Florida
Power
CORPORATION
Crystal River Unit 3
Docket No. 50-302

May 15, 1995
3F0595-14

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Crystal River Unit 3 Fifth Tendon Surveillance, Additional Information

References: A. FPC to NRC letter, 3F0894-03, dated August 12, 1994
B. NRC to FPC letter, 3N0994-16, dated September 22, 1994
C. FPC to NRC letter, 3F1294-13, dated December 15, 1994

Dear Sir:

The reference letters contain NRC questions and Florida Power Corporation (FPC) responses resulting from the NRC review of the results of the Crystal River Unit 3 (CR-3) Fifth Tendon Surveillance. FPC has discussed follow-up questions with the NRC staff and is providing this submittal to document and respond to these questions. FPC is submitting a background section, a brief conclusion and two attachments containing a summary of the follow-up questions, our responses and a study performed by Gilbert Commonwealth to supplement our responses. As discussed during an earlier teleconference, FPC and Gilbert Commonwealth are available to meet with the NRC if such a meeting could be beneficial to bring this issue to closure.

Background

FPC performed the Fifth Tendon Surveillance from November 1, 1993 through January 4, 1994. The acceptance criteria for the surveillance was contained in the Technical Specifications applicable at the beginning of the inspection. However, anticipation of Improved Technical Specification (ITS) implementation for CR-3 prompted FPC to evaluate the results of the surveillance to the criteria of Regulatory Guide (RG) 1.35, Revision 3. As the guidance in the RG provides recommendations when certain parameters are exceeded, FPC provided an engineering report (Reference A) which contained the considerations, results, evaluations and conclusions drawn from the surveillance as well as a trend analysis of the dome, hoop and vertical tendons. The submittal of the report and the inclusion of the

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trend analysis were done to facilitate the interface of the then current requirements with those that would be germane to future surveillances. The engineering report was prepared by Gilbert Commonwealth for FPC since they have been involved in all Tendon Surveillances.

In September 1994 (Reference B), NRC requested additional information. The requested information is specific to the guidance in RG 1.35, Revision 3 and associated Regulatory Guide 1.35.1. FPC provided responses in Reference C. As mentioned earlier, FPC has discussed five questions with the NRC staff in subsequent telephone conferences. FPC is providing in two attachments to this letter, these questions and our responses.

Conclusions

FPC successfully completed the Fifth Tendon Surveillance. The results of the surveillance demonstrated the integrity of the Containment Tendon System. The next tendon surveillance will be performed to more current standards in accordance with our Containment Tendon Surveillance Program as specified in the ITS. Lessons-learned from our discussions with the Staff will be incorporated in our program. We do not believe the results to be an indication of an unacceptable adverse trend. Thus, FPC is requesting closure of the Staff's review of the results of the surveillance.

Sincerely,

Gary Boldt

G. L. Boldt,
Vice President
Nuclear Production

GLB:LVC

Attachments

xc: Regional Administrator, Region II
Senior Resident Inspector
NRR Project Manager

NRC Question No. 1

In Table 4, it appears that the elongation for overstress force (OSF) of 3-3/8" is in error, because it cannot be less than that of lock-off (LOF). A clarification is in order.

FPC Response

Some of the information provided for the elongation was in error. Table 4 of Reference C provided data of elongation measurement during re-tensioning for Tendon D231 per your request in Reference B. Tendon D231 field end is the only tendon which recorded 0" for the ram extension at the start of the re-tensioning process. Since the retensioning of Tendon D231 was performed from both ends, it has been concluded that there was an omission of the base shim thickness as a reference point while recording the data during retensioning at the field end of this tendon. Since the base shim used for each tendon is a 3" thick shim plate, its omission left the measured values 3" short. Therefore, as the shop end figures and the final shim thickness look reasonable for tendon D231, an adjustment has been made to the elongation data tabulated for Tendon D231, field end previously provided to the NRC in Table 4 of Reference C. The revised table immediately follows.

The data provided in Table 4 was provided in that format as requested by the NRC in Reference B. Elongation as presented in the tables are measured values with the exception of the recorded elongation at LOF which was not based on measured data during the retensioning process as were the other values. The LOF figures were taken from shim thickness records and entered for convenience in the table. The measurement of elongation at the OSF was consistent with the procedure and data taken during prior surveillances.

The effects of this adjustment for the D231 recorded elongation was then carried forward to the calculation made for the elongation percentages. Based on the corrections made, the percentage elongation calculation and comparison with the original elongation was recalculated. Since the correction to be made to the D231 tendon elongation data was to add 3" to the measured values for the D231 field end, there is no effect on the results of the elongation percentage calculation as originally calculated and as it was presented in Section 7 of Reference A. Thus, the value of -8.7% is still correct. The conclusion of that section that the measured elongations present no adverse effect remains unchanged.

TABLE 4
(Sheet 1 of 3)

TENDON I.D.: D231 (FIELD END)

Actual Observed Force and Elongation Measurement for
Retensioned Tendons

Force	Kips	Pressure (psi)	Elongation (in.)
PTF	364	1500	3"
Step #1 (a)	520	1830	3-3/4"
Step #2 (a)	1025	3660	6-1/4"
LOF	1370	4910	6-7/16" (b)
OSF	1535	5500	6-3/8"

Total Elongation (c) = (LOF - PTF) Elongation

= 6-7/16" - 3" = 3-7/16"

Pretensioned Force (PTF)

This is the force necessary to bring the tendon into a lightly stressed condition to remove slack and seat the buttonheads. This force establishes the base for elongation measurement.

Lock-Off Force (LOF)

This is the force at which the tendon load is transferred to the shim stack from the ram and is representative of the force at which the tendon lift-off occurred during the monitoring of tendon force.

Overstress Force (OSF)

This is the force maximum elongation is determined.

(a) Step #1 and Step #2 are intermediate data required by subsection 4.2 of RG 1.35.

(b) Note that the elongation at LOF was taken from shim thickness data on Enclosure 20 of the surveillance procedure (SP-182). It was not measured during the retensioning process.

(c) Total elongation as calculated above represents format as requested by NRC (actual). Gilbert/Commonwealth report used OSF - PTF for total elongation which gives a comparison of elongation to original installation.

TABLE 4
(Sheet 2 of 3)

TENDON I.D.: D231 (SHOP END)

Actual Observed Force and Elongation Measurement for Retensioned Tendons

Force	Kips	Pressure (psi)	Elongation (in.)
PTF	359	1500	3-9/16"
Step #1 (a)	540	2360	3-3/4"
Step #2 (a)	1050	4730	4-5/16"
LOF	1345	6210	6-15/16" (b)
OSF	1535	7090	7-7/16"

Total Elongation (c) = (LOF - PTF) Elongation

= 6-15/16" - 3-9/16" = 3-3/8"

Pretensioned Force (PTF)

This is the force necessary to bring the tendon into a lightly stressed condition to remove slack and seat the buttonheads. This force establishes the base for elongation measurement.

Lock-Off Force (LOF)

This is the force at which the tendon load is transferred to the shim stack from the ram and is representative of the force at which the tendon lift-off occurred during the monitoring of tendon force.

Overstress Force (OSF)

This is the force maximum elongation is determined.

(a) Step #1 and Step #2 are intermediate data required by subsection 4.2 of RG 1.35.

(b) Note that the elongation at LOF was taken from shim thickness data on Enclosure 20 of the surveillance procedure (SP-182). It was not measured during the retensioning process.

(c) Total elongation as calculated above represents format as requested by NRC (actual). Gilbert/Commonwealth report used OSF - PTF for total elongation which gives a comparison of elongation to original installation.

TABLE 4
(Sheet 3 of 3)

TENDON I.D.: D231 (COMPOSITE RESULTS)

Actual Observed Force and Elongation Measurement for
Retensioned Tendons

Force	Kips (Average of Shop End and Field End)	Total Elongation (Sum of Shop End and Field End)
Step #1	530	7-1/2"
Step #2	1038	10-9/16"
LOF	1358	13-3/8"

NRC Question No. 2

FPC stated in its response to question No. 2 that the regression analysis based on individual data is mathematically identical to that based on average value. The staff has performed the two cases as shown in the attachment. The trend line for the two cases have different slopes and the one based on average values gives a less conservative trend. Please explain.

FPC Response

Although the difference between the results of the two curves is not significant they are not mathematically identical.

The regression analysis provided in our response to question No. 2 of Reference B was prepared using normalized averaged data (Figures 6.1, 6.2 and 6.3 represented the trend for the dome, vertical and hoop tendons respectively). Those figures are equivalent to Figures 6.1, 6.2 and 6.3 which are being provided as part of the response to Question No. 3 of this submittal. Also provided in the response to Question No. 3 are the following figures which are relevant to the response to this question.

a) Revision 1 (R1) to Figures 6.1, 6.2 and 6.3. These figures are trending curves provided in Attachment 2, Appendix A which were prepared using <u>all</u> individual data points <u>normalized</u>.

b) Revision 3 (R3) to Figures 6.1, 6.2 and 6.3. These figures (also provided in Attachment 2) are trending curves prepared using <u>all</u> individual data points <u>not</u> normalized.

As shown in those three sets of figures, and as stated above, the difference between their results is not significant, as an example, it could be seen that the plotted trends and projections up to and beyond the 40 years plant life are well above the required minimum prestress levels. This is also true for the trend curves of all tendon groups (Dome, Vertical and Hoop).

The analysis prepared by the Staff as an illustration of the tendons' trend based on individual data is equivalent to our
Figure 6.1 R3. FPC's response to your Question No. 3 of this submittal provides additional design details from the evaluation and comparative study (see attachment 2). These details address the various methods and data used in the trend regression analysis.

NRC Question No. 3

In FPC's response to the Staff question on normalization, you have not adequately provided the basis for such a procedure. Explain why the fixed tendons (e.g. D215, 12V20, 56V1, etc.) had to be normalized every time when subjected to lift-off. Normalization is typically done to adjust the lock-off force in each of the tendons due to elastic shortening caused by the seating of the subsequent tendons.

As a simple example, a prestressed concrete beam is to be prestressed by ten tendons which are to be tensioned and seated one by one. Assume the lock-off force for each tendon is 100K (kips)and will result in a 1/10" shortening with a prestress loss of 1K. On the basis of this assumption, the normalizing forces for the 1st, 2nd, 3rd...and 10th sequentially seated tendons are 9, 8, 7, 6,...0k. Excluding other prestresses losses, the normalized tendon forces should be 91,92,93,....100k. These are obtained by modifying the lock-off force of each tendon and form the bases of the predicted forces. At the time of lift-off, most of the prestress losses have occurred and the tendon lift-off force should be the actual tendon force and requires no adjustment. It should be compared with the predicted forces. Obviously, there is no need to normalize the lift-off force, for instance, in a fixed tendon every time it is lifted off. It is realized that the prestressed concrete containment shell is under multi-axial prestressing, in one direction may affect the prestress in the other direction. Therefore normalizing the tendon forces is an involved process and the sequence of prestressing at the time of construction must be known. The normalization can be accomplished only through the use of a computer program.

This is the staff's understanding of the normalization process. If this is not your understanding, provide an explanation with an example as simple as possible.

FPC Response

Question 3 of Reference B requested the basis for the use of normalization, FPC's response to that question explained the use of normalization factors in the trend analysis provided in Reference A.

In our response, FPC did not clearly note that the use of normalization factors in the force curves was to adjust the lock-off force for losses due to elastic shortening, stress relaxation, creep and shrinkage. The reason for normalizing lift-off forces values on the trend curves developed for this surveillance is to be able to establish a direct comparison with the force curves. Those force curves were developed using such normalization and have been used in this and earlier surveillances to determine tendon lift-off force acceptability. Attachment 2 to this submittal contains a detailed study prepared by Gilbert Commonwealth for FPC to address the issues in this question related to the use of normalization factors.

NRC Question No. 4

In response to Question 4, you claimed it would be a major effort to revise the graphs in accordance with RG 1.35.1. From the graphs presented in the previous submittal, it appears that for each tendon you have established the baseline values for that tendon. Therefore, it should be a simple matter to use these values to establish the graph as required by RG 1.35.1. An explanation should be provided why this is not so and how the baseline values have been established.

FPC Response

FPC has utilized the services of our Architect/Engineer Gilbert Commonwealth for the preparation of the report we provided in Reference A and the graphs we presented in our December 1994 submittal, Reference C. The cost to produce revised force curves was estimated to be approximately $30,000. Prior to the next tendon surveillance, FPC will evaluate the current method of generating force curves for its compliance with Regulatory Guide 1.35, Revision 3. As explained in previous correspondence, there was no requirement nor any technical benefit to justify the cost of developing new force curves for the Fifth Tendon Surveillance Report submittal. Attachment 2, as part of our response to question No. 3, gives background information as how the force curves were developed and baseline values established.

NRC Question No.5

The response to question 6, infers that the abnormal loss of grease doesn't affect the integrity of the tendons. Such a premise may not be acceptable, unless the effects of the grease leakage into the concrete can be determined to be harmless. Therefore, the grease injection procedure in your next surveillance should be carefully monitored to detect any further leakage before such a determination can be made.

FPC Response

Our response shall not be understood as being unconcerned with the apparent grease loss. The response to question No. 6 provided in Reference C, stated that no grease leakage had been detected during walkdowns of the Reactor Building. Additionally, Appendix D of the Gilbert Commonwealth Report in Reference A indicated that there was no evidence of tendon wire corrosion or degradation. The report discussed that the additional grease added to the tendons may be due to:

A) Additional shrinkage and contraction losses over time.

B) Additional air voids and settlement into voids over time

C) Monitoring tolerances of grease filling during original installation

We have also stated in Reference C that the grease injection procedure will be closely monitored. FPC personnel will be visiting other nuclear plants during their tendon surveillances in the near future. FPC will closely observe several aspects of their inspection such as the grease injection with the objective of enhancing our procedures prior to our next surveillance. No other actions are planned at this time.

GILBERT COMMONWEALTH STUDY

The following three areas will be addressed:

a. Were normalization factors typical of a tendon surveillance program generated and correctly used in the CR-3 surveillances?

b. Why are the normalization factors applied to the lift off forces vs. the original lockoff forces as shown in the Tables in the Engineering report. Specifically, why are they used in the trending curves? Why was an average value used instead of all data points for the tendon surveillance group?

c. Discuss Appendix B of the G/C Engineering Report.

a. Normalization Factors/Background

Normalization factors were originally calculated for the CR-3 tendons during the completion of the containment design period in the late 1970's. The engineering efforts completed in 1980/1981 documented the methodology and generation of the normalization factors which is currently applicable. The personnel involved in the program at that time were actively involved with the subject for many years and communicated regularly with NRC representatives at that time. During the second, third and fourth surveillances, the CR-3 program requirements were periodically monitored against the evolving Reg. Guide 1.35 requirements as the document evolved through the 1980 draft version of Revision 3, and into the mid 1980's.

While the force curve base curve is the same as that originally developed in the early 1980's, the presentation of the curves changed slightly. The original lock-off and predicted elastic shortening values were used in the development of the base force loss curve and this data was shown on curves generated for the first several surveillances. The current force curves as presented in the Surveillance Procedure, Revision 11 are based on the curve format as revised for the fourth surveillance. At that time, the "lower limit" and 90% lower lines were replaced with 95% base and 90% base lines to provide for ease in comparison with acceptance criteria as presented in the draft version of Regulatory Guide 1.35, Revision 3. While the "lower limit" value has changed, the base curve of the tendons in the fifth surveillance is the same as the base values as presented in the first surveillance (unless the number of effective wires has changed). The current base line on the force curves is a function of the original lock-off value and the drop in force due to elastic shortening even though this data is not currently shown on the curves.

At the time the force curves and other development work was performed, G/C's Project Engineer for tendon surveillance was very active in the industry on the subject of tendon surveillance. Furthermore, he was the author of a technical paper on the specific subject of the normalization factor in tendon surveillance. The same calculation procedures as originally developed and used throughout the past four surveillances were again used as the engineering basis for work performed in this past fifth surveillance. However, the trending data and curves as presented in the Engineering Report were newly prepared for this surveillance based on the requirement of the new Revision 3 of Reg Guide 1.35 issued in 1990. Prior to 1990, overall results and trends were still evaluated but not with the same type of curves.

At the beginning of the engineering work for this last surveillance, it was recognized that Revision 0 of Reg. Guide 1.35.1 was formally issued in July, 1990, The effect on the CR-3 program had not previously been explored since the completion of the last CR-3 surveillance in 1987/1988, several years before the Reg. Guide was issued. A brief review was made for Florida Power Corporation to compare Revision 0 of the Regulatory Guide as issued in 1990 with the earlier draft version of the document dated 1980. This review concluded that the construction of the curves was very close to the latest requirements of the new Reg Guide version but not exact. G/C kept the CR-3 tendon program reasonably up to the requirements of the two Reg Guides as they evolved through the 1980's, since our engineers were actively involved in on-going issues. However, FPC was not committed to this version of the Reg. Guide for the fifth or prior surveillances.

The original tendon stressing sequence is known and was used in the latest calculation of the Normalization Factors. Calculations for the normalization factors (NF) all are a function of the original stressing sequence, the lock-off force at original stressing, the average original tendon lock-off force, the wire stress relaxation and the calculated elastic shortening loss, as well as other specific considerations for the CR-3 plant. Each factor was calculated at the time the individual tendon force curves were generated for inclusion into the surveillance procedure, and each NF is printed on every individual tendon force curve. A separate force curve has typically been prepared for each selected tendon, its adjacent tendons and some alternate tendons. Each curve represents the summation of all predicted losses resulting from elastic shortening, stress relaxation, creep and shrinkage. There are calculations which provide the equations used for the CR-3 normalization factors. The expression for the basic normalization factor used for CR-3 is as follows:

$NF_i =$

$\Delta F^T_{es} * [(N - 2n + 1)/2N] + F_i(0) *[(F_{avg}(0)/F_i(0)) -1] * [1 - Sr(t)]$

Where.

NF_i is the normalization force factor for a particular tendon in Kips.

F^T_{es} is the total elastic shortening force loss for the particular tendon.

N is the total number of stressing sequences for the tendon group.

n is the stressing sequence for the particular tendon.

$F_i(0)$ is the lockoff force for the specific tendon at original stressing

$F_{avg}(0)$ is the group average lock-off force at original stressing.

Sr(t) is the wire relaxation (%/100) at time t, from test data.

b. Use of Normalization Factors.

The trending curves as presented in the Engineering Report as Figures 6.1, 6.2 and 6.3, were prepared new for this surveillance period as a formal method of addressing Reg. Guide 1.35, Section 7.1.6. As such, the curves had never before been reviewed by the NRC.

Typically, the average liftoff force, as measured (not normalized) is plotted on the individual force curves where it can be readily compared with the predetermined values of base, 95% base, and 90% base as required per Reg. Guide 1.35. The surveillance procedure was revised so that this comparison could be easily done by the contractor and allowed for the decision for additional required work on adjacent tendons to be made within the requirements of the surveillance procedure.

The approach taken on the new trending curves was to take the measured liftoff values for each tendon group and to add the normalization factors as shown on Tables 6.1, 6.2 and 6.3 (see pages A1, A2 and A3 of Appendix A to this study). Based on the small number of data points, it is believed that it is more conservative to include the data in a normalized manner than based only on the measured results. To illustrate, suppose that the small sample of dome tendons as selected on a random but representative manner all had very high negative normalization factors and the normalization factors were ignored in the trending plot. Then the plot of measured liftoff values would show a non-conservative trend line plotted higher in the vertical scale than that of the normalized data. By using the normalization factors, this small sample bias is eliminated and is representative of the average force condition for the inspected group.

Another concern raised by the NRC is with the average values used for the plotting of the trend curves. At the time the original plots were prepared, all data points from the individual tendons were tabulated on Tables 6.1, 6.2, and 6.3 and normalized averages computed for tendons in each surveillance period within a group. Plots were prepared by plotting the averages and using the regression feature of the program to determine the trend line. The resulting curve was compared against curves also prepared from best fit curves using all the data points. This was specifically done at the time of initial issue as a means of checking the best fit curve to be included in the Engineering report. The results at that time indicated that the averages used for the plots as presented were representative of the data and that there was no significant difference between them and the plots using all data points.

To further review and study the recent NRC concerns, the data in the Tables and Figures has been re-tabulated and is attached for review. Revised Figures were prepared to review the affect of using the normalizing factor vs. omitting it; as well as averaging the data vs. using all data points. The curves were prepared using similar scales allowing comparisons to be made between them.

Curves representing the reworked data are attached as an Appendix and include the following:

Dome Tendons

Figure 6.1	Normalized averages of liftoff data.
Figure 6.1 R1	Normalized data, all tendons data points.
Figure 6.1 R2	Not normalized averages of liftoff data.
Figure 6.1 R3	Not normalized all tendon data points.
Table 6.1 R1	Averages for measured liftoff data.

Hoop Tendons

Figure 6.2	Normalized averages of liftoff data.
Figure 6.2 R1	Normalized data, all tendons data points.
Figure 6.2 R2	Not normalized averages of liftoff data.
Figure 6.2 R3	Not normalized all tendon data points.
Table 6.2 R1	Averages for measured liftoff data.

Vertical Tendons

Figure 6.3	Normalized averages of liftoff data.
Figure 6.3 R1	Normalized data, all tendons data points.
Figure 6.3 R2	Not normalized averages of liftoff data.
Figure 6.3 R3	Not normalized all tendon data points.
Table 6.3 R1	Averages for measured liftoff data.

COMPARATIVE RESULTS

Comparison of Averaged data vs. All data points, Normalized

Dome Figures 6.1 vs. 6.1R1	Same linear slope.
Hoop Figures 6.2 vs. 6.2R1	Same linear slope.
Vertical Figures 6.3 vs. 6.3R1	Curve with all data points is slightly lower.

Comparison of Averaged data vs. All data points, Not Normalized

Dome Figures 6.1R2 vs. 6.1R3	Same linear slope.
Hoop Figures 6.2R2 vs. 6.2R3	Same linear slope.
Vertical Figures 6.3R2 vs. 6.3R3	Curve with all data points is slightly lower.

The conclusion from the above two comparisons is that there is no significant difference between the plots of the average values vs.the plots of all the data points for tendons in the group. This was true whether the normalization factor was used or not.

The results from comparisons of normalized versus not normalized data are:

Comparison of Normalized vs. Not normalized Data, Averaged Liftoffs.

Dome Figures 6.1 vs. 6.1R2	Lower slope without normalizing factor
Hoop Figures 6.2 vs. 6.2R2	Slightly lower slope with normalized data
Vertical Figures 6.3 vs. 6.3R2	Slightly lower slope without normalizing factor

Comparison of Normalized vs. Not normalized Data, Averaged Liftoffs.

Dome Figures 6.1R1 vs. 6.1R3	Lower slope without normalizing factor.
Hoop Figures 6.2R2 vs. 6.2R3	Lower slope with normalized factor.
Vertical Figures 6.3R1 vs. 6.3R3	Slightly lower slope without normalizing factor.

The conclusion from the above two comparisons (with vs. without normalization factors) is not consistent among all groups of tendons. The dome and vertical groups show lower slopes on the curves without normalization factors, while the hoop group shows a lower slope on the two curves where the normalization factors have been included.

CONCLUSIONS

The use of the average point representing all data points from individual tendon measured liftoffs does not affect the results as presented. Mathematically, the best fit curve is not significantly different than the same curve generated using all data points.

The approach taken on these new trending curves was very similar to the approach taken for the comparison of average normalized liftoff forces with the minimum required prestress levels for the CR-3 containment (per Enclosures 40 and 41). That comparison has essentially been in place since the first surveillance.

Based on the review of the additional force curves for the dome group, the lowest force occurring out at 40 years after SIT is on the curve using all data points and without normalization factors. A difference of about 60 kips exists between the normalized vs. not normalized points. See Figures 6.1R1 vs 6.1R3.

For the hoop group, the lowest force occurring out at 40 years after SIT is on the curve using all data points with normalization factors. A difference of about 30 kips exists between the normalized vs. not normalized points. See Figure 6.2R1 vs 6.2R3.

For the vertical group,the lowest force occurring out at 40 years after SIT is on the curve using all data points and without normalization factors. A difference of less than 20 kips exists between the normalized vs. not normalized data making this an insignificant difference. See Figures 6.3R1 vs 6.3R3.

Note that the comparison Figure generated by the NRC in the Reference 4 response varies from the attached figures since the NRC example curve starts in year 1 on the log scale. The first surveillance period for CR-3 actually starts later on the log scale for each tendon group. The corrected NRC figure would be comparable to the attached Figure 6.1 R3 and the results are basically the same. In all cases, the plotted trends are well above the required minimum prestress levels for the plant. Projections out at the 40 yr.point are still well above the required minimum prestress levels for the CR-3 containment

c. Discuss Appendix B of the CR-3 Engineering Report

The information presented in Appendix B of the Reference D Engineering Report is based on the overall results of the surveillance. As part of Surveillance Procedure, SP-182, Rev 11, the contractor was required to record the actual measured liftoff forces for each tendon (average of both ends) on each individual force curve and on Enclosure 41 of the Surveillance Procedure. Once the entire group was completed, a normalized average of the tendon forces was calculated and compared with the minimum required prestress force as determined from an original design basis calculation for that tendon group. This procedure has been in place since the first surveillance and was left in the procedure for this past surveillance since FPC compliance to the latest Reg Guide 1.35 Revision 3 was not fully established or accepted by the NRC.

Normalizing factors necessary for the completion of Enclosure 41 were computed by engineering and presented in Enclosure 42 of the Surveillance Procedure. The calculation of the normalization factors was completed just prior to the surveillance, when tendons were selected, the force curves were generated, and the surveillance procedure was revised and updated to be in compliance with Reg Guide 1.35, Revision 3. During the surveillance, an additional tendon was

selected for evaluation which was not previously scheduled for the surveillance, therefore requiring the addition of another normalizing factor on Enclosures 41 and 42 of the Procedure. Also, during the surveillance, minor errors were discovered on some force curves which affected the normalization factors. Since none of these additions or corrections had any affect on the actual field work, it was not necessary to revise the surveillance procedure to correct the Enclosures at that time. The correction was held for documentation in the final Engineering Report, along with other data and field deviations being dispositioned as a result of surveillance effort.

The presentation of the revised Enclosure 41 and 42 as shown in the Engineering Report, Appendix B, Pages 2 and 3, was made only to formally document the revision as it was a deviation from the Surveillance Procedure, Revision 11 as used by the Contractor. The revised information was also factored into the contractors report during the review process for that report. The explanation on page 1 of Appendix B provides a brief summary based on the above discussion.

References

1. US NRC Letter to Florida Power Corporation, L. Raghavan to Mr. P. Beard, 9/22/94.

2. Engineering Evaluation Report for the Fifth Tendon Surveillance Inspection Period, 6/20/94, as prepared by Gilbert/Commonwealth Inc. for Florida Power Corporation, Crystal River unit 3.

3. Review of Draft Response to Staff's RAI's, Crystal River Plant, Telecopy from USNRC, 11/17/94.

4. Request for Clarification of Responses to RAI's and telephone discussions with the NRC.

TABLE 6.1 R1

SUMMARY OF DOME TENDON FORCES THROUGH FIFTH SURVEILLANCE

SORTED BY SURVEILLANCE NO. / TENDON NO.

02-Feb-95
03:59:16 PM

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	1557						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	1596	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	1563						Average	1531	
D123	1611	1306	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	1643	1506	3	1295	1249	16.3	20.6	-12	1494	1215
	Average	1447						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	1448						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	1426						Average	1454	
Average	1394	1501				13.5	20.2			

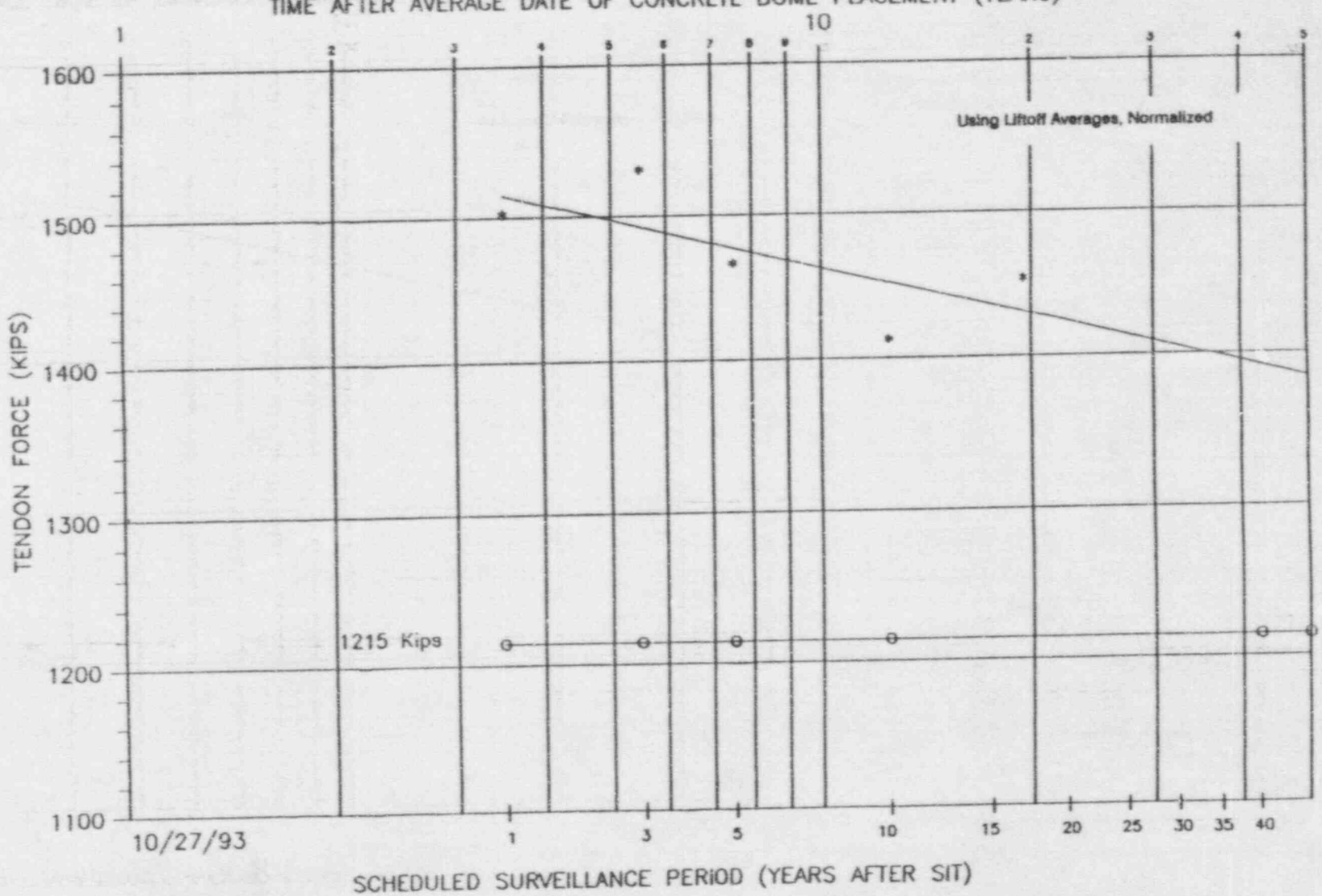
* Lower limit values for Surveillance 1 through 3 were revised to represent 95% Base value currently specified by R.G. 1.35, Revision 3. (Previous lower limits were at approximately 97% Base.)

File: 180M95.XLS

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



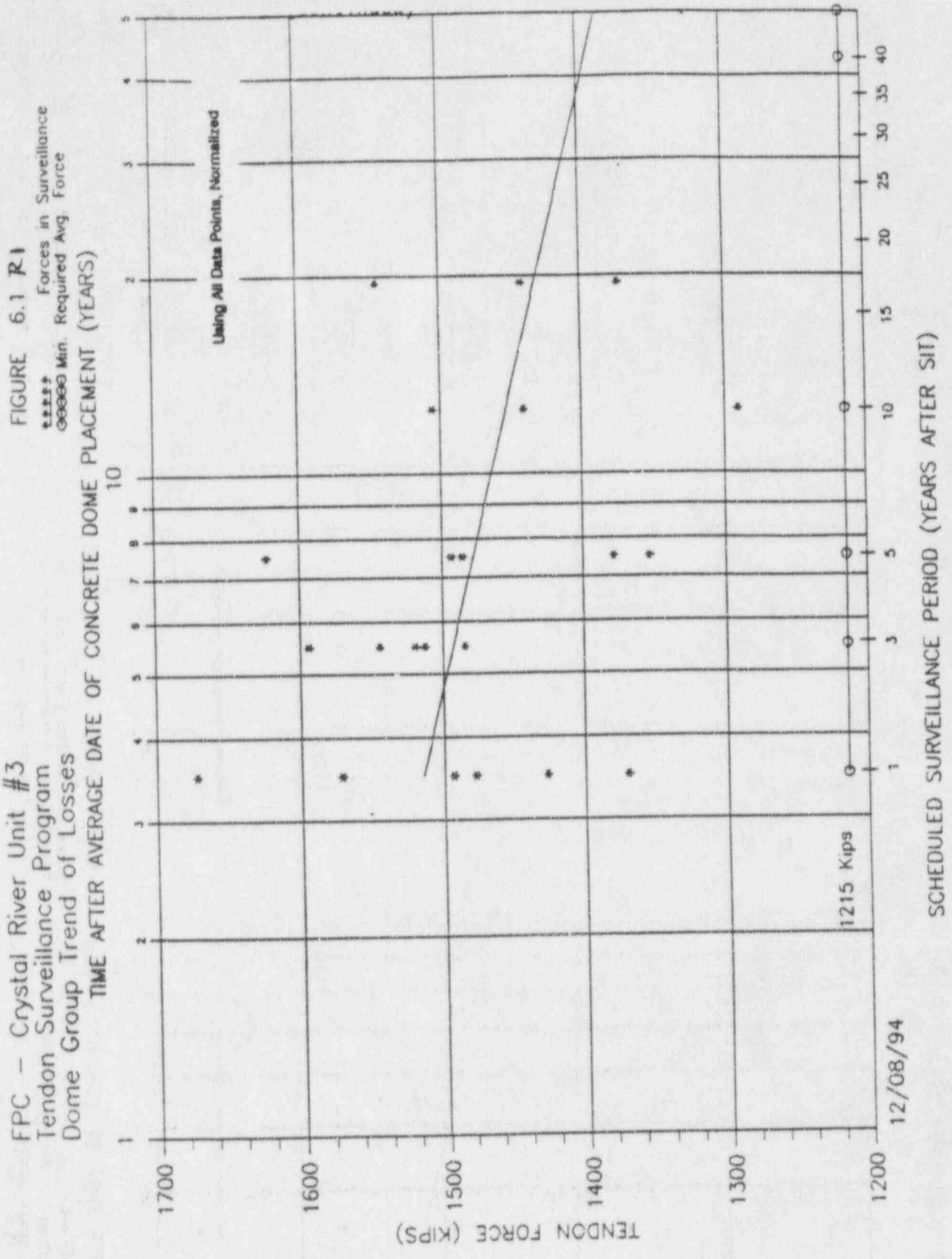
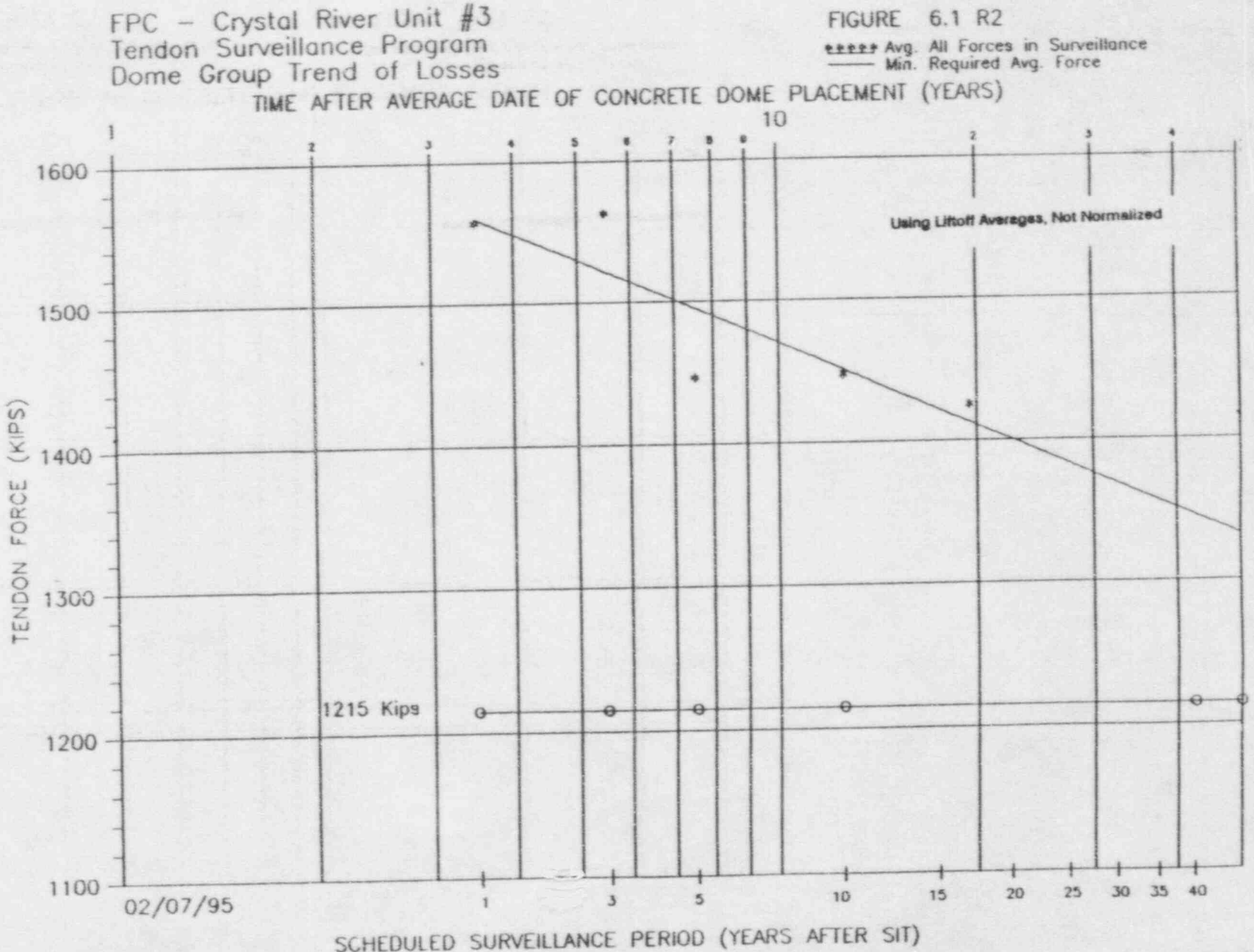

FPC – Crystal River Unit #3
Tendon Surveillance Program
Dome Group Trend of Losses
Using All Data Points, Normalized
Forces in Surveillance
Required Avg. Force
Min.
1215 Kips
TENDON FORCE (KIPS)
1700
1600
1500
1400
1300
1200
TIME AFTER AVERAGE DATE OF CONCRETE DOME PLACEMENT (YEARS)
SCHEDULED SURVEILLANCE PERIOD (YEARS AFTER SIT)
12/08/94

FIGURE 6.1 R1

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

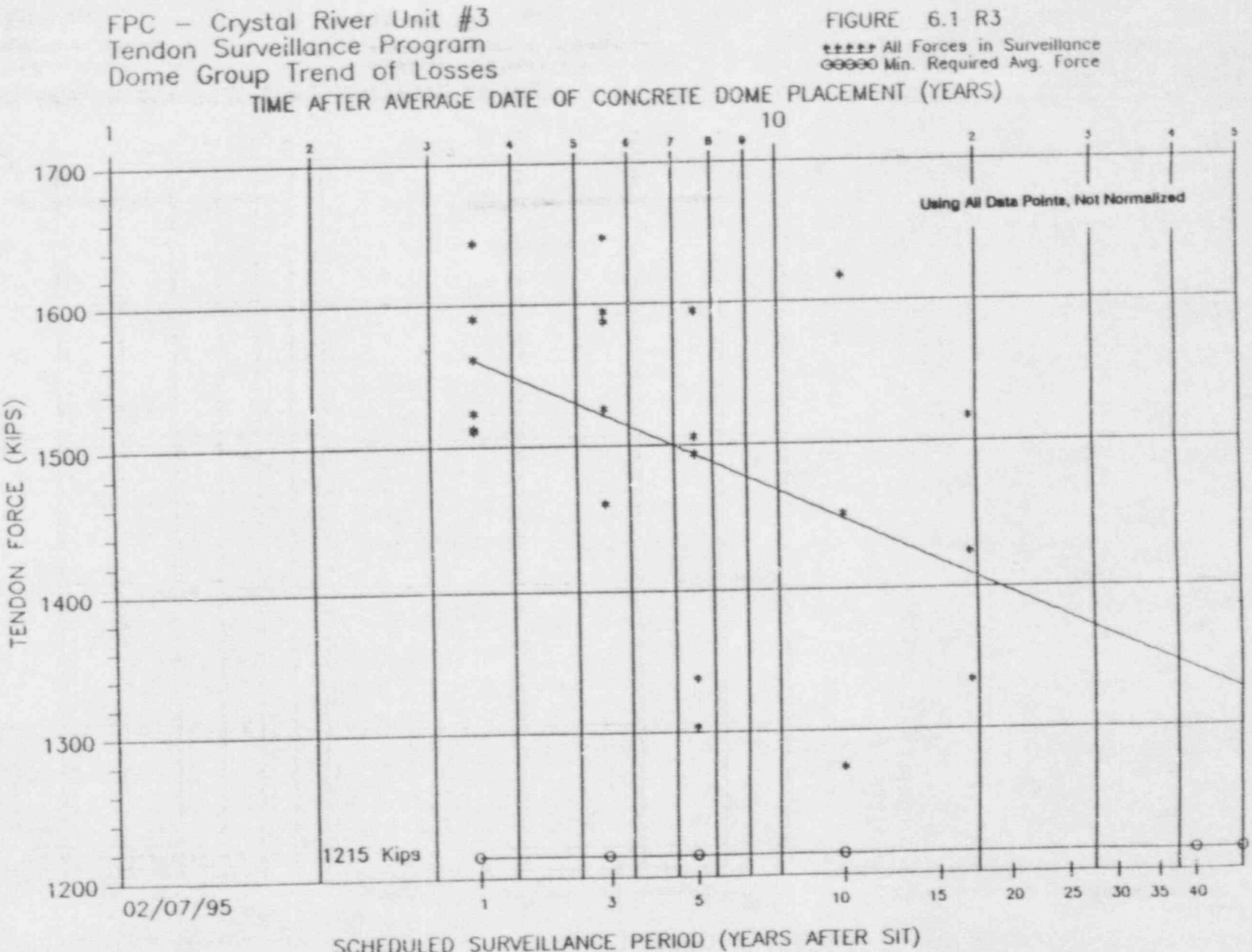
FIGURE 6.1 R2



FILE: DOME95R2

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

FIGURE 6.1 R3



FILE: DOME95R3

SH 1 of 2

TABLE 6.2 R1

SUMMARY OF HOOP TENDON FORCES THROUGH FIFTH SURVEILLANCE

SORTED BY SURVEILLANCE NO. / TENDON NO.

02-Feb-95
05:30:42 PM

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	1516						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	1557						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	1446	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	1471						Average	1506	

ADDED THIS REVISION
TYPICAL ALL TABLES

TABLE 6.2 R1

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

02-Feb-95
05:30:42 PM

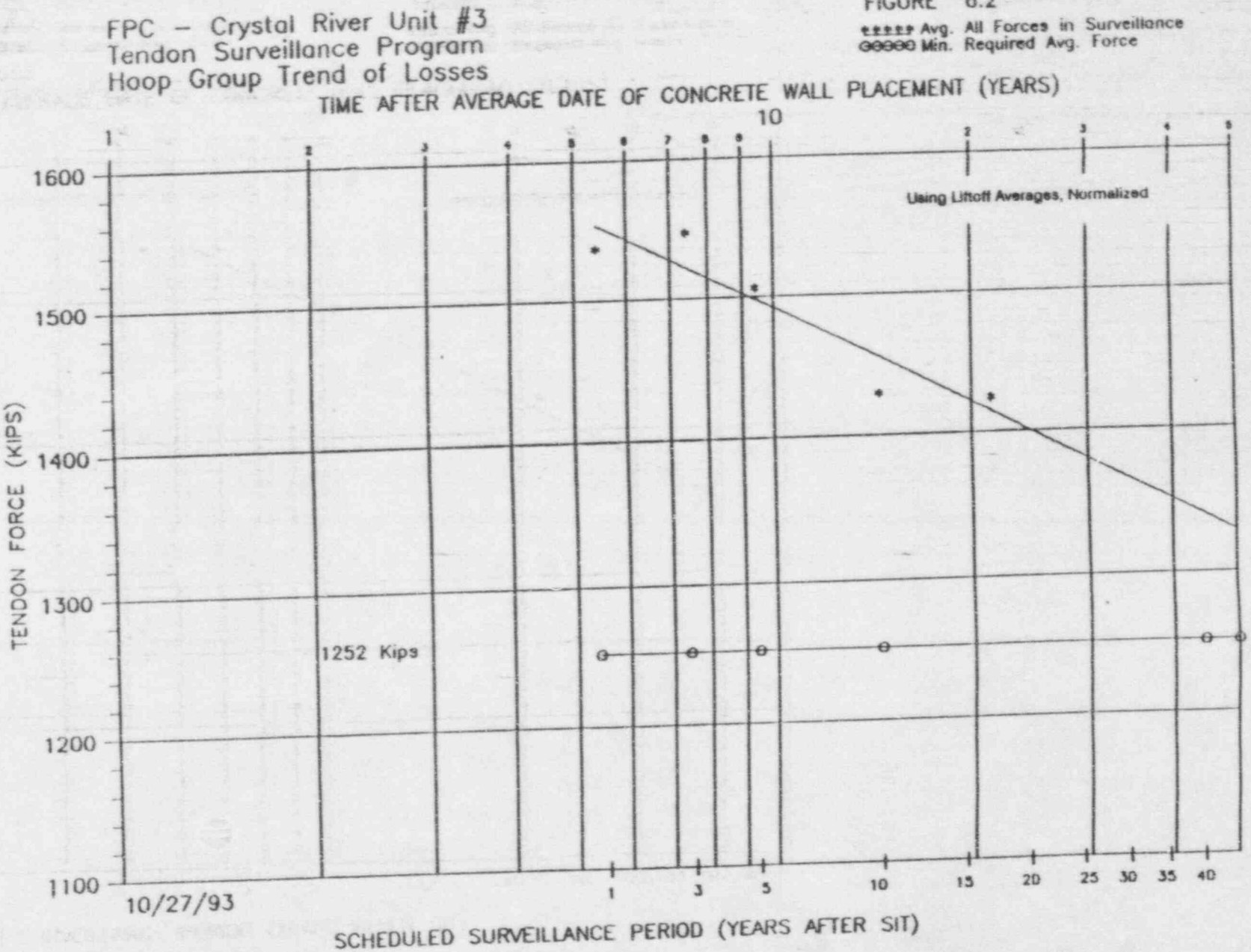
Tendon Number	Original Lock-Off Force (Kips)	Measured Lift-Off Force (Kips)	Surveillance Number	Lower Limit * 95% Base per Reg. Guide 1.35 (Kips)	Lower Limit per Tech. Spec. (Kips)	Measured vs. Reg. Guide (3-5)/5 X 100%	Measured vs. Tech. Spec. (3-6)/6 X 100%	Normalizing Factor NF (Kips)	Normalized Force (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	1434						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	1440						Average	1424	
Average	1496	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.XLS

FIGURE 6.2

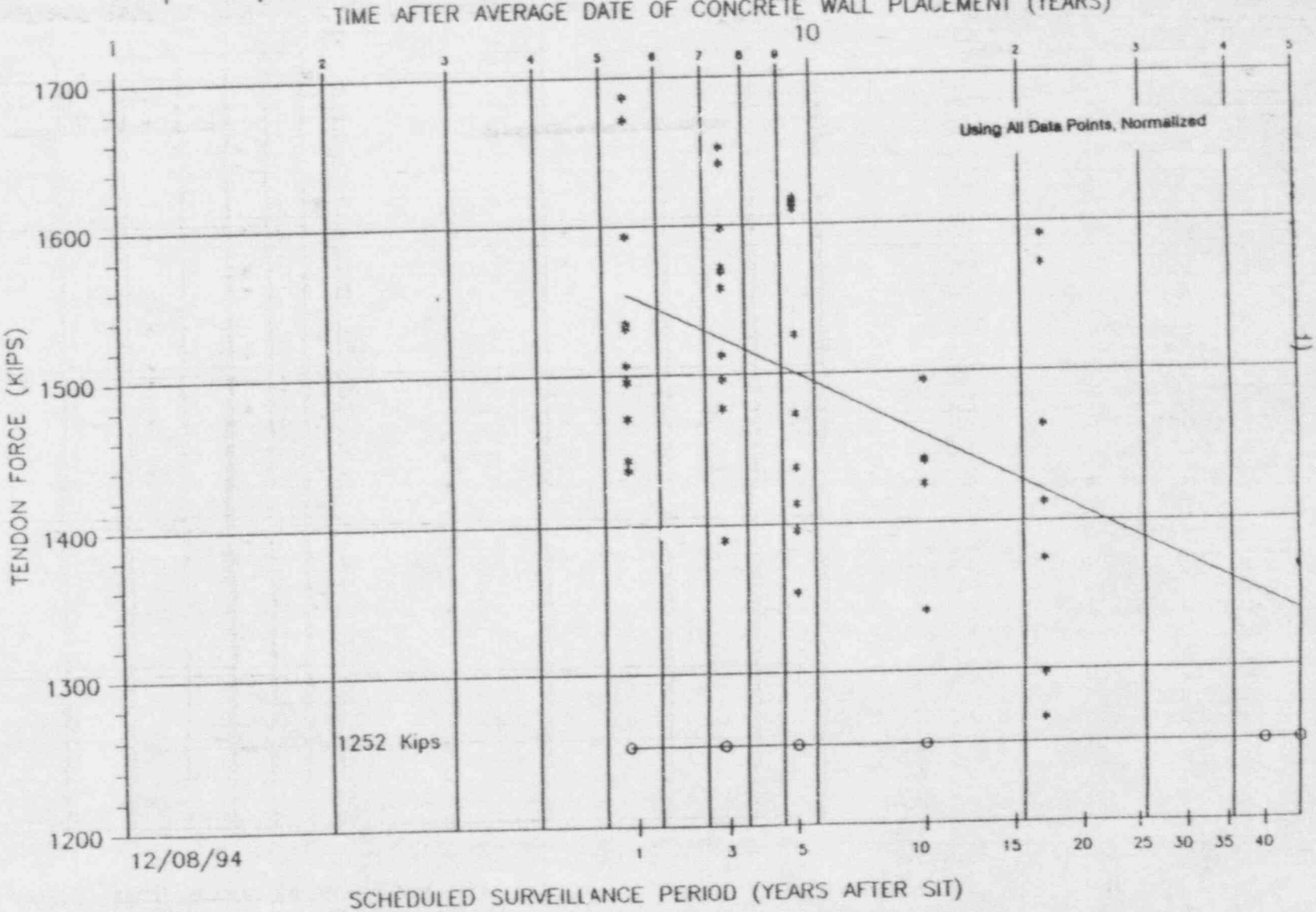
FPC – Crystal River Unit #3
Tendon Surveillance Program
Hoop Group Trend of Losses



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

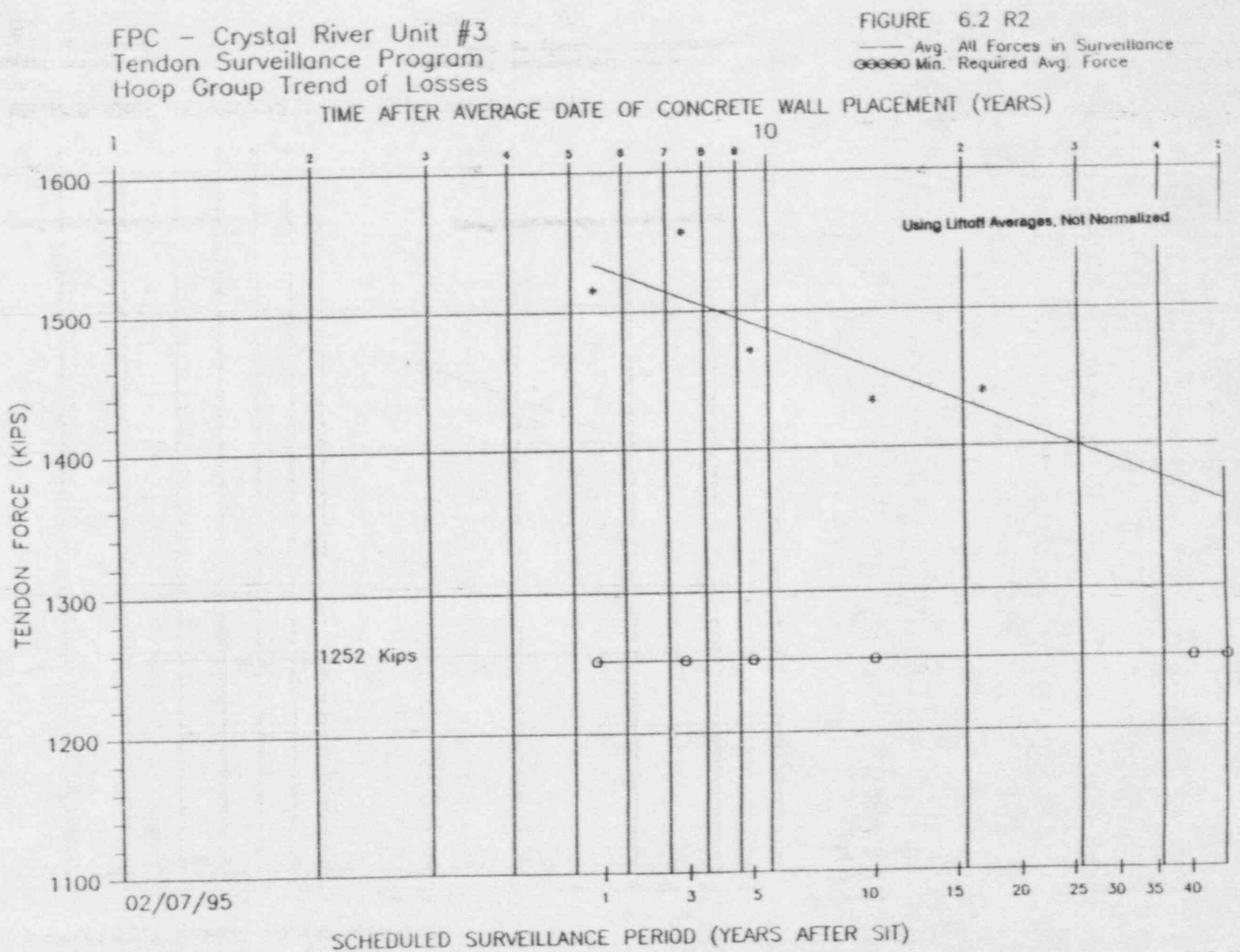
FIGURE 6.2 R1

All Forces in Surveillance
Min. Required Avg. Force



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

FIGURE 6.2 R2

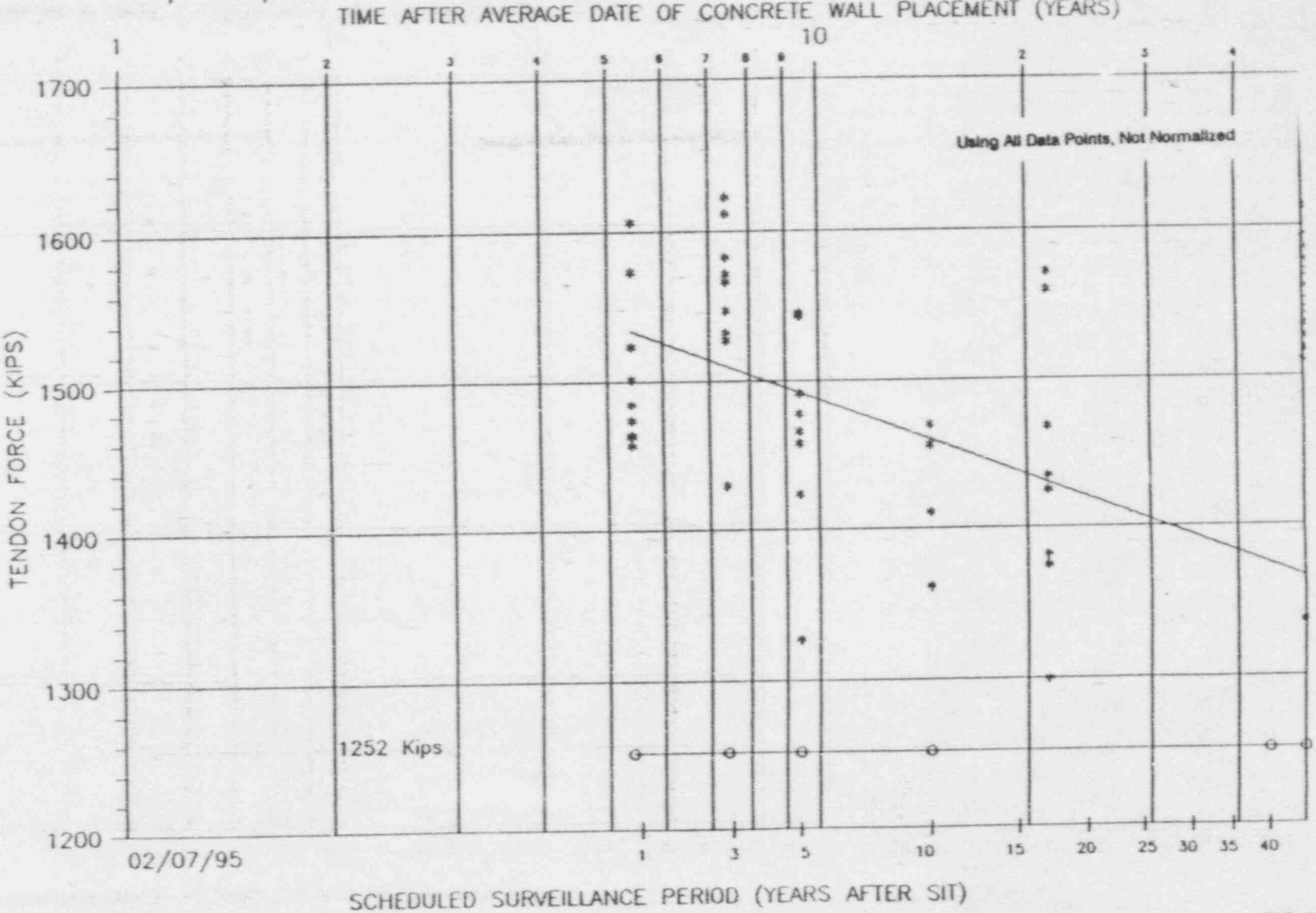


FILE: HOOP95R2

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

FIGURE 6.2 R3

ttttt All Forces in Surveillance
GGGGG Min. Required Avg. Force



FILE: HOOP95R3

TABLE 6.3 R1

SUMMARY OF VERTICAL TENDON FORCES THROUGH FIFTH SURVEILLANCE

SORTED BY SURVEILLANCE NO. / TENDON NO.

02-Feb-95
05:07:46 PM

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	1655						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	1661						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	1536						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	1602						Average	1627	
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	1573						Average	1571	
Average	1428	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.)

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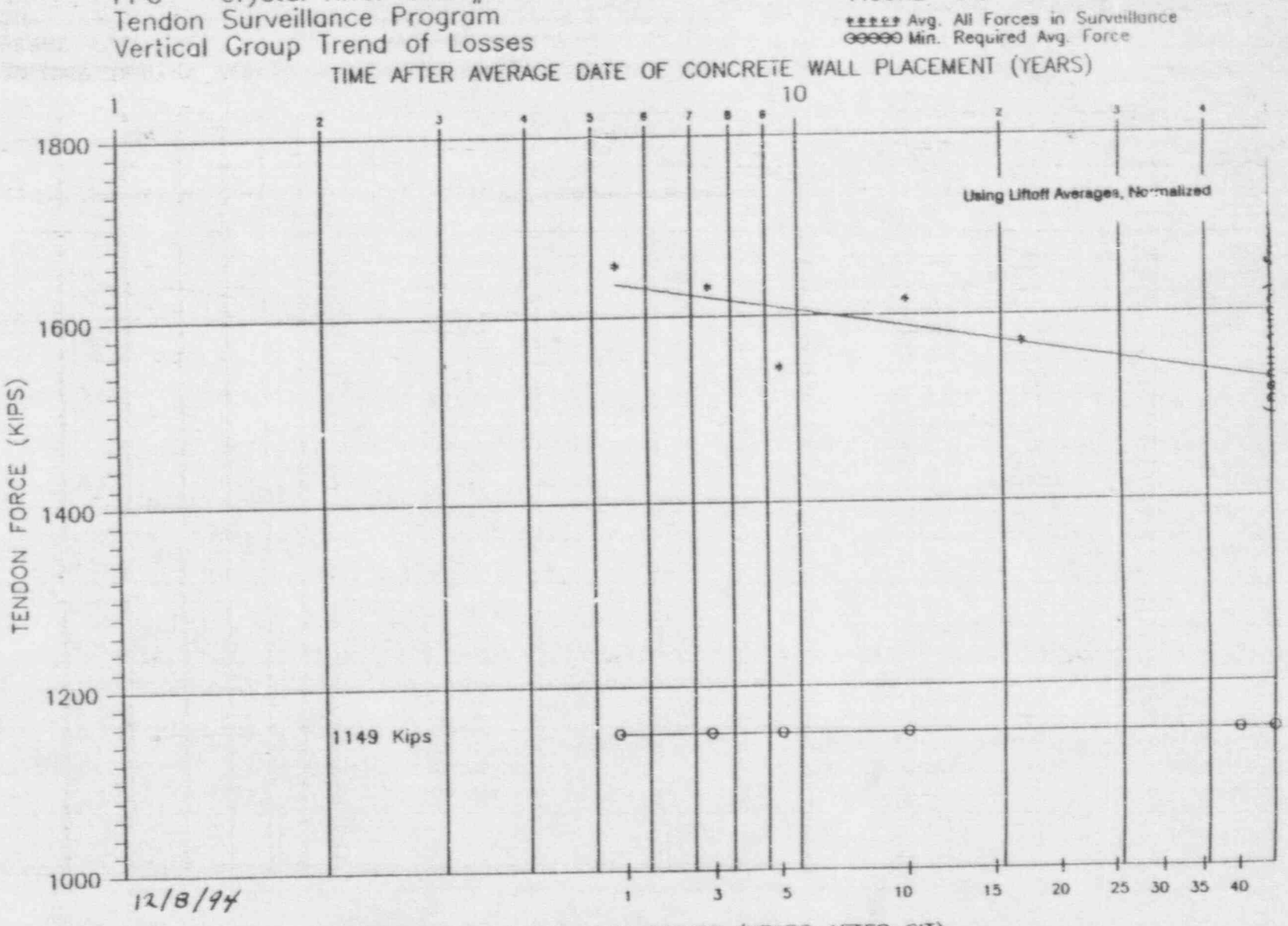
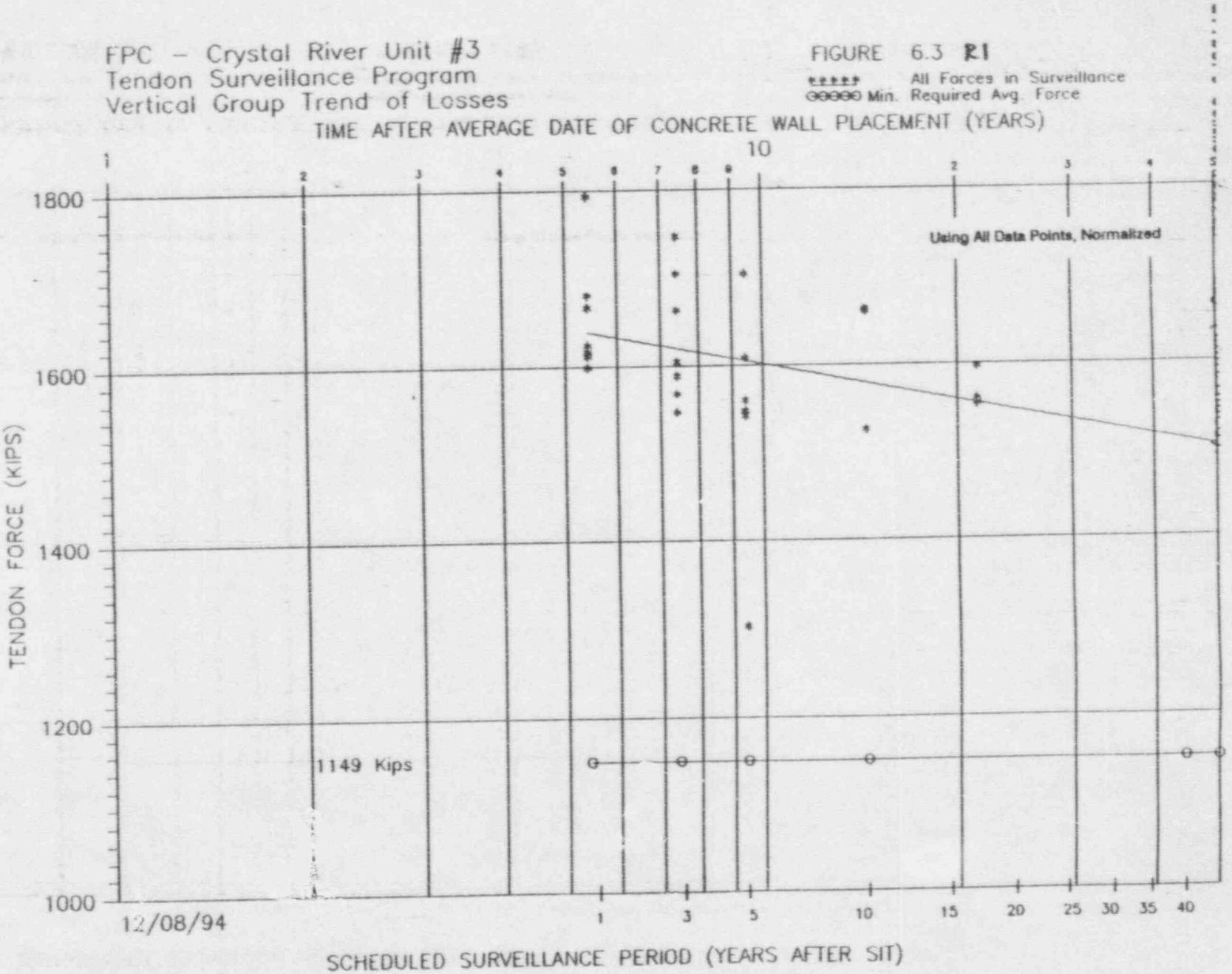
FPC – Crystal River Unit #3
Tendon Surveillance Program
Vertical Group Trend of Losses

FIGURE 6.3



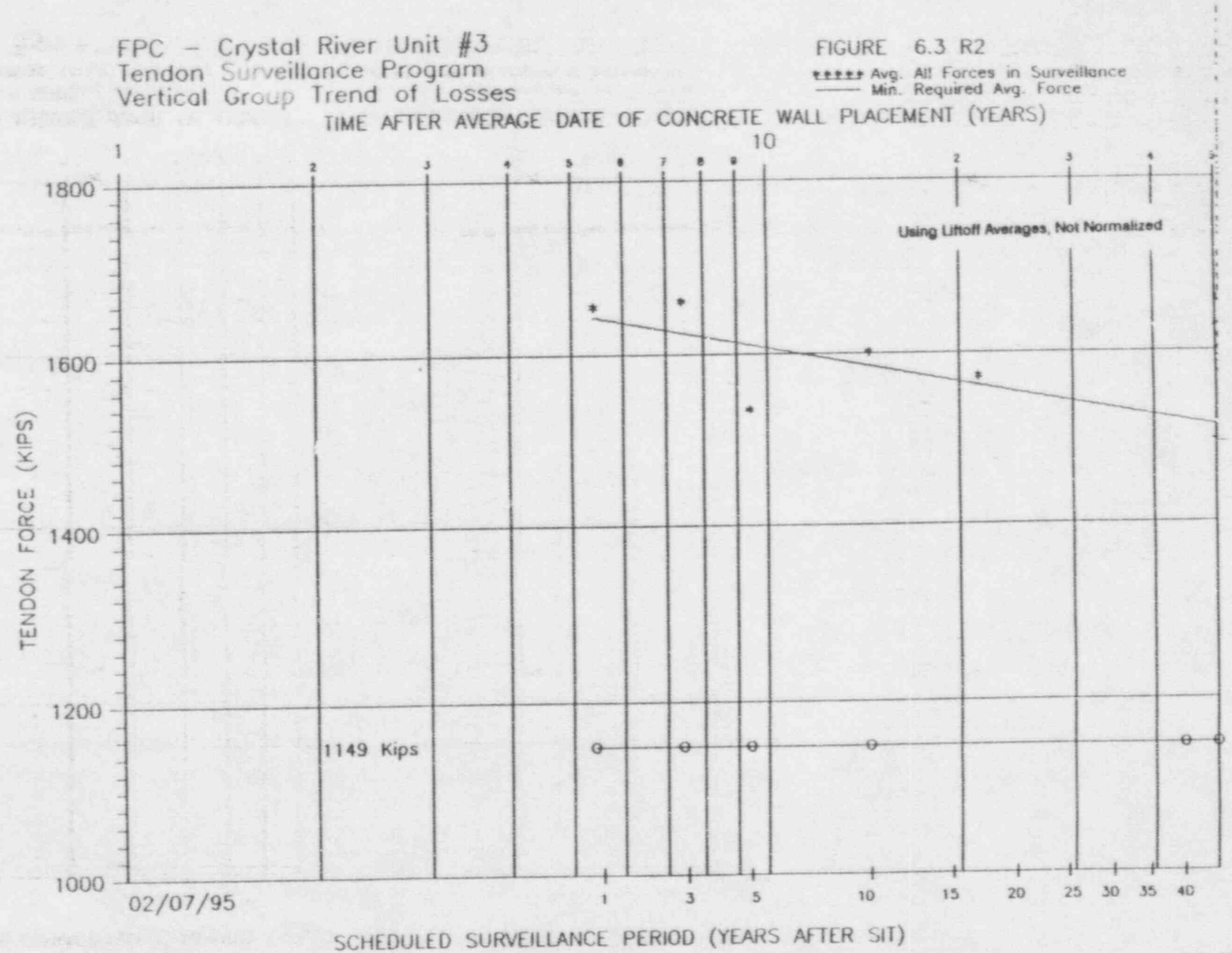
FPC – Crystal River Unit #3
Tendon Surveillance Program
Vertical Group Trend of Losses

FIGURE 6.3 R1



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

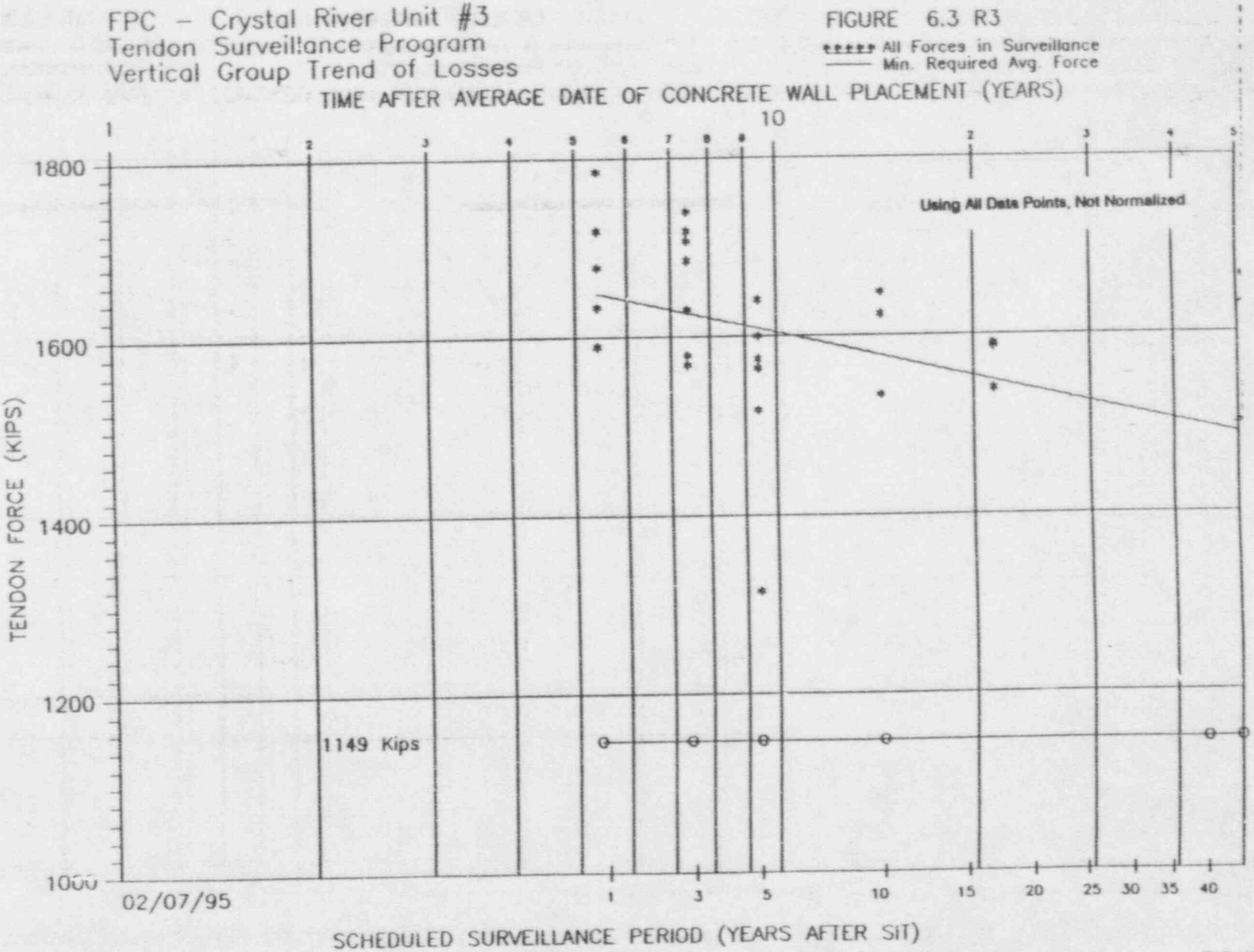
FIGURE 6.3 R2



FILE: VERT95R2

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

FIGURE 6.3 R3



FILE: VERT95R3