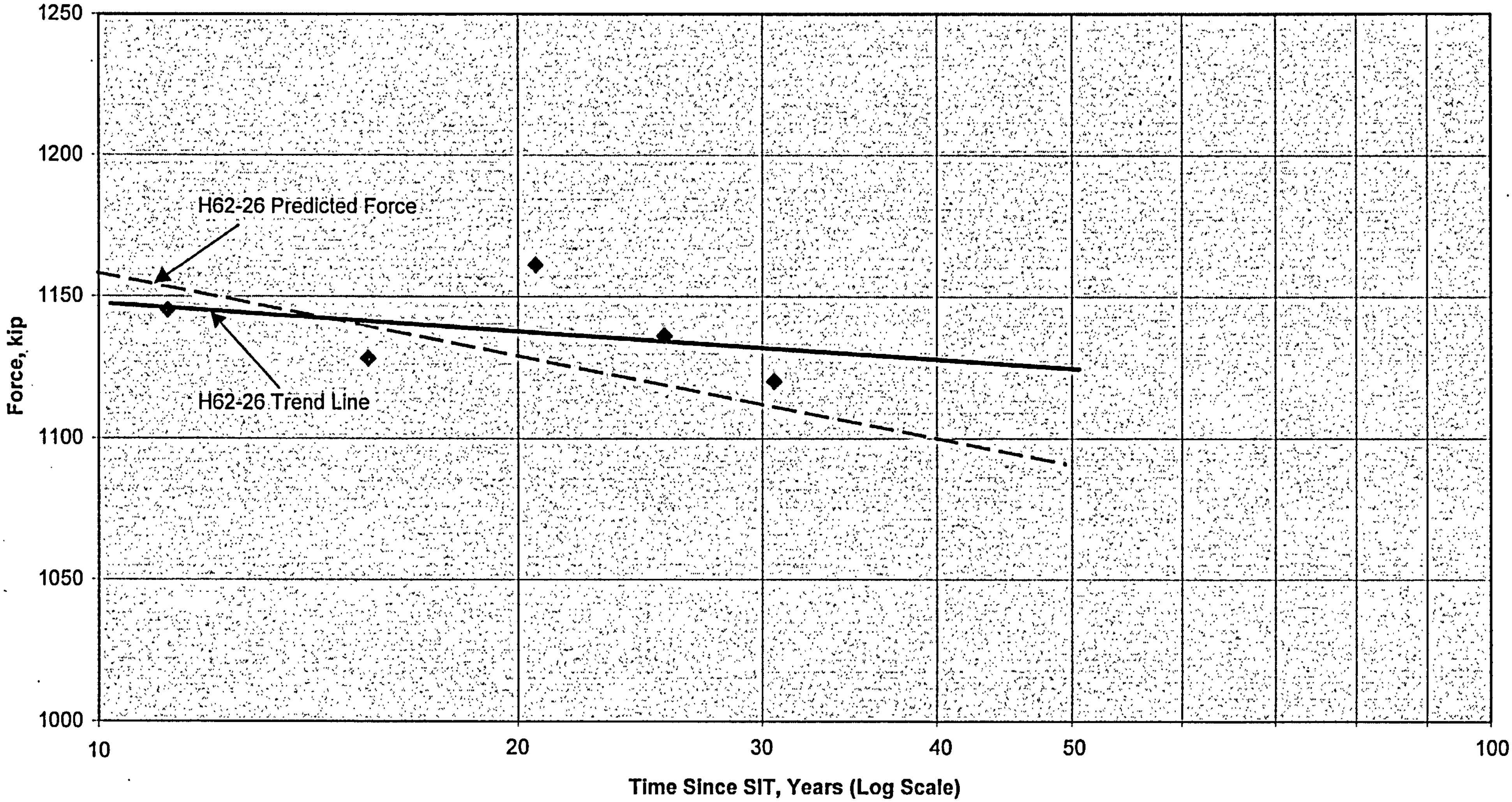


Figure 3-6
Dome Control Tendon D225

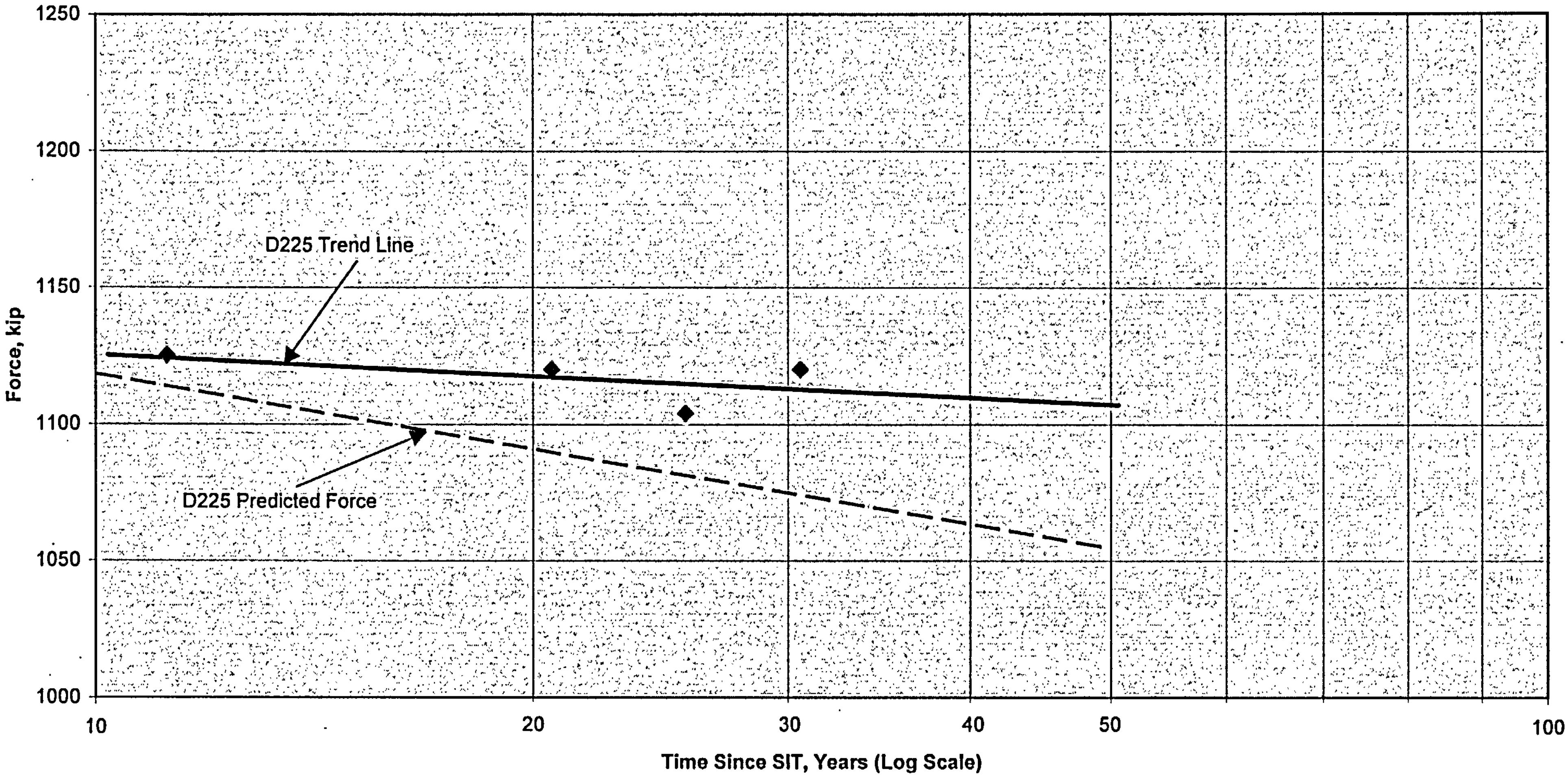


Figure 3-7
V-137 Elongation

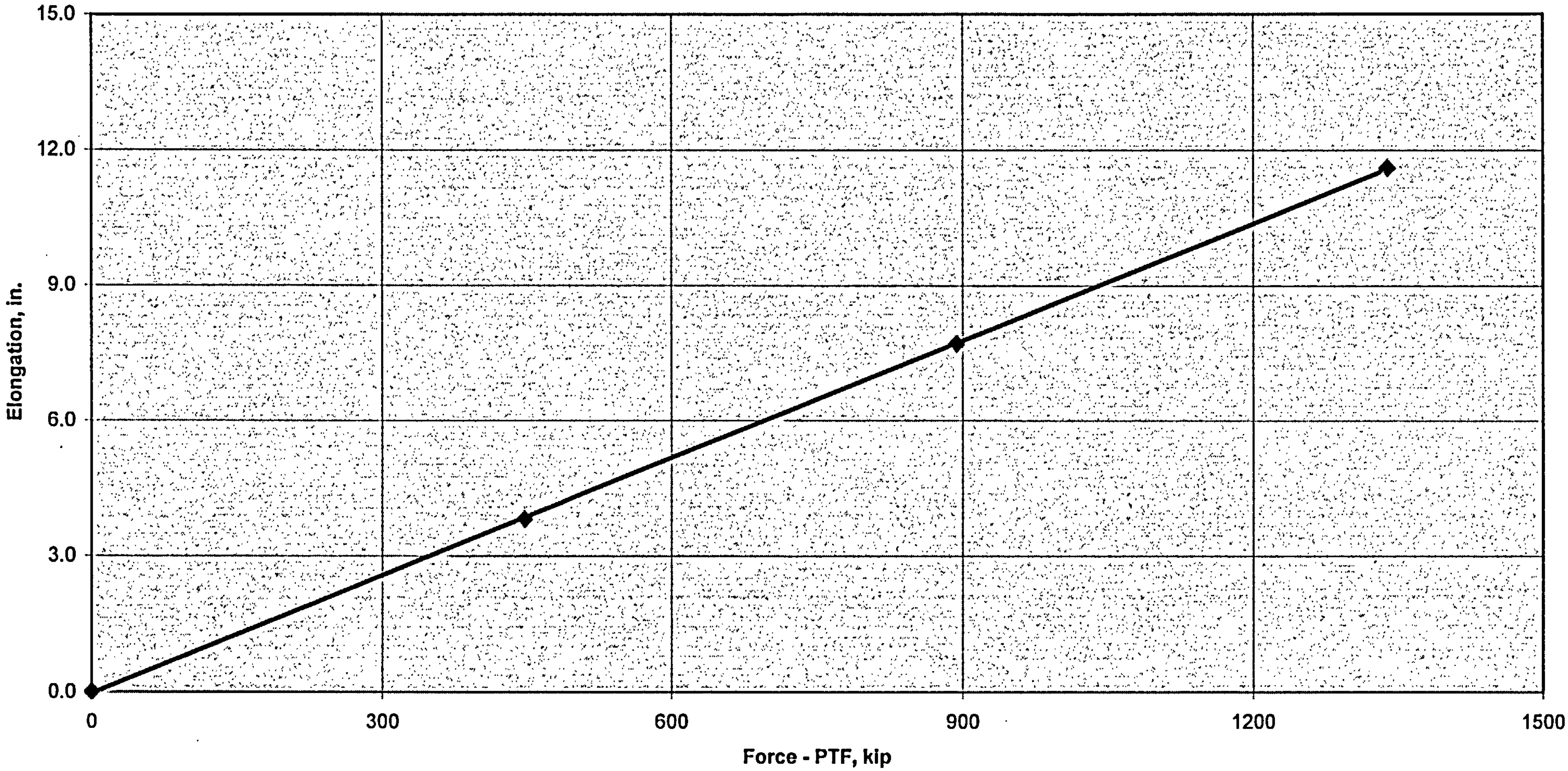


Figure 3-8
V-140 Elongation (Trial 1)

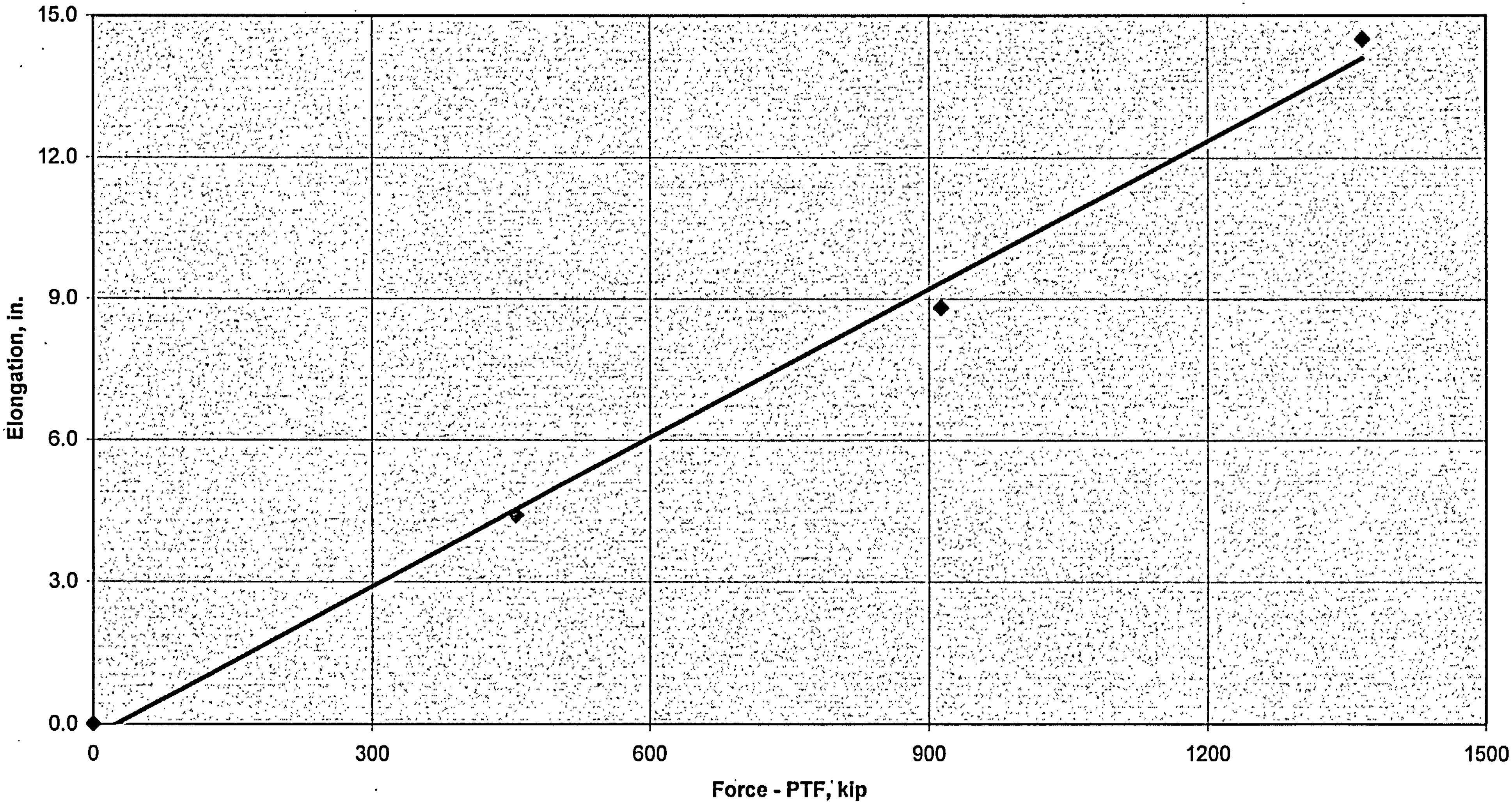


Figure 3-9
V-140 Elongation (Trial 2)

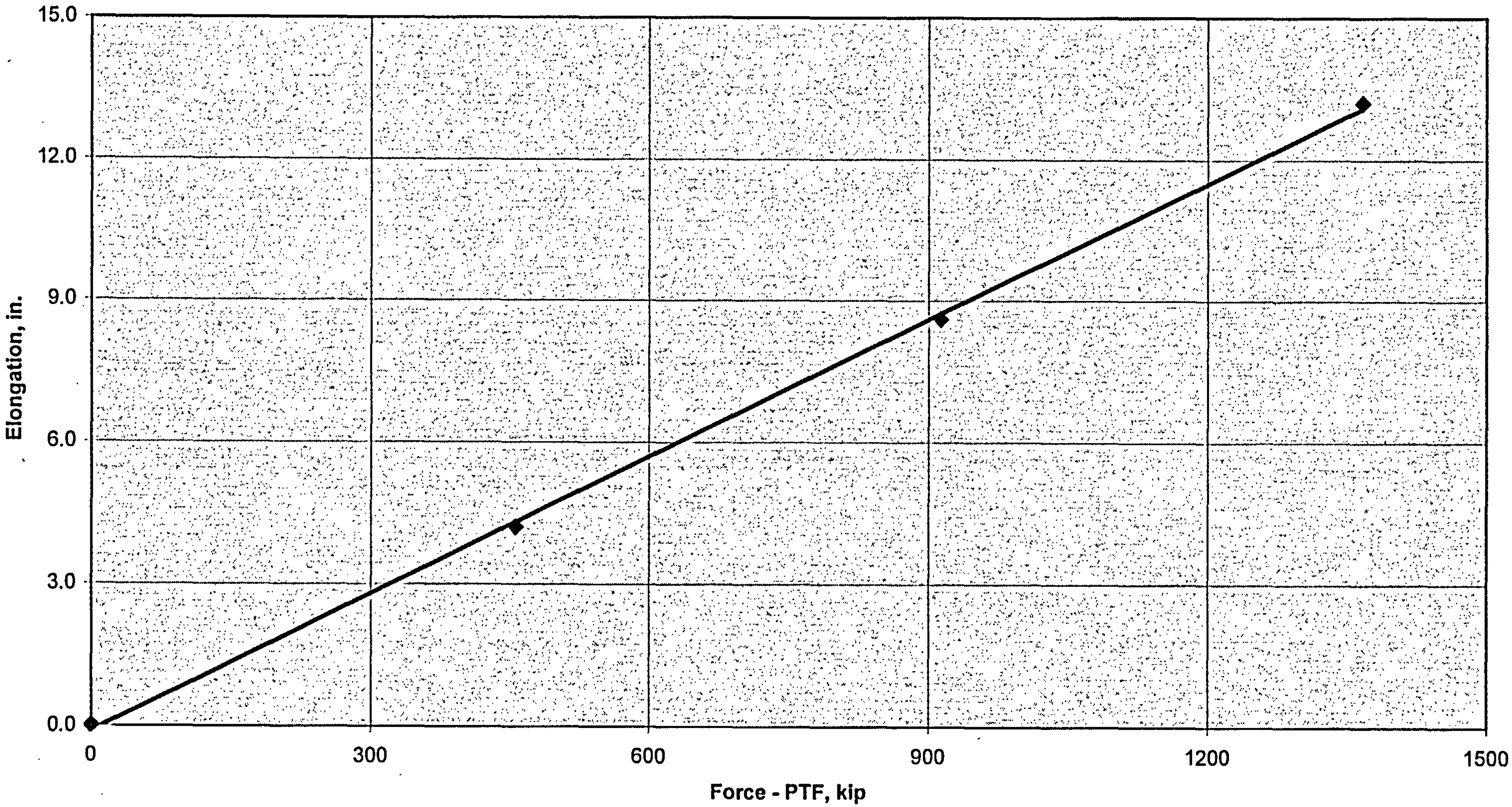


Figure 3-10
V-141 Elongation (Trial 1)

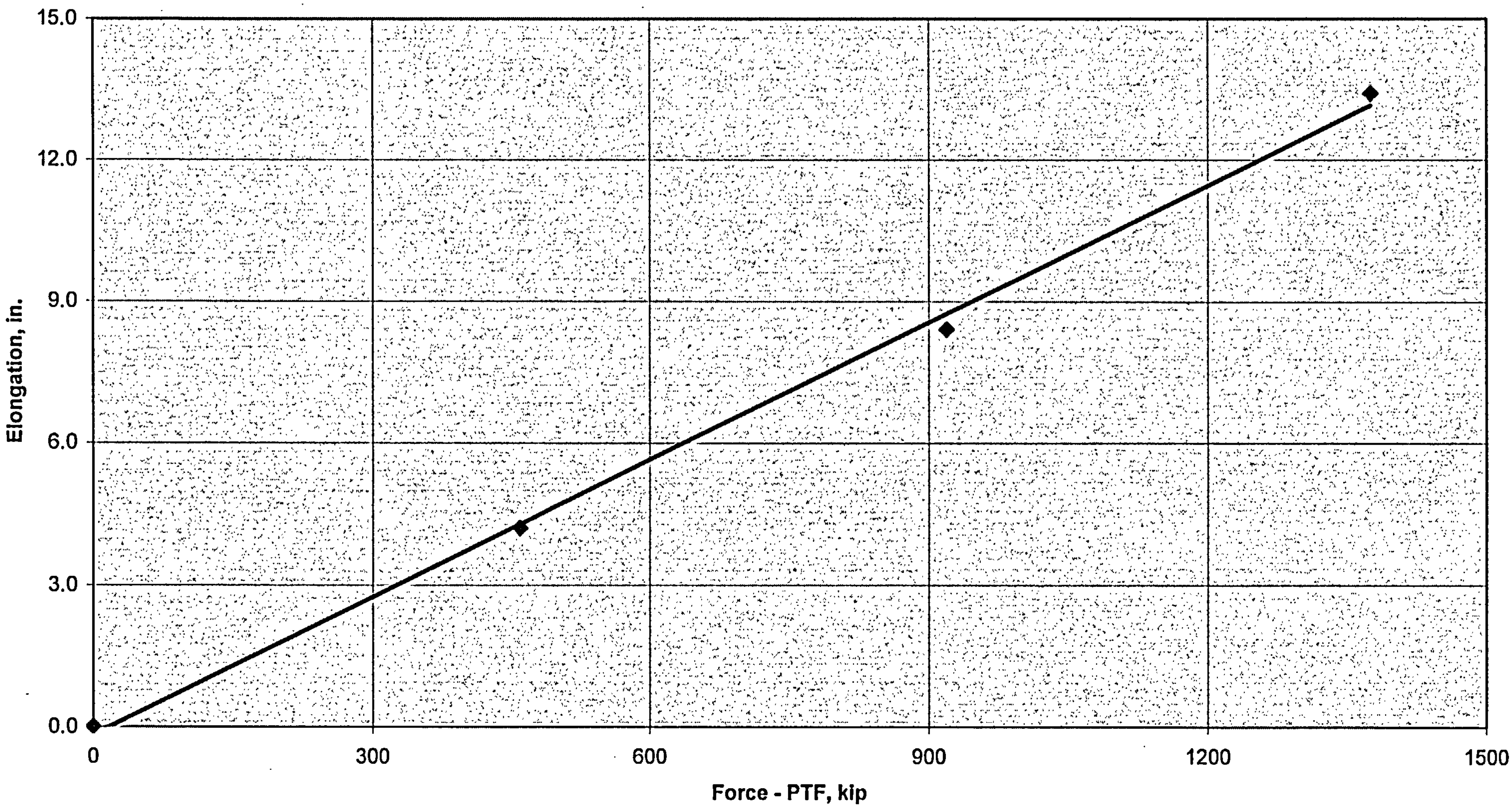


Figure 3-11
V-141 Elongation (Trial 2)

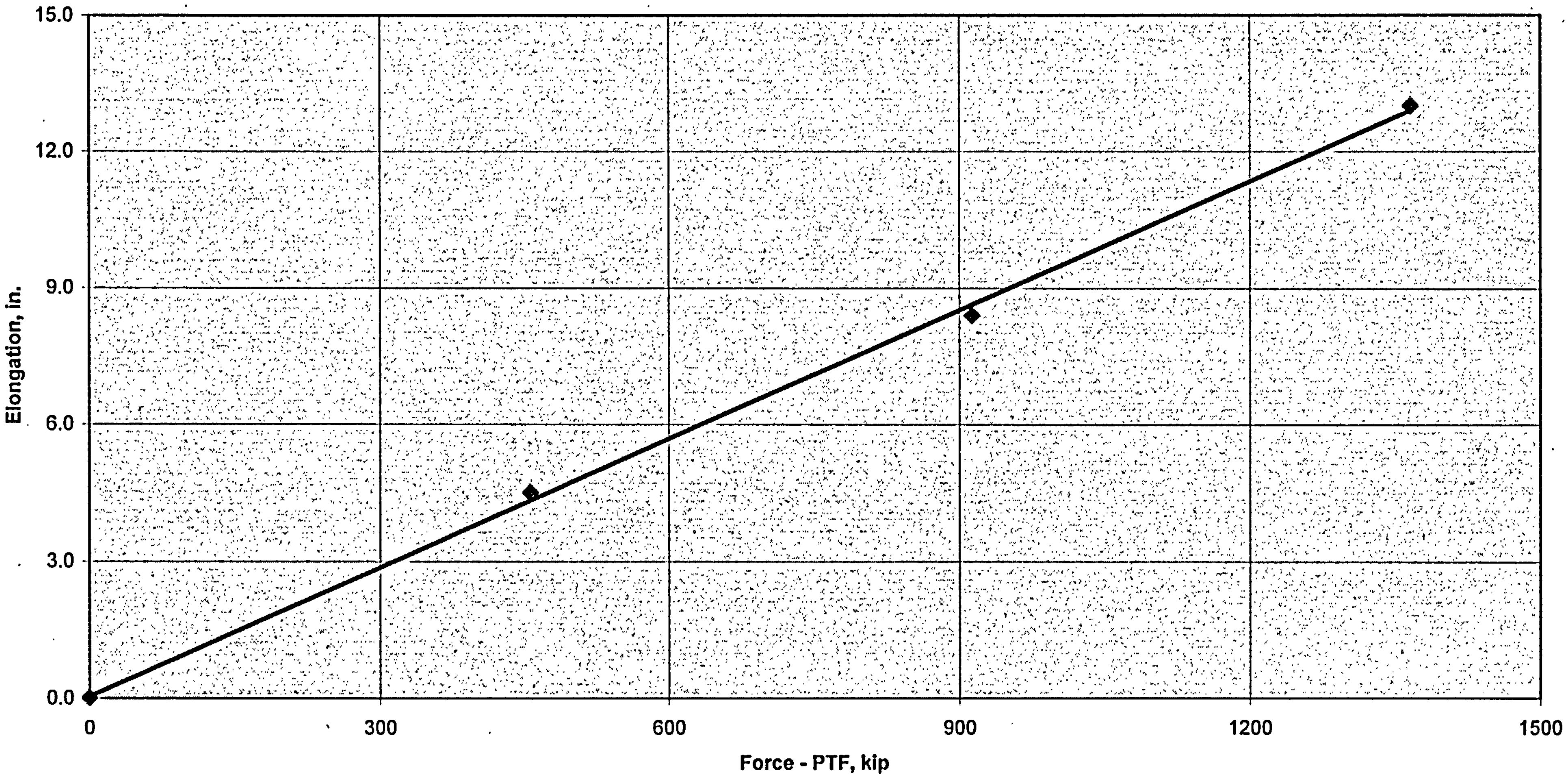


Figure 3-12
H46-25 Elongation

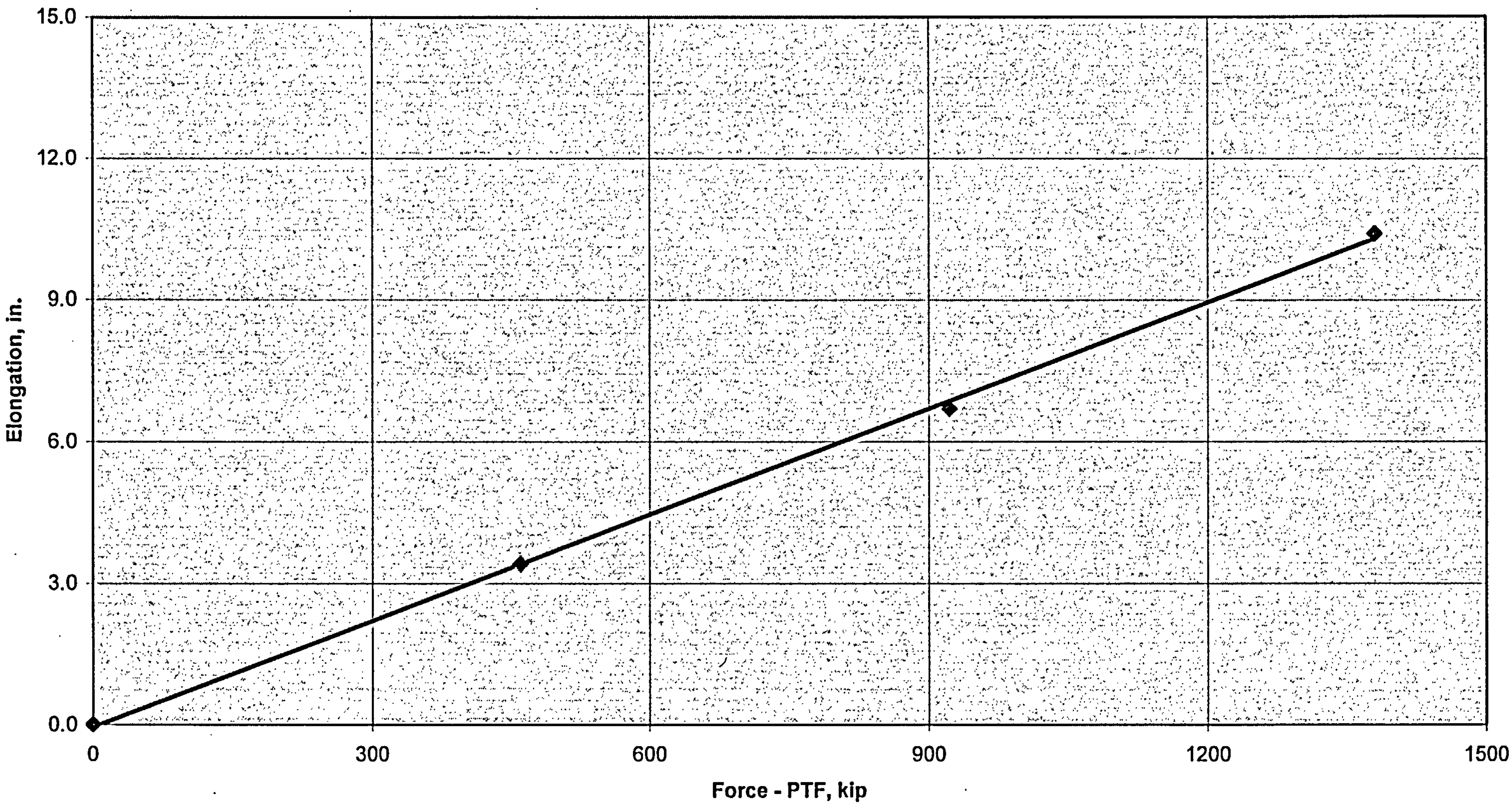


Figure 3-13
D230 Elongation

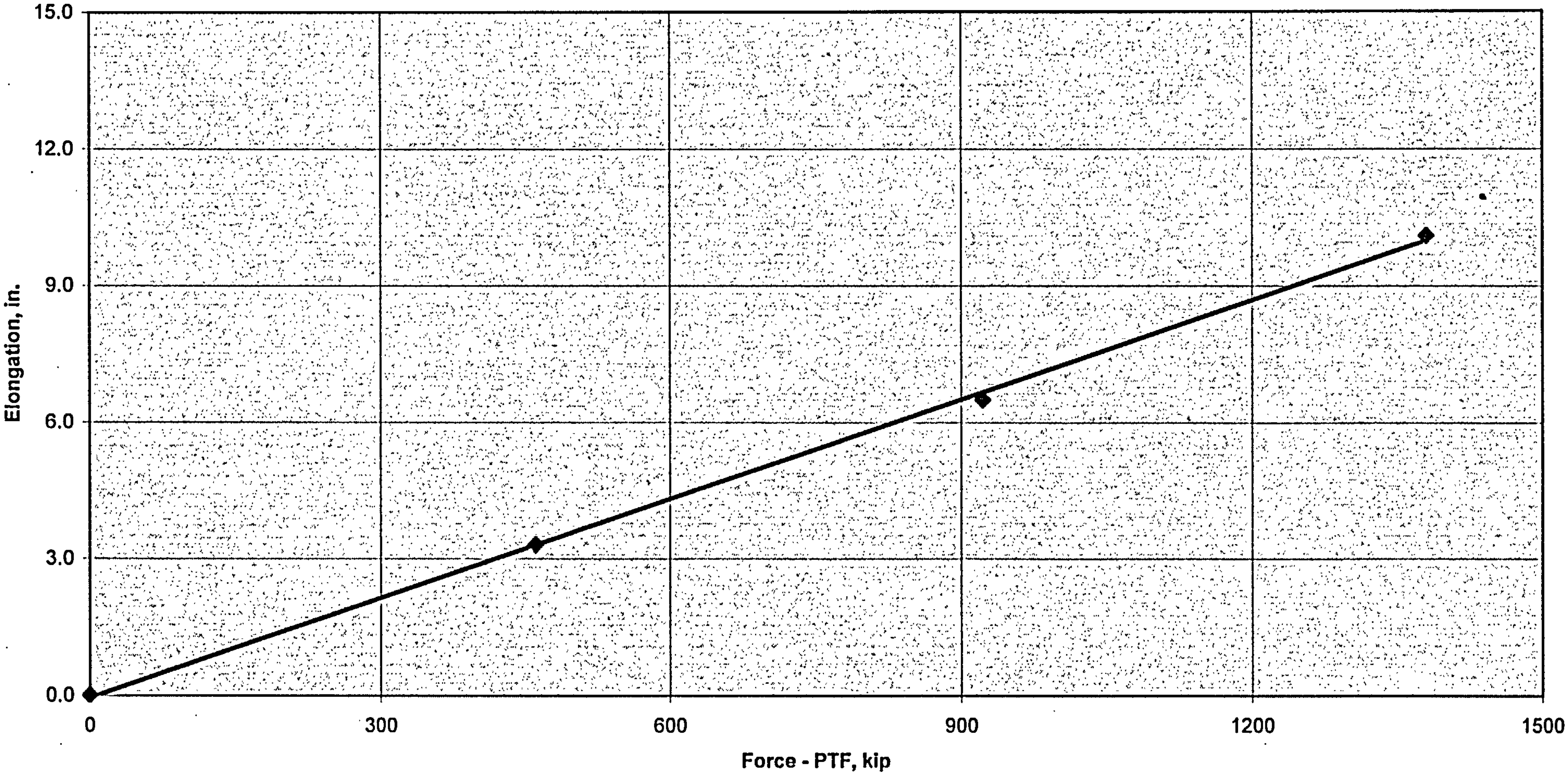


Figure 4-1
Efflorescence at Embedded Plate on Dome

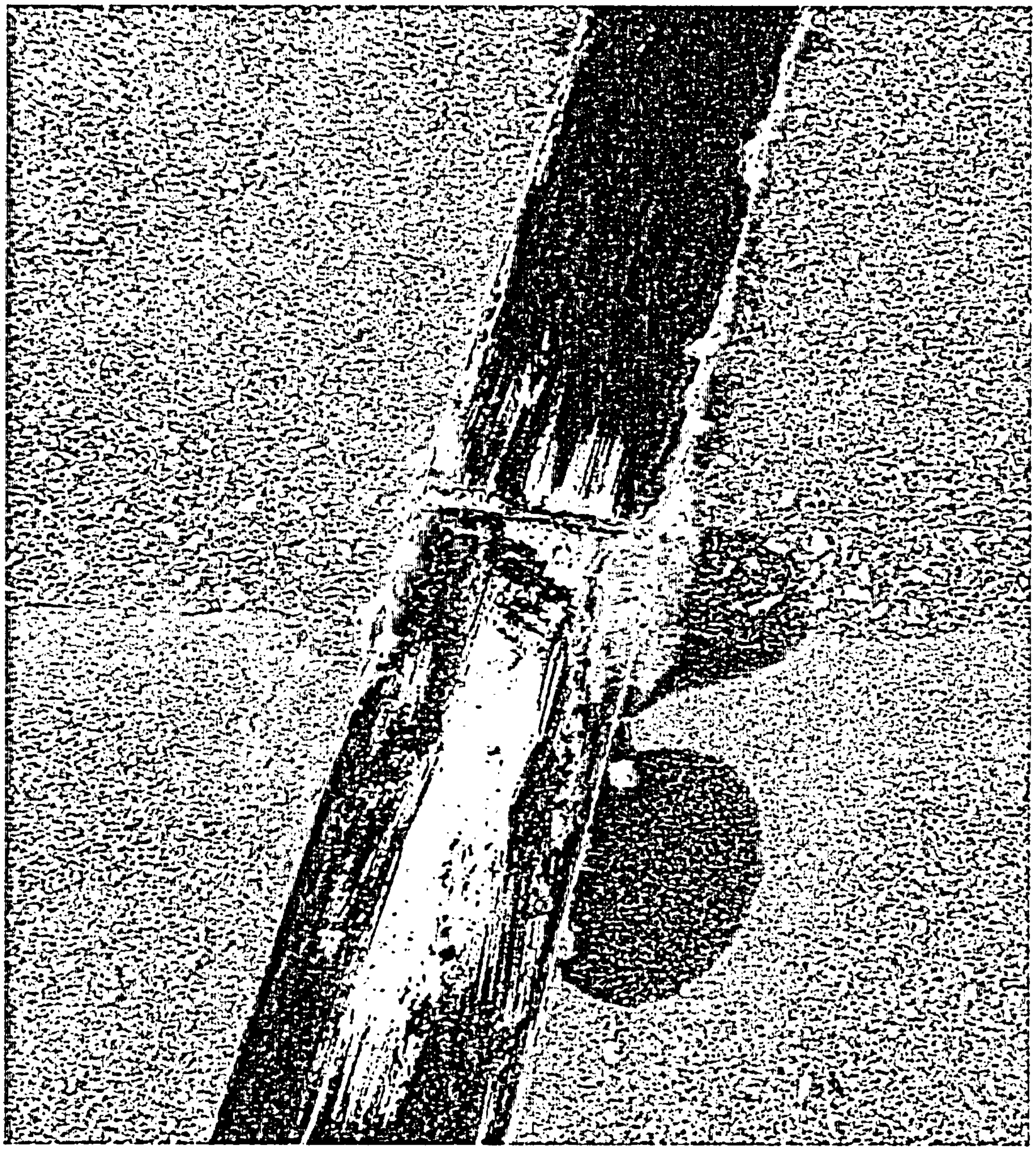


Figure 4-2
Grout Spall on Dome

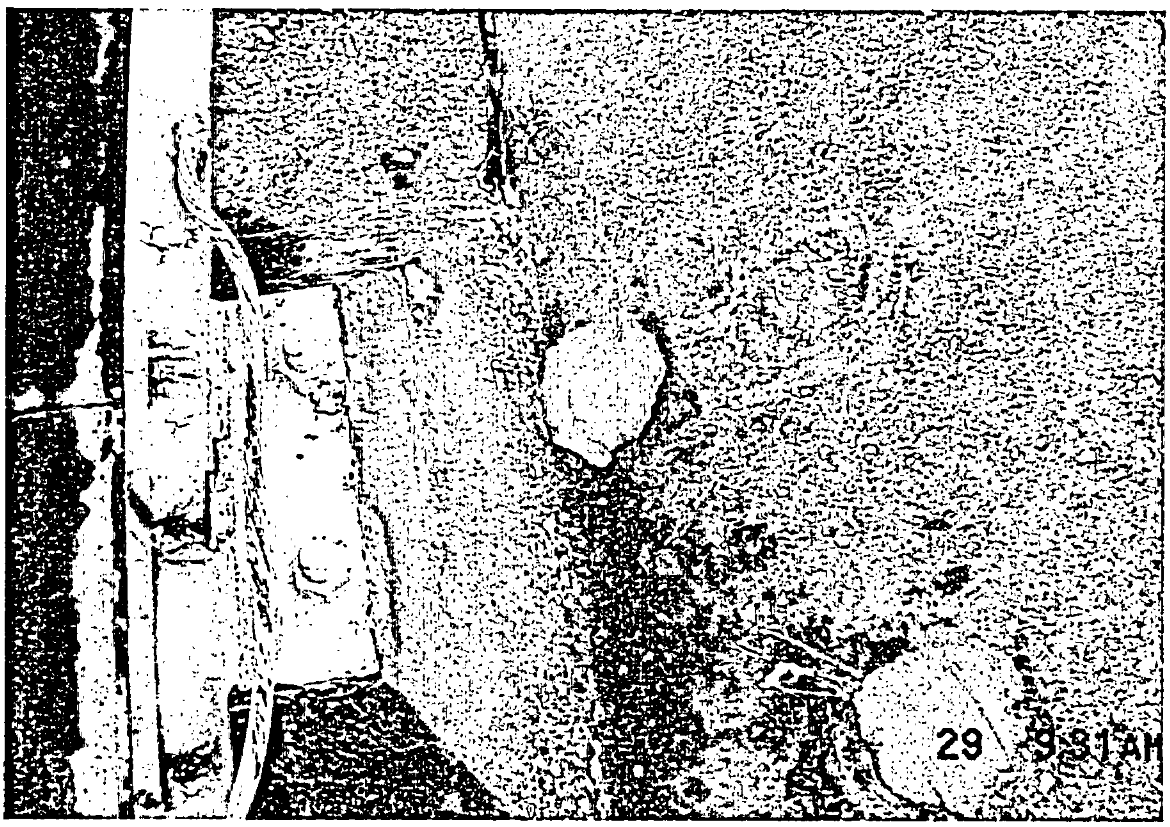


Figure 4-3
Gallery Efflorescence

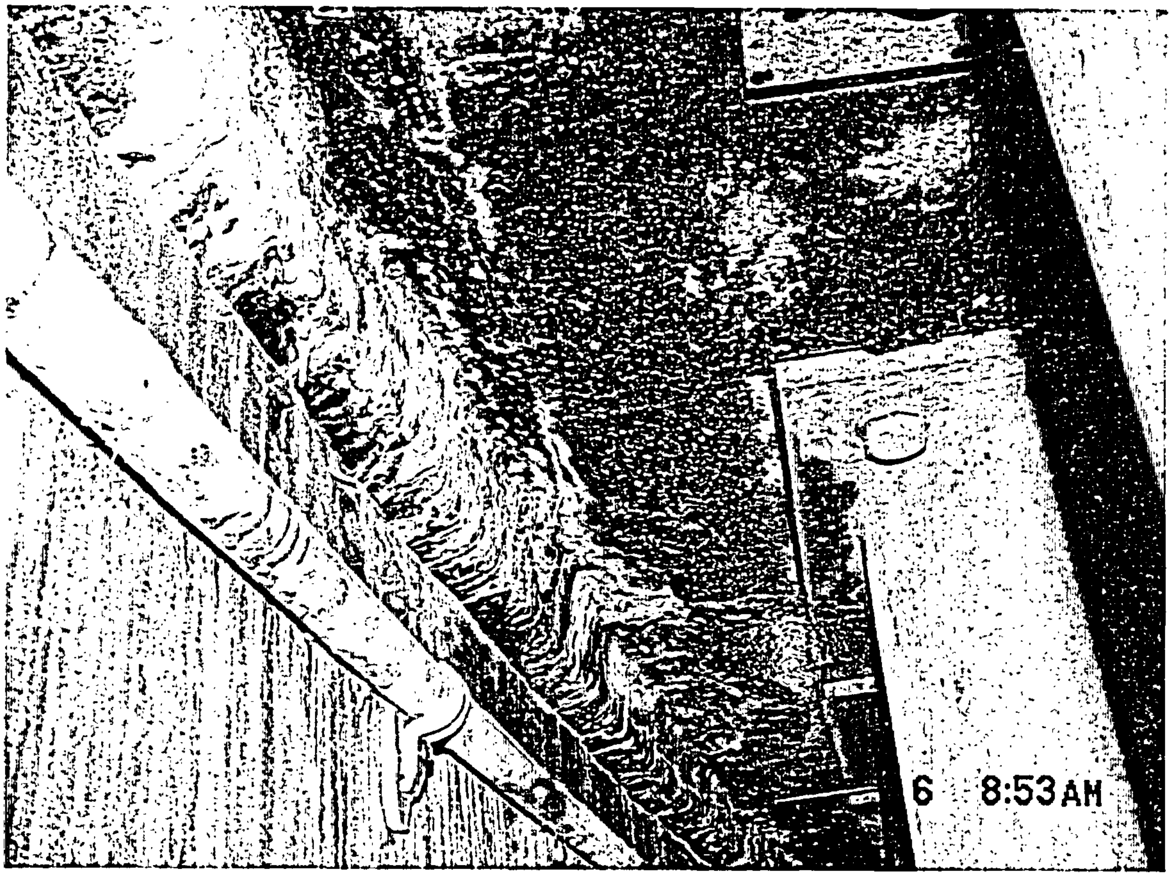


Figure 4-4
Spalling at Embedded Plate

Figure 4-5
Cracks in Wall Above Fuel Handling Building Roof

Figure 4-6
Grout Patch Loss above Equipment Opening

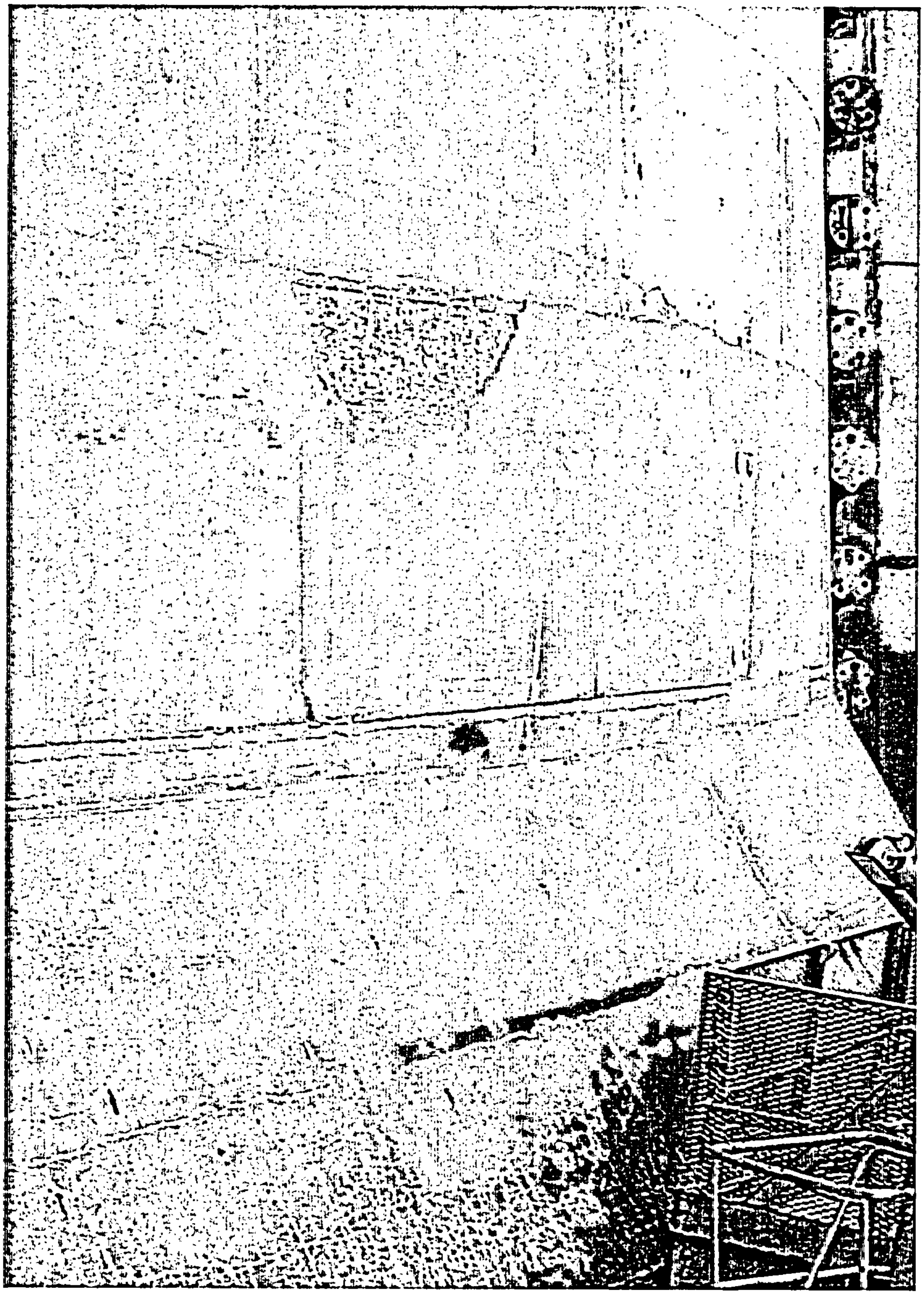


Figure 4-7
Spall at Dome Handrail Base Plate

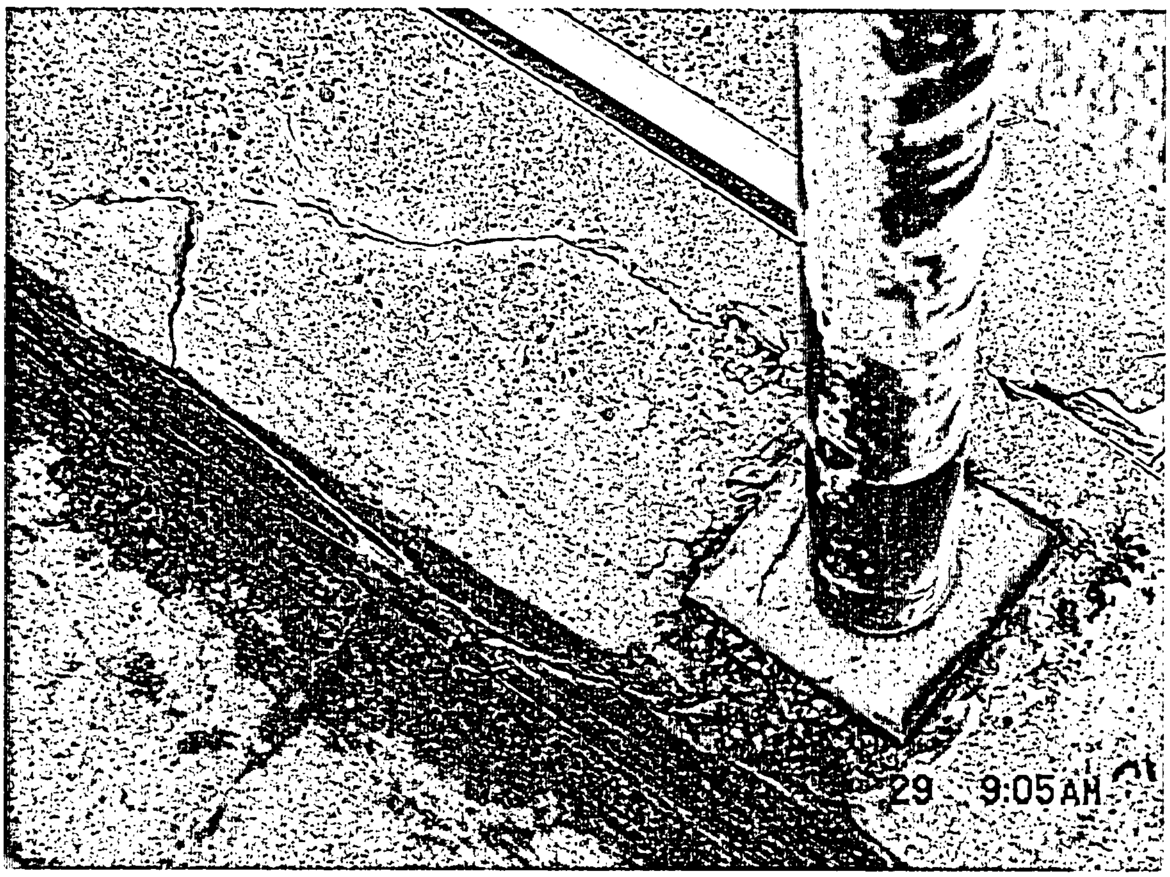


Figure 4-8
Spall at Dome Rain Gutter

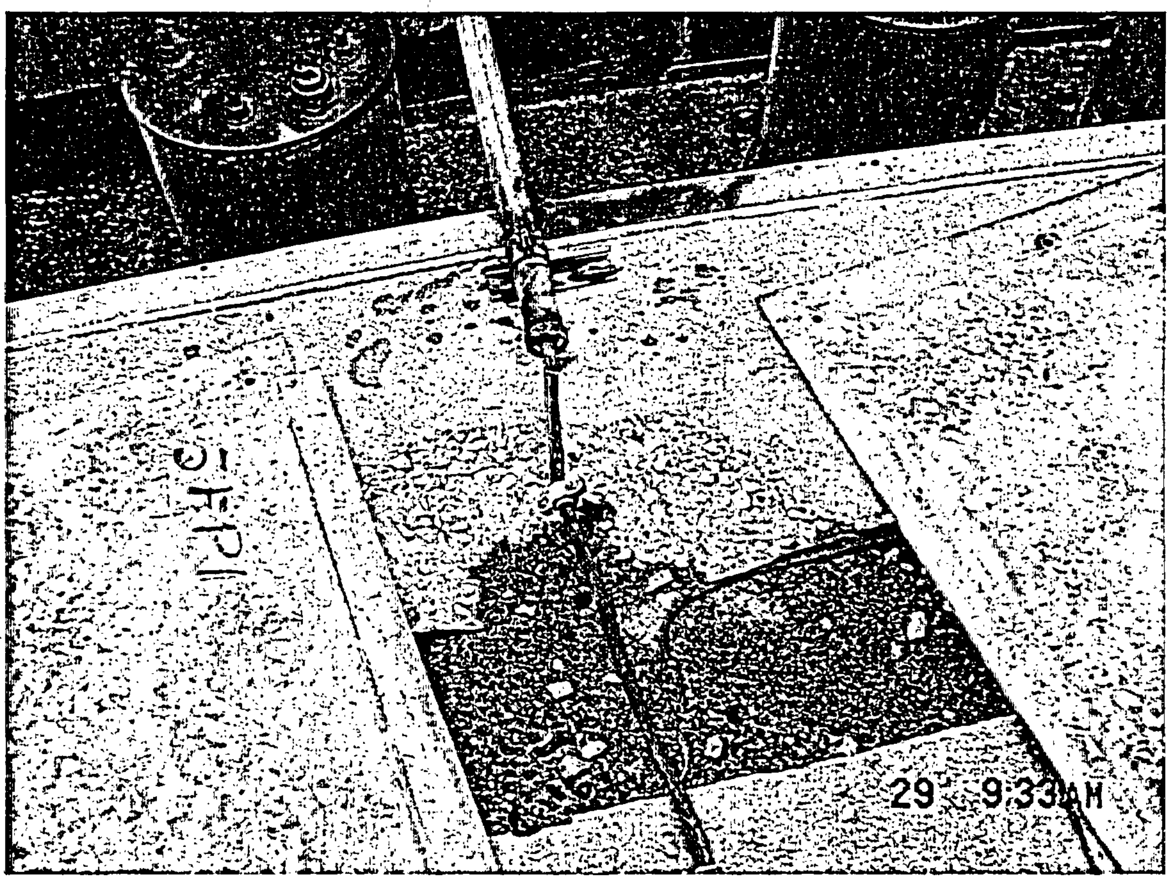
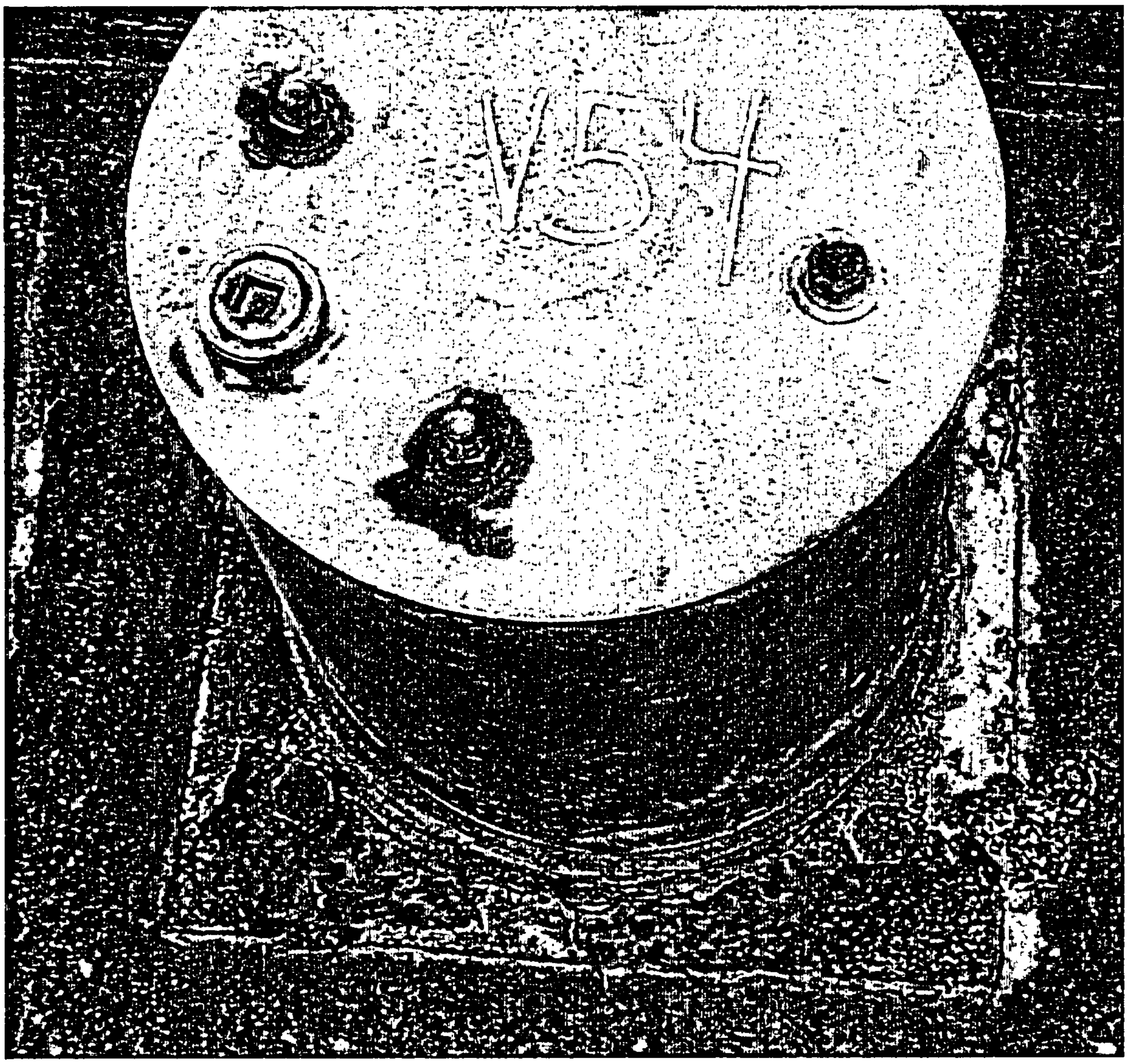


Figure 4-9
Cavity in Vertical Tendon Trench Wall

Figure 4-10
Corroded Reinforcing Steel at Ring Girder Spall

Figure 4-11
Vertical Tendon Upper End Bearing Plate Corrosion



9. ATTACHMENT

Precision Surveillance Corporation Report, *Thirtieth Year Surveillance of the Post-Tensioning System at the Three Mile Island Unit 1 Containment Building, 2004* (3 Volumes).

Attachment follows.