

ATTACHMENT B

CALCULATION REVIEW AND APPROVAL NUCLEAR POWER DEPARTMENT

Calculation #

N-03-042

Number of pages

COVER + 13

Title of Calculation:

TENDON SURVEILLANCE PROGRAM PRESTRESS SUMMARY

☒ Original calculation

☐ Revised calculation. Revision # _____

☐ Superseding calculation. Supersedes calculation # _____

Modification #

N/A

Description:

Other References:

SEE CALC.

Prepared By:

Matthew J. Kelly JCM

Date: 7/21/93

This calculation has been reviewed in accordance with QP 3-6. The review was accomplished by one or a combination of the following (as checked):

_____ A review of a representative sample of repetitive calculations

☒ A detailed review of the original calculation

_____ A review of the calculation against a similar calculation previously performed

_____ A review by an alternate, simplified or approximate method of calculation

Comments:

None

Reviewed By:

Adm. R. Bay

Date:

8-30-93

Approved By:

B. S. S.

Date:

8/30/93

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PDR ADOCK 05000266
P PDR

Form QP 3-6.1
Rev. 0

Purpose:

The PBNP Technical Specifications require the periodic evaluation of prestress levels existing in the tendons of the containment prestressing system. The tendon prestress evaluation consists of obtaining anchor seat lift-off values for randomly selected tendons and comparing the results against tolerance bands of acceptable prestress force. This information is used to assist in the determination of the adequacy of the containment prestressing system during the course of the design life of the Plant. The purpose of this calculation is to superimpose prestress data collected from PBNP tendon surveillances on to tolerance bands of acceptable prestress force.

References:

1. PBNP Technical Specifications, Section 15.4.4.VII, "Tendon Surveillance", March 27, 1985
2. PBNP FSAR, Section 5.1.2.4, "Prestress Losses"
3. USNRC Regulatory Guide 1.35, "Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment Structures", Rev. 2
4. USNRC Regulatory Guide 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments", July 1990
5. Bechtel Calculation 050-C-039, "Tendon Prestressing Force Limits as Time Function at Anchorage for PBNP", Rev. 0
6. WEPCo, PBNP Unit 1, "Containment Building Post-Tensioning System One-Year Surveillance", November, 1971
7. WEPCo, PBNP Unit 2, "Containment Building Post-Tensioning System One-Year Surveillance", November, 1972
8. WEPCo, PBNP Unit 1, "Containment Building Post-Tensioning System Three-Year Surveillance", February 25, 1974
9. WEPCo, PBNP Unit 2, "Containment Building Post-Tensioning System Three-Year Surveillance", October, 1974
10. WEPCo, PBNP Unit 1 and 2, "Containment Building Post-Tensioning System Eight-Year Surveillance", September, 1979
11. WEPCo, PBNP Unit 1 and 2, "Containment Building Post-Tensioning System Thirteen-Year Surveillance", May 15, 1985

12. WEPCo, PBNP Unit 1 and 2, "Eighteen-Year Inservice Tendon Surveillance Test Report", Rev. 0

Tendon Surveillance Plots:

Tolerance bands included with this calculation have been reproduced from graphs supplied with Ref. 5. These tolerance bands were constructed in accordance with RG 1.35.1 (Ref. 4) using FSAR values for tendon stresses and losses.

Lift-off forces tabulated in Table 1 and 2 of these calculations have been taken from tendon surveillance reports for PBNP (Ref. 6 - 12). These lift-off forces have been calculated by taking the actual lift-off force measured at the anchor and dividing by the number of effective wires defining the tendon. Dome and hoop tendons have a lift-off measurement taken at each end. The lift-off forces indicated in Table 1 and 2 have been averaged between each end for these tendons. Vertical tendons have lift-off measurements taken at one end only.

Tendon lift-off forces included with Table 1 and 2 have been plotted on the tolerance bands of acceptable prestress force and have been included with this calculation. These plots include dome, vertical and hoop tendons for both Unit 1 and 2.

Conclusion:

All lift-off forces measured during the PBNP tendon surveillance program lie above 90 percent of the predicted lower limit prestress and are acceptable. Most of the data for Unit 1 and the one, three and eight-year surveillance for Unit 2 lies near or above the predicted upper limit prestress. This is mainly due to the conservatism in the FSAR predicted loss values and that the same tendons were tested during each of the first three surveillances for each unit. When these tendons were retensioned after lift-off measurements, the tolerance for retensioning was -0%, +5%. Typically retensioning approached the +5% value giving the data an apparent low loss or slightly upward trend (retensioning tolerance offset losses between surveillances). Random tendon sampling will mitigate this occurrence since the majority of selected tendons will not have been retensioned since original installation.

Tendon D2-227 had an unusually high level of prestress force per wire. During the one-year surveillance for Unit 2, this tendon was discovered with two broken wires. These wires were most likely broken during or prior to initial tensioning. The tendon was jacked assuming 90 wires were present. Since 88 wires would be carrying the entire force, this would account for the high

force per wire measured.

The eighteen-year surveillance for Unit 2 indicates a downward trend in the prestress data. This has been attributed to a change in the lift-off measurement procedure (Ref. 12).

TABLE 1 - UNIT 1 TENDON SURVEILLANCE LIFT-OFF FORCE SUMMARY

TENDON	DATE OF ORIGINAL PRESTRESS	ONE - YEAR		THREE - YEAR		EIGHT - YEAR		13 - YEAR		- YEAR	
		DATE	LIFT-OFF (K/WIRE)	DATE	LIFT-OFF (K/WIRE)	DATE	LIFT-OFF (K/WIRE)	DATE	LIFT-OFF (K/WIRE)	DATE	LIFT-OFF (K/WIRE)
BD-28	1/22/70	7/29/71	7.34	7/25/73	7.22	7/2/79	7.34	-	-	-	-
BF-23	1/14/70	8/3/71	7.31	7/24/73	7.25	6/29/79	7.23	8/1/84	7.24	-	-
BF-54	3/17/70	8/2/71	7.55	7/27/73	7.37	7/11/79	7.41	-	-	-	-
V-3	3/6/70	8/19/71	7.68	7/16/73	7.69	6/14/79	7.80	8/1/84	8.13	-	-
V-58	3/6/70	7/30/71	7.78	7/23/73	7.46	6/21/79	7.61	-	-	-	-
V-120	3/7/70	8/9/71	7.48	7/20/73	7.46	6/20/79	7.76	-	-	-	-
D1-25	12/2/69	8/11/71	7.50	7/20/73	7.49	7/9/79	7.63	-	-	-	-
D2-23	12/16/69	8/6/71	7.48	7/17/73	7.71	6/26/79	7.68	8/22/84	7.75	-	-
D3-25	12/2/69	8/5/71	7.62	7/31/73	7.42	7/12/79	7.61	-	-	-	-
AC-52	4/29/70	-	-	-	-	-	-	8/1/84	7.41	-	-
CE-11	4/10/70	-	-	-	-	-	-	8/7/84	7.38	-	-
BD-42	1/26/70	-	-	-	-	-	-	8/1/84	7.04	-	-
BF-61	1/28/70	-	-	-	-	-	-	8/7/84	7.31	-	-
V-23	3/8/70	-	-	-	-	-	-	7/30/84	7.54	-	-
V-79	3/8/70	-	-	-	-	-	-	7/30/84	7.72	-	-
V-135	3/8/70	-	-	-	-	-	-	7/30/84	7.51	-	-
D1-32	12/8/69	-	-	-	-	-	-	8/28/84	7.31	-	-

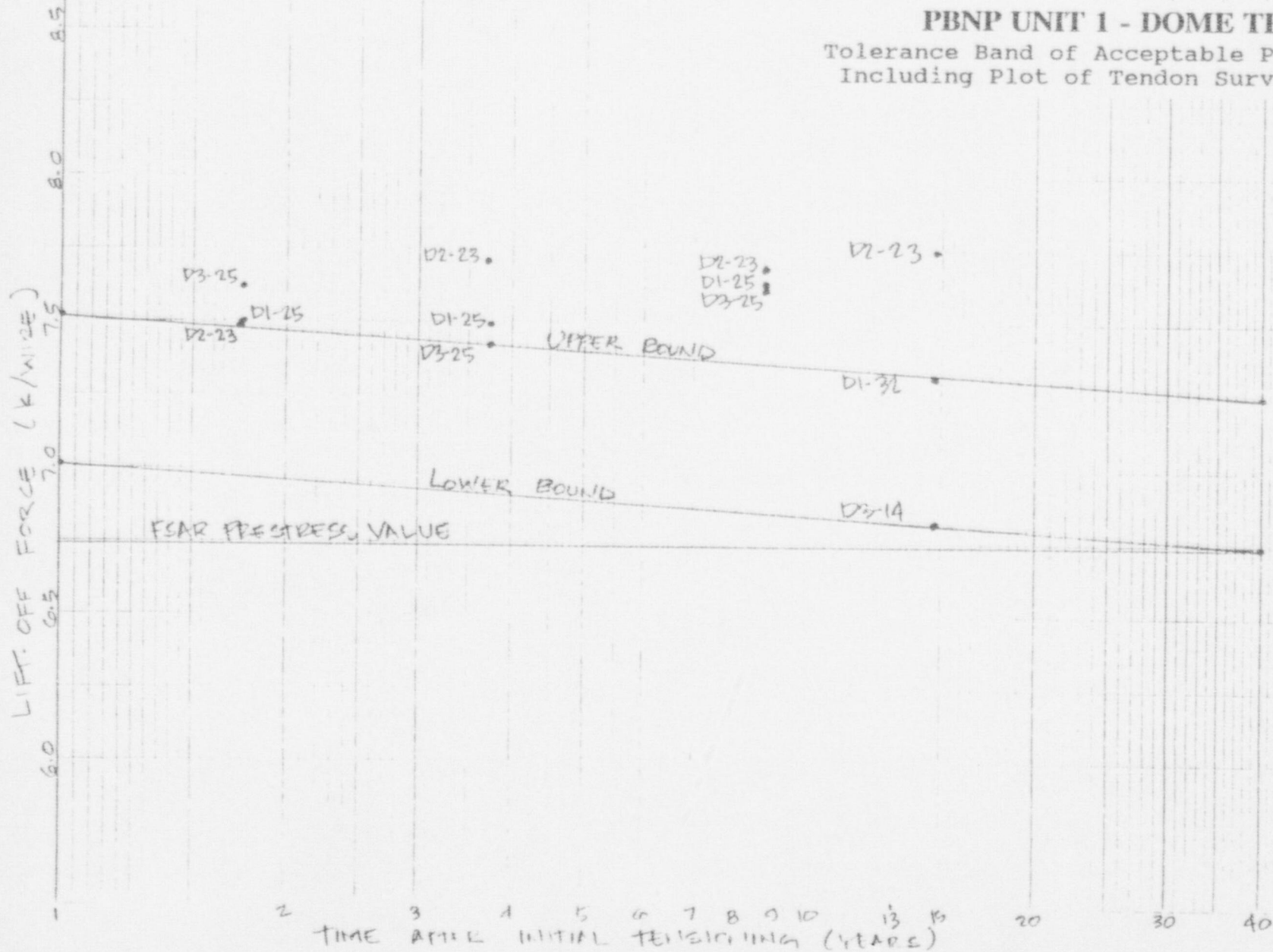
TABLE 1 - UNIT 1 TENDON SURVEILLANCE LIFT-OFF FORCE SUMMARY (CONT.)

TABLE 2- UNIT 2 TENDON SURVEILLANCE LIFT-OFF FORCE SUMMARY

TENDON	DATE OF ORIGINAL PRESTRESS	ONE - YEAR		THREE - YEAR		EIGHT - YEAR		18 - YEAR		- YEAR	
		DATE	LIFT-OFF (K/INCH)	DATE	LIFT-OFF (K/INCH)	DATE	LIFT-OFF (K/INCH)	DATE	LIFT-OFF (K/INCH)	DATE	LIFT-OFF (K/INCH)
HK-22	2/27/71	5/15/72	7.78	7/23/74	7.58	7/26/79	7.47	-	-	-	-
MK-39	2/28/71	5/17/72	7.83	7/18/74	7.59	7/25/79	7.50	-	-	-	-
ML-54	3/2/71	5/18/72	7.83	7/26/74	7.71	7/31/79	7.73	6/27/89	7.45	-	-
V-226	1/20/71	5/16/72	7.89	7/20/74	7.65	7/27/79	7.49	-	-	-	-
V-278	1/18/71	5/9/72	7.56	7/15/74	7.16	7/19/79	7.48	-	-	-	-
V-339	1/15/71	5/22/72	7.78	7/30/74	7.08	8/10/79	7.41	6/27/89	7.23	-	-
B1-223	9/25/70	5/11/72	7.61	7/25/74	7.52	7/30/79	7.60	-	-	-	-
B2-227	9/25/70	5/10/72	8.35	7/17/74	7.99	7/23/79	7.09	6/23/89	7.62	-	-
B3-225	8/31/70	5/19/72	7.28	7/20/74	7.24	8/1/79	7.28	-	-	-	-
HK-31	2/28/71	-	-	-	-	-	-	7/14/89	6.91	-	-
KM-55	3/2/71	-	-	-	-	-	-	7/5/89	7.03	-	-
GJ-1	8/4/70	-	-	-	-	-	-	6/21/89	7.05	-	-
JL-15	8/6/70	-	-	-	-	-	-	6/23/89	6.89	-	-
V-208	1/25/71	-	-	-	-	-	-	7/12/89	7.08	-	-
V-264	1/25/71	-	-	-	-	-	-	7/10/89	6.96	-	-
B1-205	9/1/70	-	-	-	-	-	-	7/31/89	6.97	-	-
B3-214	9/24/70	-	-	-	-	-	-	7/6/89	6.79	-	-

PBNP UNIT 1 - DOME TENDONS

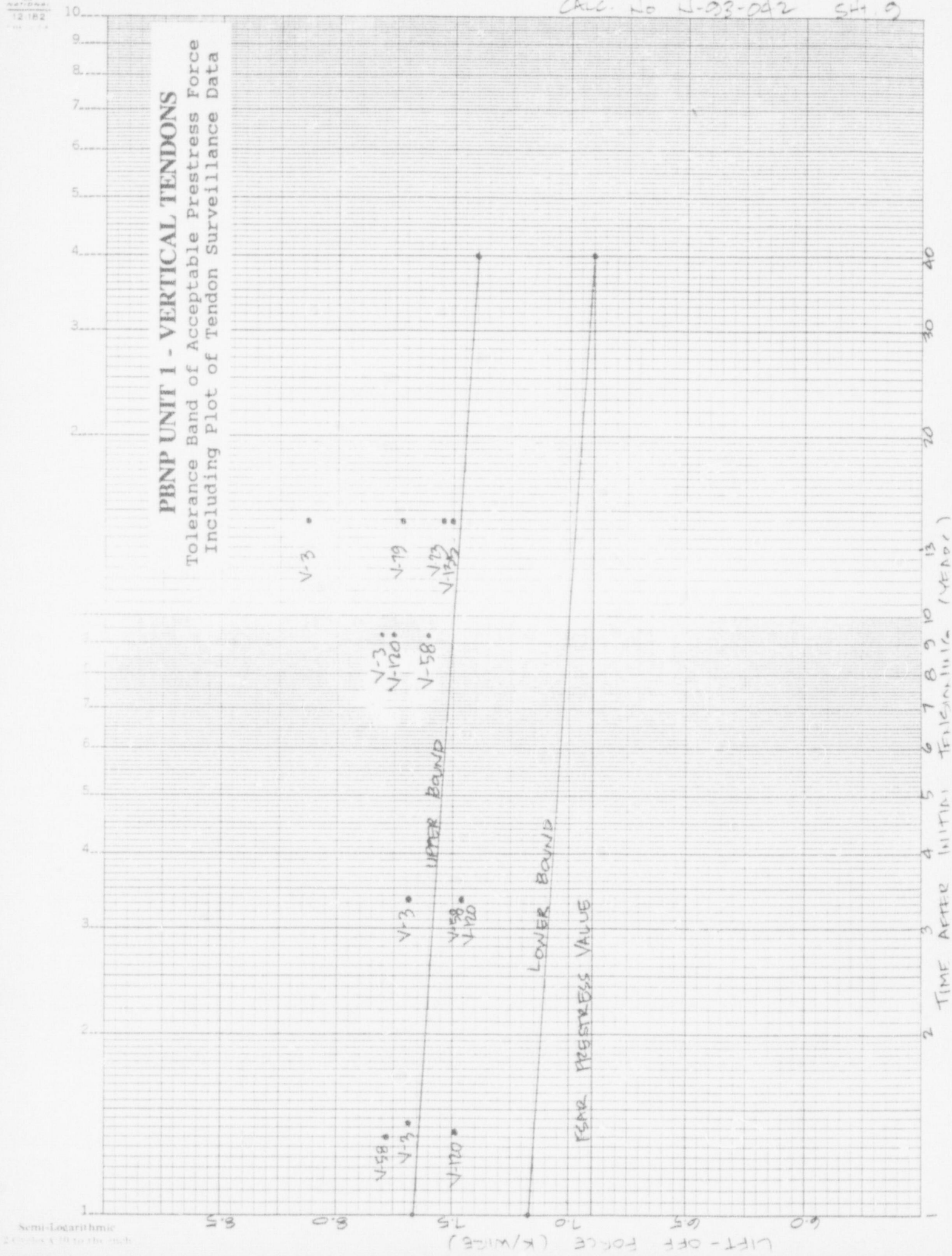
Tolerance Band of Acceptable Prestress Force
Including Plot of Tendon Surveillance Data



CALC NO. N-93-042 SAT. 5

PBNP UNIT 1 - VERTICAL TENDONS

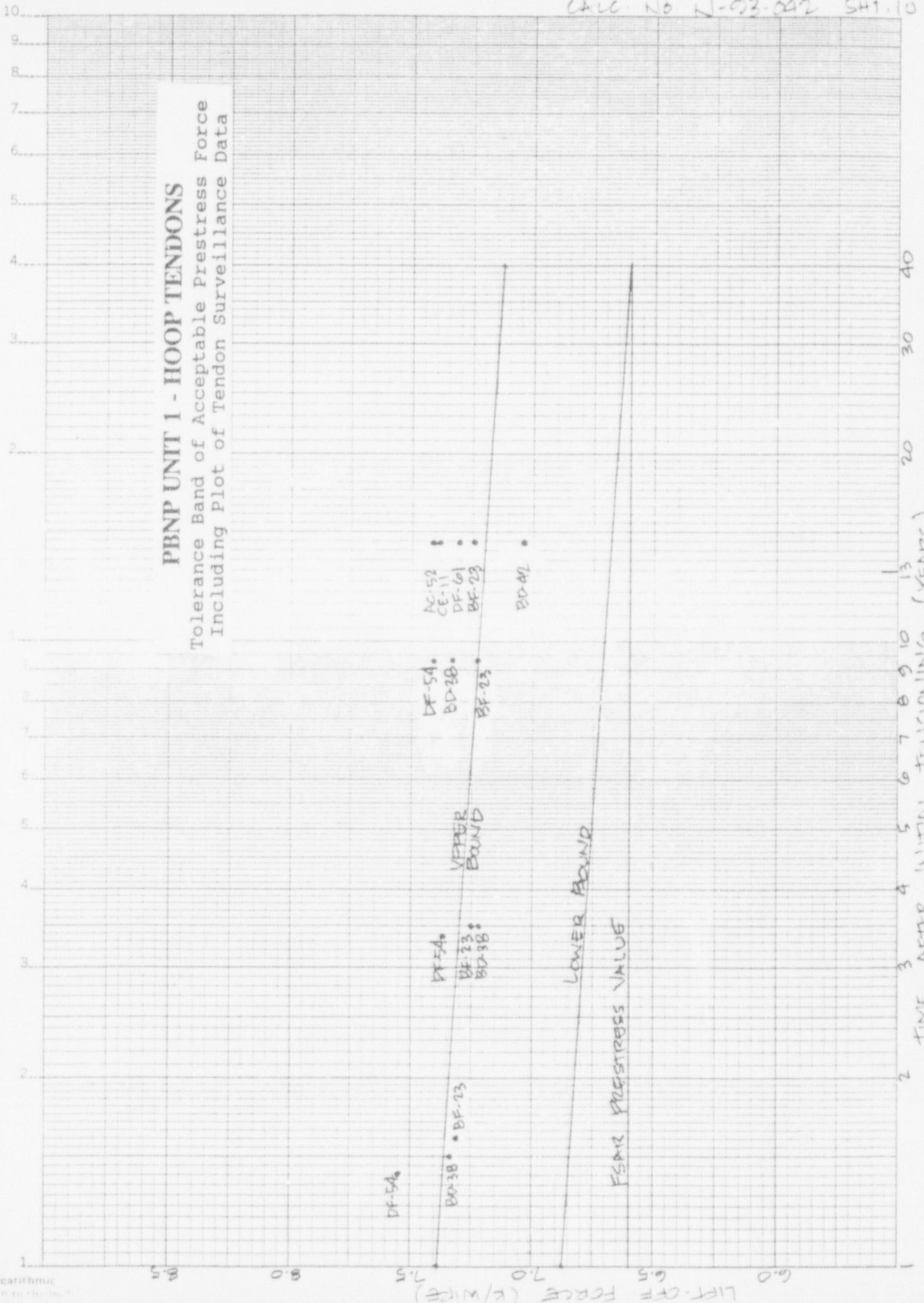
Tolerance Band of Acceptable Prestress Force
 Including Plot of Tendon Surveillance Data



PBNP UNIT 1 - HOOP TENDONS

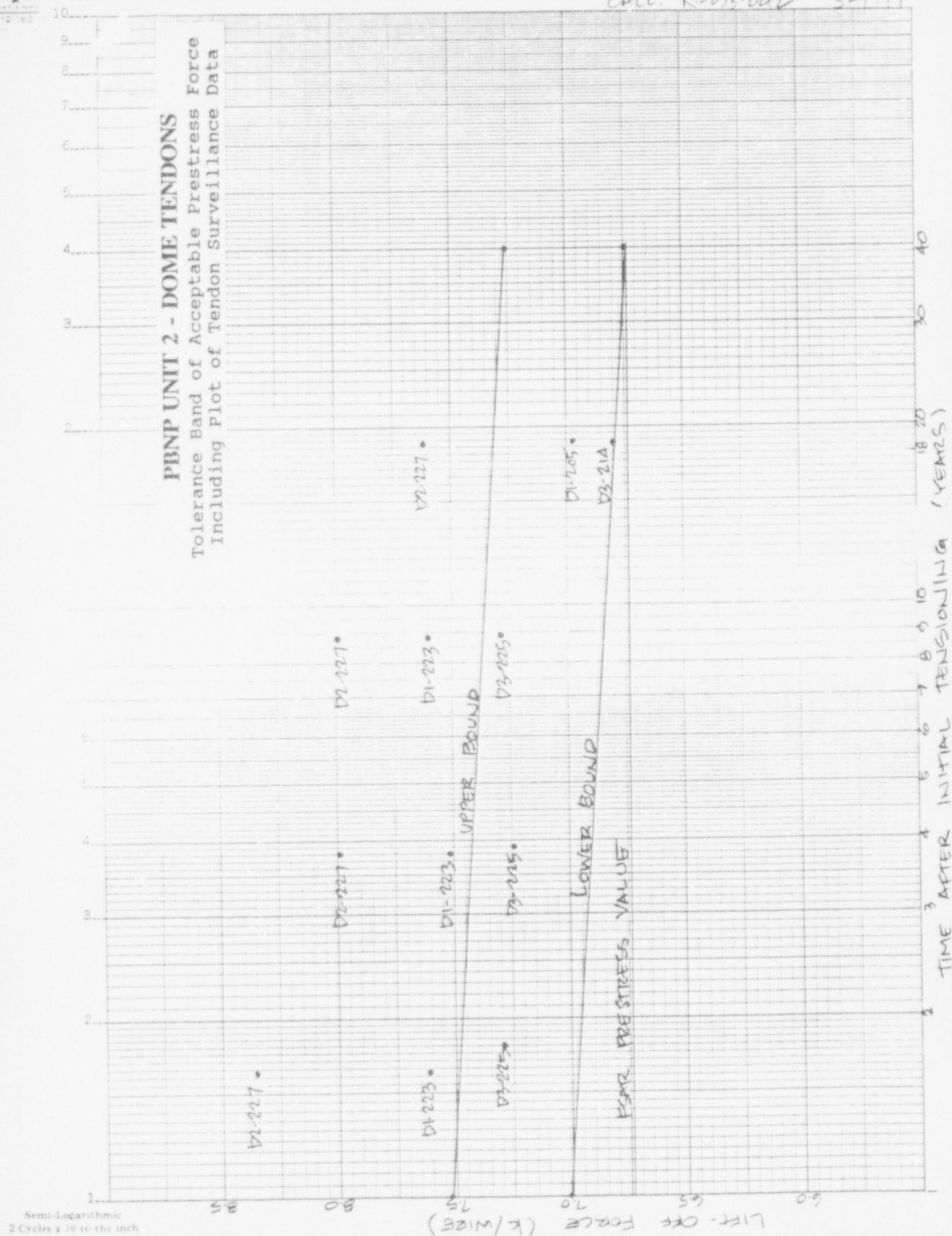
Tolerance Band of Acceptable Prestress Force
Including Plot of Tendon Surveillance Data

Semi-Logarithmic
2 Cycles 10 to 100 lbs.

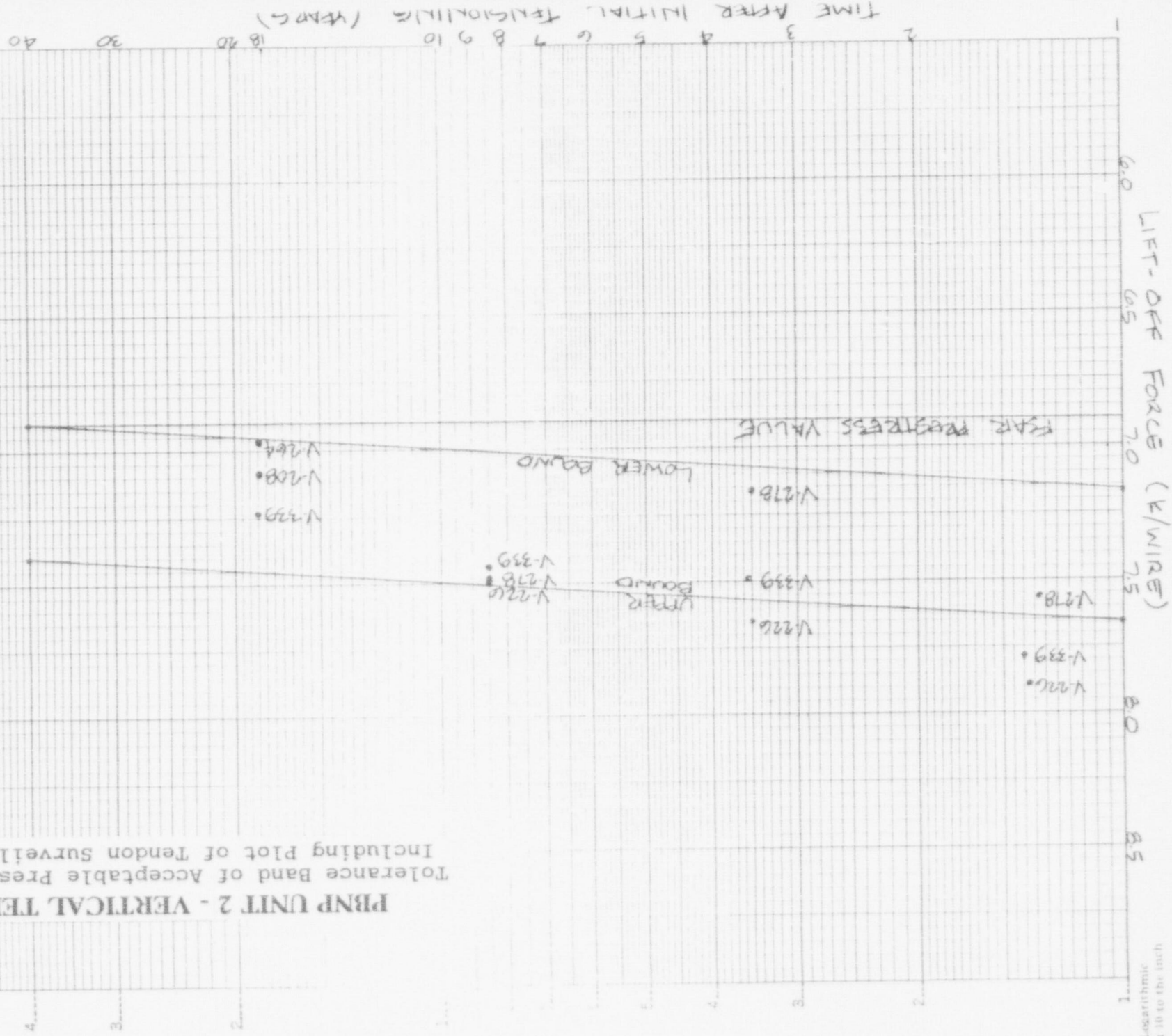


PBNP UNIT 2 - DOME TENDONS

Tolerance Band of Acceptable Prestress Force
Including Plot of Tendon Surveillance Data



PBNP UNIT 2 - VERTICAL TENDONS Tolerance Band of Acceptable Prestress Force Including Plot of Tendon Surveillance Data



Case N-03-CAR

PBNP UNIT 2 - HOOP TENDONS

Tolerance Band of Acceptable Prestress Force
Including Plot of Tendon Surveillance Data

