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VINDICATOR ETW-250 TEST REPORT

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INTRODUCTION

The Vindicator ETW-250 (and its successor product, the VTW-300) bring new technology to the taut wire fence marketplace. Instead of using a mechanical contact for an alarm condition like the other taut wire system on the market, the ETW-250 (and the VTW-300) use strain gauge technology.

TESTING

The nine phases of testing performed are listed below.

Phase I: Qualitative testing of stainless aircraft wire.

Phase II: Functional testing of stainless aircraft wire.

Phase III: Replacement of bottom 10 stainless aircraft wires with galvanized flat wire.

Phase IV: Qualitative testing of galvanized flat wire.

Phase V: Functional testing of galvanized flat wire.

Phase VI: Removal of intermediate spirals.

Phase VII: Functional testing of stainless aircraft cable and galvanized wire combination minus intermediate spirals.

Phase VIII: Functional testing of stainless aircraft cable and galvanized flat wire combination minus all intermediate spirals and using different wire tensions.

Phase IX: Defeat attempts.

NAR/FAR TESTS

The Nuisance Alarm Rates (NAR) and False Alarm Rates (FAR) were monitored during the entire test period by the Nuisance Alarm Data System (NADS) in Area III. The NADS monitored, recorded, and provided video assessment of all the alarms created by the ETW-250 during nonworking hours (i.e., nights and weekends).

SENSOR APPLICATION

The ETW-250 can be mounted onto an existing chain-link fence or used as a stand-alone fence sensor. The ETW-250 can also be used to replace existing taut wire systems that may need to be upgraded.

EQUIPMENT DESCRIPTION

SOURCE AND COST

The ETW-250 (which is no longer available) was designed and manufactured in West Germany and distributed in the United States by Vindicator Corporation in San Jose, CA. (The replacement product, the VTW-300, was designed and is manufactured in the United States by Vindicator Corporation.)

8' sensor post w/24 sensors & 1 processor..	$4060	x 1	=	$4060
8' anchor post (each)......................	$ 375	x 2	=	$ 750
8' slider device (each)....................	$ 35	x 31	=	$1085
Intermediate spirals (each)................	$ 4	x 32	=	$ 128
1320' roll taut wire.......................	$ 60	x 7	=	$ 420
Tensioners (each)..........................	$ 3	x 24	=	$ 72
TW-250 Processor Programmer/Test Unit......	$1360	x 1	=	$1360

TOTAL COST FOR ONE STANDARD 320-FOOT ZONE...............$7875

This price does not cover the recommended spare parts (equal to 10% of the system) or labor for installing the system.

DESCRIPTION OF OPERATION

The Vindicator ETW-250 taut wire system combines a physical taut wire barrier with an intrusion detection sensor network. The sensor wires deter and/or slow physical entry into protected areas. The sensors themselves generate an alarm if the sensor wires are pulled, spread, cut, or climbed on.

This physical motion is converted into an electrical waveform that is analyzed by the processor. The processor then determines if this motion is within the pre-programmed parameters. If it is not, an alarm is generated through a relay back to the monitoring station. Small changes, such as those caused by temperature, are rejected.

INSTALLATION REQUIREMENTS

Vindicator provided a very detailed installation manual with the ETW-250. All of the recommended procedures, cautions, and mounting hardware outlined in the installation manual were followed. Because installation is a lengthy process, the installation requirements are not included in this report. A copy of these procedures is available for loan to any interested parties. The Area III installation followed the manual as closely as existing conditions would allow.

TEST INSTALLATION

The test fence was installed as a stand-alone system in an unused section of the Area III testbed. The manufacturer's recommended maximum zone length of 320 feet was installed and tested. The sensor post was placed midway between the two anchor posts at 160 feet. A standard seven-foot sensor post with 21 sensors was used. An outrigger was not used for this test.

Because the Savannah River Project requested a test of various barbless wires, 1/16th-inch stainless steel aircraft cable was used for the top 10 sensor wires and a continuous twist barbless wire was used for the bottom 11 wires.

The drawing on page 12 shows the location and configuration of the test fence installed at Sandia in Area III.

For this test, the Vindicator processor was set at highest sensitivity. The sensitivity was left this way for the entire test.

TESTING

The procedure and set up used for each test phase follows. The results from each phase are recorded on the reports cited.

Phase I: Qualitative Testing on stainless aircraft wire

The object of this test was to visually inspect the sensor components to identify failures, misalignments, or faulty installation techniques.

Adjustments were made or parts replaced as needed to optimize the system. All repairs to the system are recorded on the Phase I Qualitative Test Report (page 13).

Phase II: Functional Testing on stainless aircraft wire

The object of this test was to measure the tension (lbs), and deflection (in), and pull (lbs) required to cause an alarm on the 21 sensor wires.

The tension of each wire was measured with a tensiometer calibrated for 1/16th-inch aircraft cable. These measurements are recorded on the Phase II Functional Test Report (page 14). The bottom wire was designated as number 1 and the top wire as number 21. For this test, the tension of each wire was approximately 90 lbs + 10 lbs.

The deflection and pull tests were performed using the following tools:

- a fish scale having a capacity of 50 lbs to measure the amount of pull required to generate an alarm on each sensor wire,

- a yardstick to measure how far each wire was deflected before a sensor alarm was generated, and

- an audible alarm box connected to the sensor output to annunciate when a sensor has alarmed.

The deflection and pull test were performed at four points along the fence (designated as points A through D),

- 12-1/2 feet to the right of the left anchor post, (A),

- 12-1/2 feet to the left of the sensor post, (B),

- 12-1/2 feet to the right of the sensor post, (C), and

- 12-1/2 feet to the left of the right anchor post, (D).

All deflection measurements were used to determine an average measurement. The two wires on the fence closest to this average were then tested for deflection and pull every 10 feet, for a total of 64 tests.

The procedure for the deflection and pull test was:

1. At point A, the yardstick was attached to a sensor wire adjacent to the sensor wire to be tested.

2. The fish scale was positioned on the sensor wire to be tested.

3. The fish scale was pulled perpendicular to the ground at approximately 1/2-inch per second until an alarm was generated.

4. The deflection and pull are recorded on the Phase II Functional Test Report (page 14).

5. The procedures listed were repeated for the remaining sensor wires, repositioning the yardstick as needed, until all 21 sensor wires at this location were tested.

6. The test equipment was moved to location B.

7. Procedures 1 through 5 were repeated for location B.

8. The test equipment was moved to location C.

9. Procedures 1 through 5 were repeated for location C.

10. The test equipment was moved to location D.

11. Procedures 1 through 5 were repeated for location D.

The data from locations A and D were averaged together, as were the data from locations B and C. This data was then used to determine which two of the 21 sensor wires were to be considered average. The procedure for testing those two sensor wires was:

1. At point 1, the yardstick was attached to a sensor wire adjacent to the sensor wire to be tested.

2. The fish scale was positioned on the sensor wire to be tested.

3. The fish scale was pulled perpendicular to the ground at approximately 1/2-inch per second until an alarm was generated.

4. Procedures 1 through 4 were repeated for the remaining 31 locations.

5. The results of this test are graphed on the Phase II graphs (pages 15 and 16).

6. Steps 1 through 6 were repeated for the second wire.

Phase III: Replacement of bottom 10 stainless aircraft wires with galvanized flat wire

The object of this procedure was to test the pull-to-alarm characteristics of different wires.

1. The 32 intermediate spirals were removed from the bottom 10 wires.

2. The 31 post spirals were raised above the bottom 10 wires.

3. The bottom 10 stainless aircraft cables were removed from the fence.

4. 10 new galvanized flat wire sensor wires were installed.

5. The 31 post spirals were re-installed.

6. The 32 intermediate spirals were re-installed.

7. The system was allowed to stand for one week to stabilize before testing.

Phase IV: Qualitative testing on galvanized flat wire

The object of this test was to visually inspect the sensor components to identify failures, misalignments, or faulty installation techniques.

Adjustments were made or parts replaced as needed to optimize the system. All repairs to the system are recorded on the Phase IV Qualitative Test Report (page 17).

Phase V: Functional testing on galvanized flat wire

The object of this test was to measure the tension (lbs) and deflection (in) and pull (lbs) required to cause an alarm on the bottom 10 galvanized sensor wires.

The tension of each wire was measured with a tensiometer calibrated for 1/16th-inch aircraft cable. These measurements are recorded on the Phase V Functional Test Report (page 18). The bottom galvanized wire was designated as number 1 and the top galvanized flat wire as number 10. The tension of each wire was approximately 90 lbs $\pm$ 10 lbs. All of the equipment used for testing the stainless wire in Phase II was used for this test.

The deflection and pull test was performed at four points along the fence (designated as points A through D),

- 12-1/2 feet to the right of the left anchor post (A),
- 12-1/2 feet to the left of the sensor post, (B),
- 12-1/2 feet to the right of the sensor post, (C), and
- 12-1/2 feet to the left of the right anchor post, (D).

All deflection measurements were used to determine an average measurement. The one wire of the bottom 10 on the fence closest to this average was then tested for deflection and pull every 10 feet, for a total of 32 tests.

The procedure for the deflection and pull test was the same as outlined in Phase II.

The results from the deflection and pull on these 10 sensor wires are recorded on the Phase V Functional Test Report (page 18).

The data from locations A and D were averaged together, as were the data from locations B and C. This data was then used to determine which of the 10 sensor wires was to be considered average. The procedure for testing that sensor wire was the same as outlined in Phase II.

The results from this test are shown on the Phase V graphs (page 19).

Phase VI: Removal of intermediate spirals

All 32 of the intermediate spirals on the 11 stainless aircraft cables and the 10 galvanized flat wires were removed from the fence. The system was then checked for conformity in tension and stability.

Phase VII: Functional testing of stainless aircraft cable and galvanized flat wire combination minus all intermediate spirals

The object of this test was to see if the sensitivity of the system increased when the mechanical drag induced by the intermediates spirals was removed.

This test was accomplished by measuring the deflection (in) and pull (lbs) required to cause an alarm on any of the 21 sensor wires minus the intermediate spirals.

The bottom wire was designated as number 1 and the top wire as number 21.

All of the equipment used for testing the stainless wire in Phase II was used for this test.

The deflection and pull test was performed at four points along the fence (designated as points A through D),

- 15 feet to the right of the left anchor post, (A),
- 15 feet to the left of the sensor post, (B),
- 15 feet to the right of the sensor post, (C), and
- 15 feet to the left of the right anchor post, (D).

All deflection measurements were used to determine an average measurement. The two wires on the fence closest to this average were then tested for deflection and pull every 10 feet, for a total of 64 tests.

The procedure for the deflection and pull test was the same as outlined in Phase II.

The results for the deflection and pull on this test are recorded on the Phase VII Functional Test Report (page 20).

The data from locations A and D were averaged together, as were the data from locations B and C. This data was then used to determine which two of the 21 sensor wires were to be considered average. The procedure for testing those sensor wires was the same as outlined in Phase II.

The results from these tests are shown on the Phase VII graphs (page 21).

Phase VIII: Functional testing of stainless aircraft cable and galvanized flat wire combination minus all intermediate spirals and using different wire tensions

The object of these tests was to measure the deflection (in) and pull (lbs) required to cause an alarm on any of the 21 sensor wires minus the intermediate spirals. The difference between these tests and the Phase VII test was that the wire tension in the system was changed to see if there was a more optimum operating tension than the manufacturer's recommended 90 lbs.

The tensions used for these tests were 75 lbs and 60 lbs. All wires were tensioned to the appropriate tension, $\pm$ 10 lbs for each test.

The bottom wire was designated as number 1 and the top wire as number 21.

All of the equipment used for testing the stainless wire in Phase II were used for this test.

The deflection and pull tests were performed at four points along the fence (designated as points A through D),

- 15 feet to the right of the left anchor post, (A),
- 15 feet to the left of the sensor post, (B),

- 15 feet to the right of the sensor post, (C), and
- 15 feet to the left of the right anchor post, (D).

All deflection measurements were used to determine an average measurement. The two wires on the fence closest to this average were then tested for deflection and pull every 10 feet, for a total of 64 tests. The procedure for the deflection and pull tests was the same as outlined in Phase II.

The results for the deflection and pull on the 75 lbs test are recorded on the Phase VIII Functional Test Report (page 22).

The results for the deflection and pull on the 60 lbs test are recorded on the Phase VIII Functional Test Report (page 24).

After each test, the data from locations A and D were averaged together, as were the data from locations B and C. This data was then used to determine which two of the 21 sensor wires were to be considered average. The procedure for testing these sensor wires was the same as outlined in Phase II.

The results from the 75 lbs test are shown on the Phase VIII Graphs (page 23).

The results from the 60 lbs test are shown on the Phase VIII Graphs (page 25).

Phase IX: Defeat Attempts

Numerous methods were used in attempts to defeat the system. One of the methods tried did successfully penetrate the system without generating an alarm. This method took less than five minutes. Anyone with access to the maintenance manual and some spare time to become familiar with the system could discover the method it would take to quickly defeat the system. Because of the sensitive nature of documenting defeat methods, the specific method used will not be included in this report.

NAR/FAR RESULTS

The NADS was used to collect Nuisance Alarm Rates (NAR) and False Alarm Rates (FAR) on the Vindicator ETW-250 from October 27, 1988, until September 7, 1989, during all nonworking hours (i.e., nights and weekends). The total run time was 6304.9 hours. During this time, 40 alarms were recorded; 16 test alarms and 24 of unknown cause. The total run time, 6304.9 hours, is equal to 262.7 days or 8.8 months. Averaging the 24 alarms over this period results in an average of 2.7 false alarms per month.

The NADS-generated Data listing NAR and FAR results are shown on pages 26 and 27.

CONCLUSIONS AND RECOMMENDATIONS

The Vindicator ETW-250 functioned well during all the tests performed. Even with the RF problems experienced after the system was first installed, 2.7 false alarms per month is very low. (The VTW-300 is reportedly designed to eliminate any RF problems.) The ETW-250 was easy to install and required very little maintenance and upkeep. Most of the problems encountered during the test were relatively minor and easily taken care of.

In Phase II, the test results were consistent from wire to wire. As was expected, each wire was more sensitive closer to the sensor post than 160 feet away at the anchor posts. The deflection to alarm ranged from a high of 5.5 inches to a low of 3.25 inches. When considering the non-stretch properties of stainless steel aircraft cable, these results were very positive.

In Phase V, the galvanized wires reacted only slightly better than the stainless. The highest deflection was still 5.5 inches yet the low was 2.5 inches. The galvanized wire gave more inconsistent results than the stainless cable. This is probably due to the induced mechanical drag of the galvanized wire not being as smooth as the stainless cable and catching or binding in the intermediate spirals.

In Phase VII, the results were still consistent, as with the other tests. The high was still 5.5 inches. The low was 3.25 inches. For some currently unexplainable reason, throughout this entire phase, the entire fence was more sensitive on the right side of the sensor post. No logical reason was ever found for this phenomenon. The engineers at Vindicator were also unable to explain why this happened. It should be noted that if at any time a measurement was drastically different from the others within that same phase, the measurement was taken two more times to see if the results were the same.

In Phase VIII, it was discovered that lowering the tension resulted in a drastic reduction of sensitivity in the galvanized wires. At 75 lbs the galvanized wire had a deflection high of seven inches, while the stainless had a high of six inches. The lows were 3.75 inches and 3.5 inches, respectively. At 60 lbs of tension the results were not any better. Overall, the stainless cable reacted quicker at 60 lbs of tension than at any other tension. If a recommendation were to be made, the stainless cable at 60 lbs would be the most ideal.

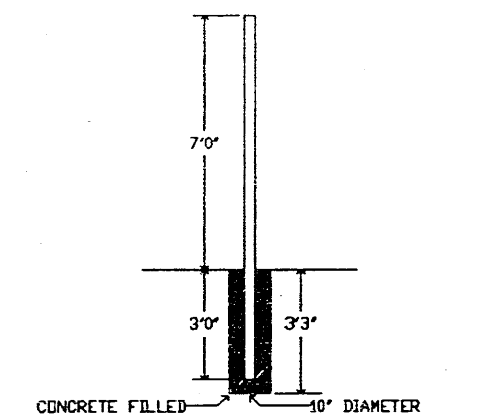
There are, however, two major factors which make any recommendation for buying this product impossible.

1. The manufacturer of the ETW-250, KTV in Germany, has stopped producing and distributing this system.

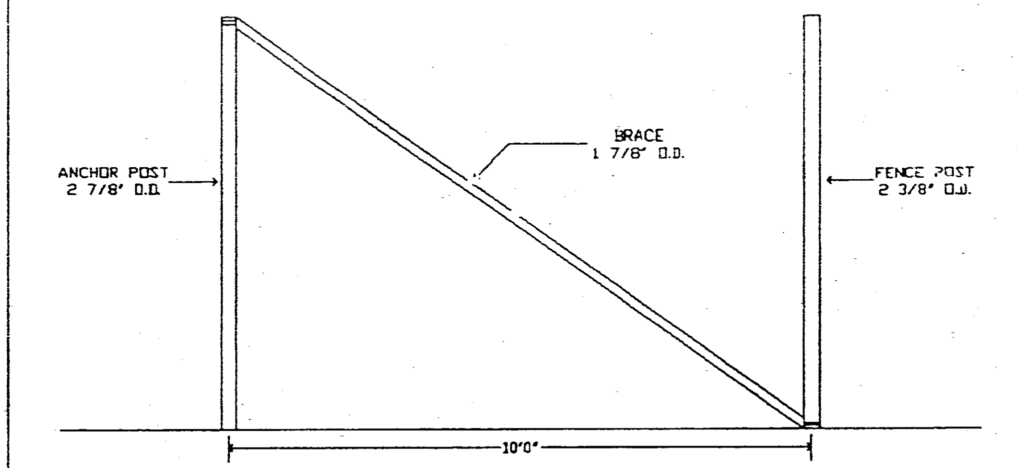
2. KTV's decision resulted in Vindicator no longer being able to obtain spare or replacement parts for any existing systems.

Because of these two factors, I do not recommend that any facility buy the KTV product.

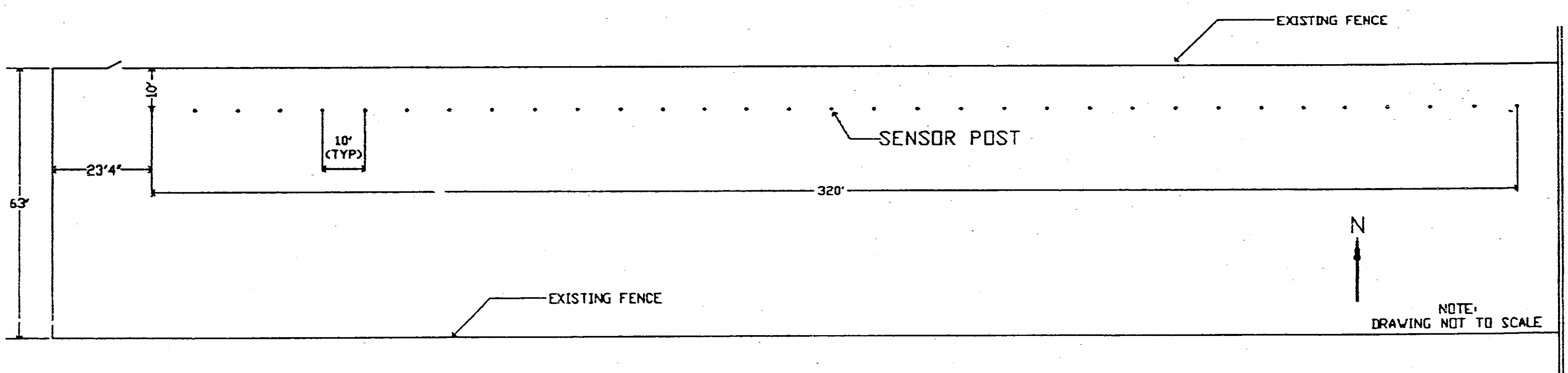
Vindicator Corporation has developed its own sensor, the VTW-300, and has offered to replace all of the existing KTV sensors in the U.S. free of charge. As of this writing, most of the KTV systems have been replaced with the VTW-300 system. While Sandia tested and approved installation of the VTW-300 system in a unique application at Savannah River Site, Sandia has not yet tested the standard Vindicator VTW-300 taut wire fence system.



TYPICAL POST INSTALLATION



TYPICAL ANCHOR POST INSTALLATION



VINDICATOR
SANDIA INSTALLATION

QUALITATIVE TEST REPORT
PHASE I

SENSOR POST: **No problems observed.**

SENSORS: **No problems observed.**

SENSOR WIRES: **No problems observed.**

ANCHOR POSTS: **Both anchor posts have deformed under tension. There is approximately 1 inch of bow on each anchor post. No break-away strips have broken or deformed on either anchor post.**

SLIDER POSTS: **No problems observed.**

INTERMEDIATE SLIDERS: **No problems observed.**

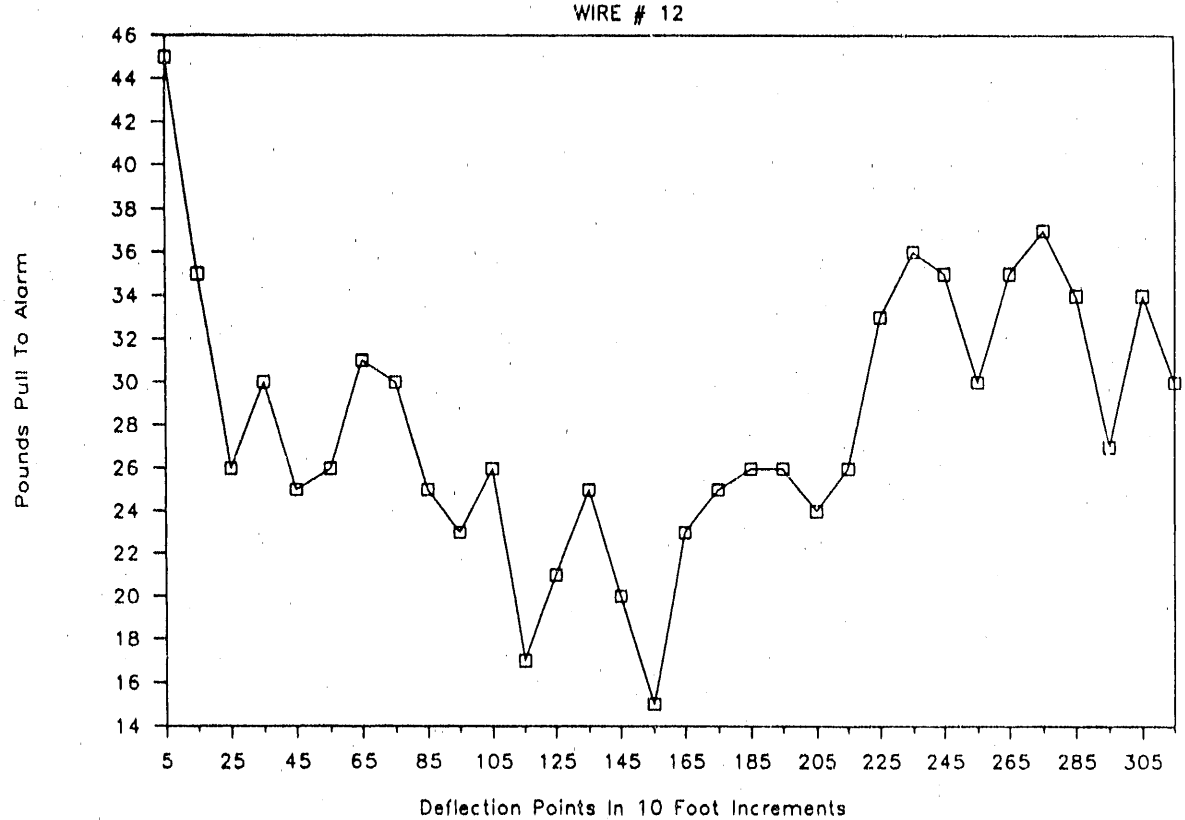
TENSIONERS: **All 21 sensor wires had lost their original tension of 90 lbs. All wires were retensioned before testing started.**

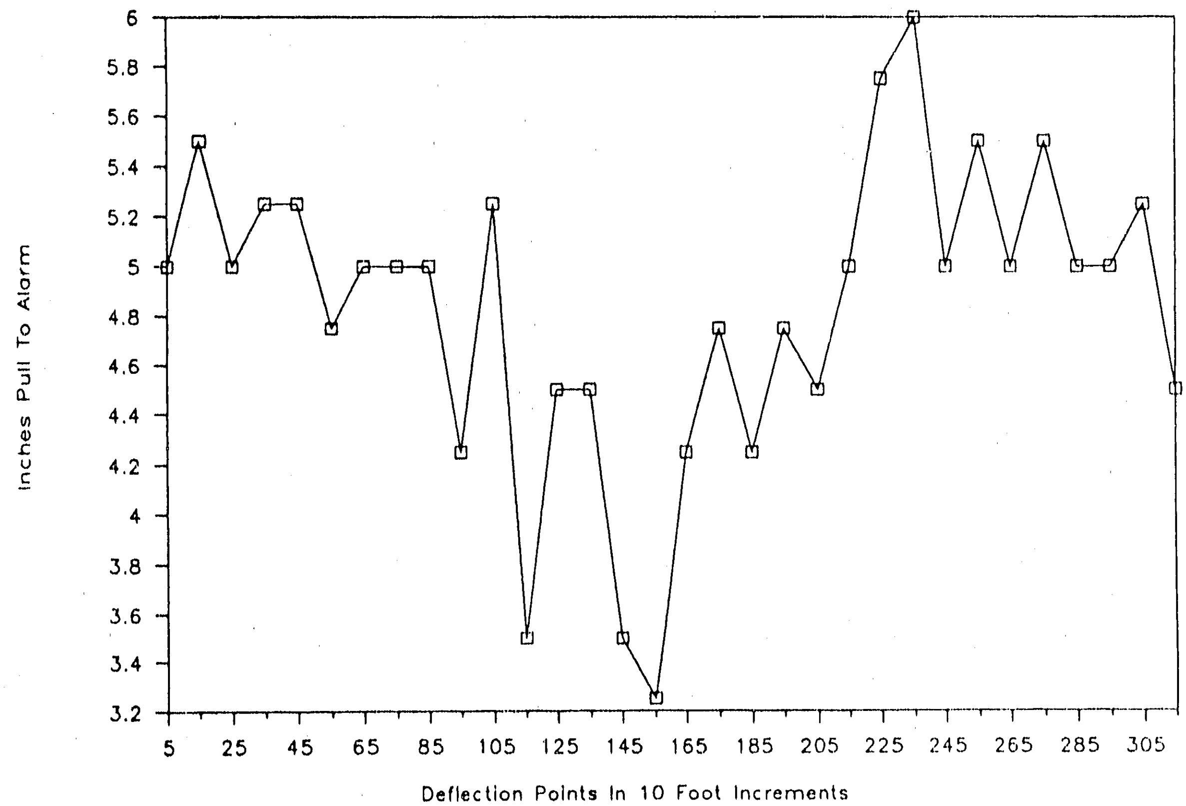
FUNCTIONAL TEST REPORT
PHASE II

WIRE #	TENSION	POINT A DEFL	POINT A PULL	POINT B DEFL	POINT B PULL	POINT C DEFL	POINT C PULL	POINT D DEFL	POINT D PULL
1	84 LBS	5 IN	36 LBS	4 IN	26 LBS	3.5IN	26 LBS	4 IN	23 LBS
2	81 LBS	5 IN	42 LBS	4.5IN	27 LBS	4 IN	34 LBS	4 IN	20 LBS
3	86 LBS	5.5 IN	50 LBS	4 IN	25 LBS	4 IN	33 LBS	5 IN	30 LBS
4	88 LBS	5.5 IN	46 LBS	4 IN	33 LBS	3.25IN	28 LBS	4 IN	28 LBS
5	88 LBS	4.75 IN	43 LBS	3.5IN	25 LBS	4 IN	32 LBS	4.5IN	29 LBS
6	84 LBS	4.25 IN	33 LBS	3.5IN	25 LBS	3.25IN	33 LBS	4.5IN	37 LBS
7	81 LBS	4.5 IN	40 LBS	4.5IN	35 LBS	3.5IN	32 LBS	5 IN	37 LBS
8	84 LBS	5 IN	39 LBS	3.5IN	25 LBS	4.25IN	28 LBS	4.5IN	32 LBS
9	81 LBS	5 IN	35 LBS	3.5IN	20 LBS	4.25IN	28 LBS	5 IN	37 LBS
10	81 LBS	4.5 IN	33 LBS	4.5IN	35 LBS	4.75IN	29 LBS	6 IN	38 LBS
11	81 LBS	5.5 IN	35 LBS	4.5IN	33 LBS	4 IN	31 LBS	5.5IN	44 LBS
12	84 LBS	4.75 IN	30 LBS	4.5IN	31 LBS	4 IN	32 LBS	5 IN	43 LBS
13	84 LBS	5 IN	33 LBS	4 IN	25 LBS	3.25IN	29 LBS	5.25IN	41 LBS
14	84 LBS	4.75 IN	32 LBS	4 IN	29 LBS	3.5IN	27 LBS	5 IN	46 LBS
15	84 LBS	4.25 IN	25 LBS	3.5IN	20 LBS	3.75IN	26 LBS	5.5IN	43 LBS
16	90 LBS	4.5 IN	30 LBS	4 IN	25 LBS	4 IN	26 LBS	5.5IN	38 LBS
17	80 LBS	4.5 IN	32 LBS	4 IN	25 LBS	4.5IN	32 LBS	4.5IN	40 LBS
18	80 LBS	5 IN	37 LBS	4 IN	22 LBS	3.75IN	33 LBS	4.5IN	45 LBS
19	90 LBS	5 IN	45 LBS	4.5IN	30 LBS	4.5IN	29 LBS	5.75IN	47 LBS
20	86 LBS	4 IN	30 LBS	4 IN	30 LBS	4 IN	28 LBS	5 IN	38 LBS
21	86 LBS	5 IN	40 LBS	4 IN	30 LBS	4 IN	28 LBS	4.5IN	28 LBS

PHASE II

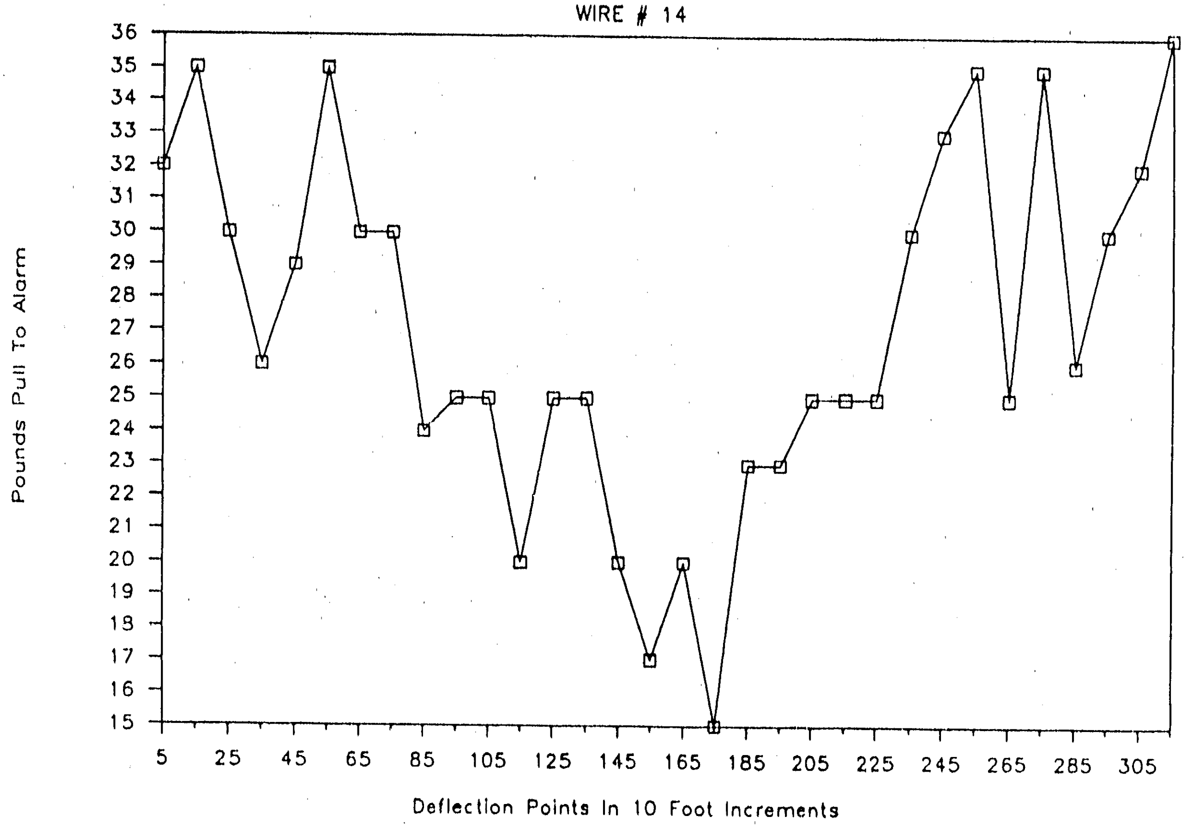
WIRE # 12

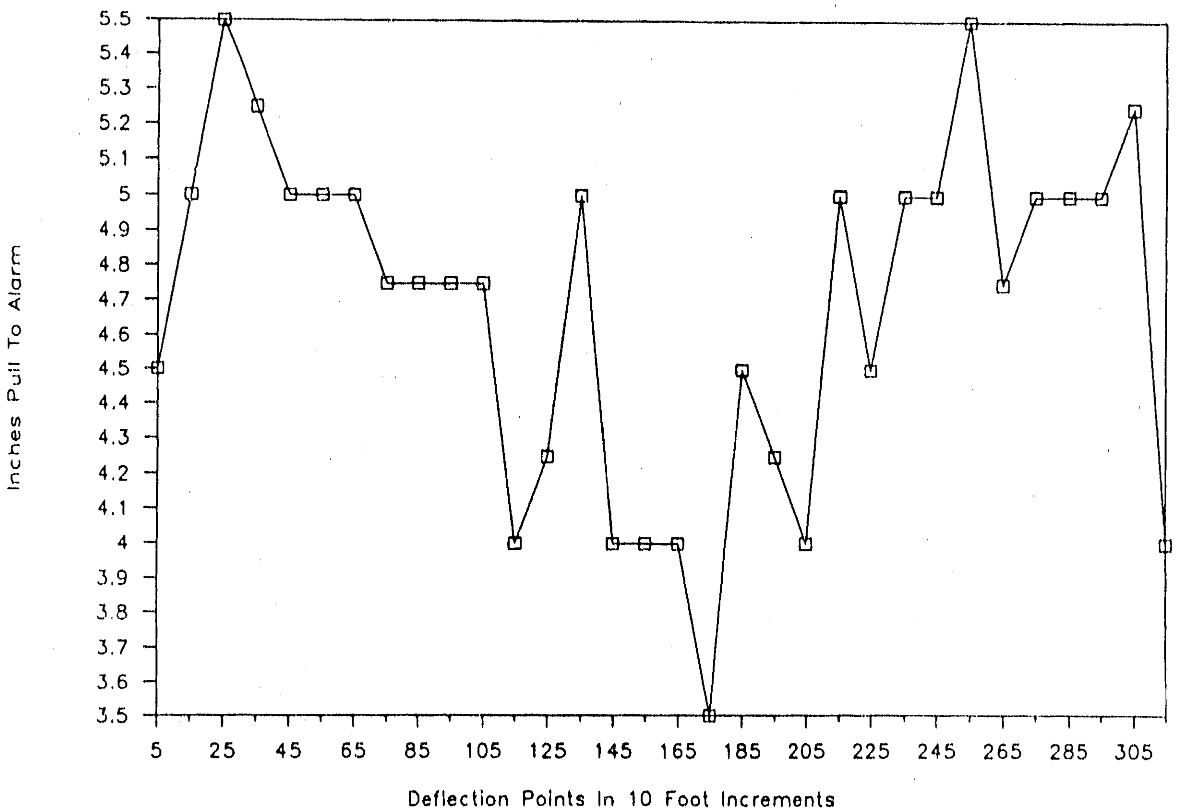




Phase II

WIRE # 14





QUALITATIVE TEST REPORT
PHASE IV

SENSOR POST: **No problems observed.**

SENSORS: **No problems observed.**

SENSOR WIRES: **# 6, 7, & 8 wires tensions dropped to 75 lbs. All three were retensioned to specs.**

ANCHOR POSTS: **No problems observed.**

SLIDER POSTS: **No problems observed.**

INTERMEDIATE SLIDERS: **A high number are binding on the wire and not allowing the wire to slide through them properly.**

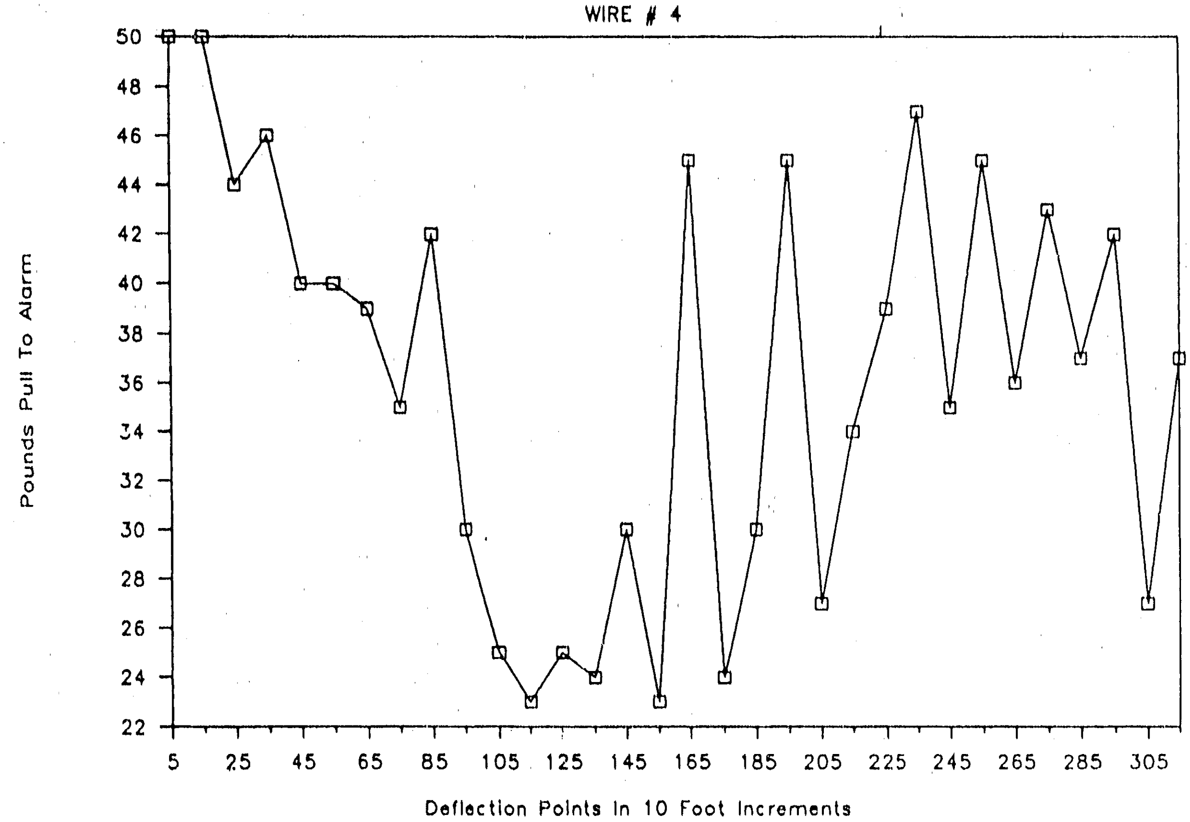
TENSIONERS: **No problems observed.**

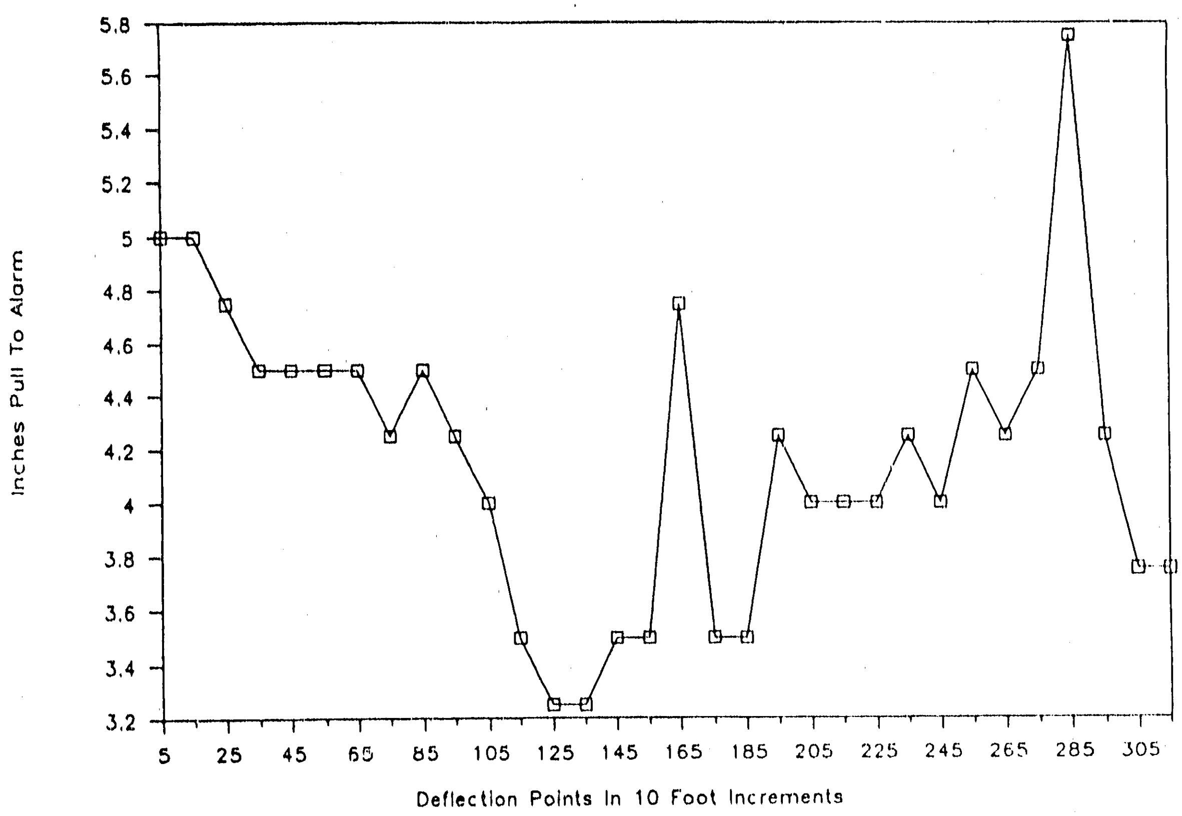
FUNCTIONAL TEST REPORT
PHASE V

IRE #	TENSION	POINT A DEFL	POINT A PULL	POINT B DEFL	POINT B PULL	POINT C DEFL	POINT C PULL	POINT D DEFL	POINT D PULL
1	88 LBS	5 IN	35 LBS	3 IN	20 LBS	4 IN	15 LBS	4.5IN	28 LBS
2	86 LBS	4 IN	32 LBS	2.5IN	16 LBS	3.5IN	20 LBS	3.5IN	33 LBS
3	86 LBS	4.5 IN	42 LBS	3 IN	22 LBS	2.5IN	15 LBS	3.5IN	25 LBS
4	88 LBS	4 IN	32 LBS	3 IN	16 LBS	3.25IN	25 LBS	4 IN	35 LBS
5	87 LBS	4 IN	33 LBS	3.25IN	19 LBS	3.25IN	20 LBS	3.75IN	27 LBS
6	92 LBS	3.5 IN	33 LBS	2.5IN	17 LBS	2.5IN	20 LBS	3.75IN	33 LBS
7	89 LBS	4 IN	42 LBS	3.25IN	27 LBS	3.5IN	30 LBS	4.5IN	47 LBS
8	89 LBS	4.75 IN	44 LBS	3 IN	21 LBS	3 IN	20 LBS	4.5IN	43 LBS
9	90 LBS	3.75 IN	36 LBS	2.5IN	19 LBS	3 IN	27 LBS	4.5IN	35 LBS
10	88 LBS	5.5 IN	45 LBS	3.25IN	25 LBS	2.75IN	22 LBS	4.5IN	43 LBS

PHASE V

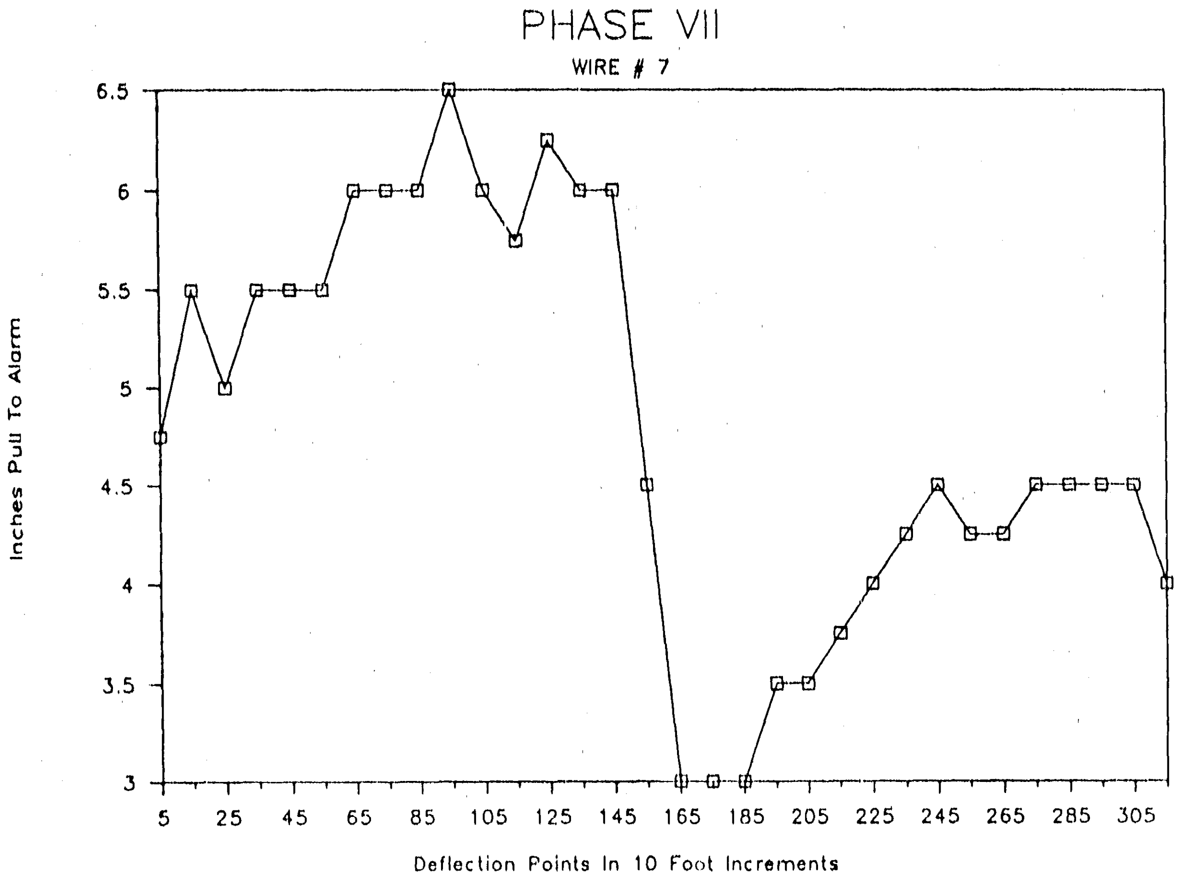
WIRE # 4

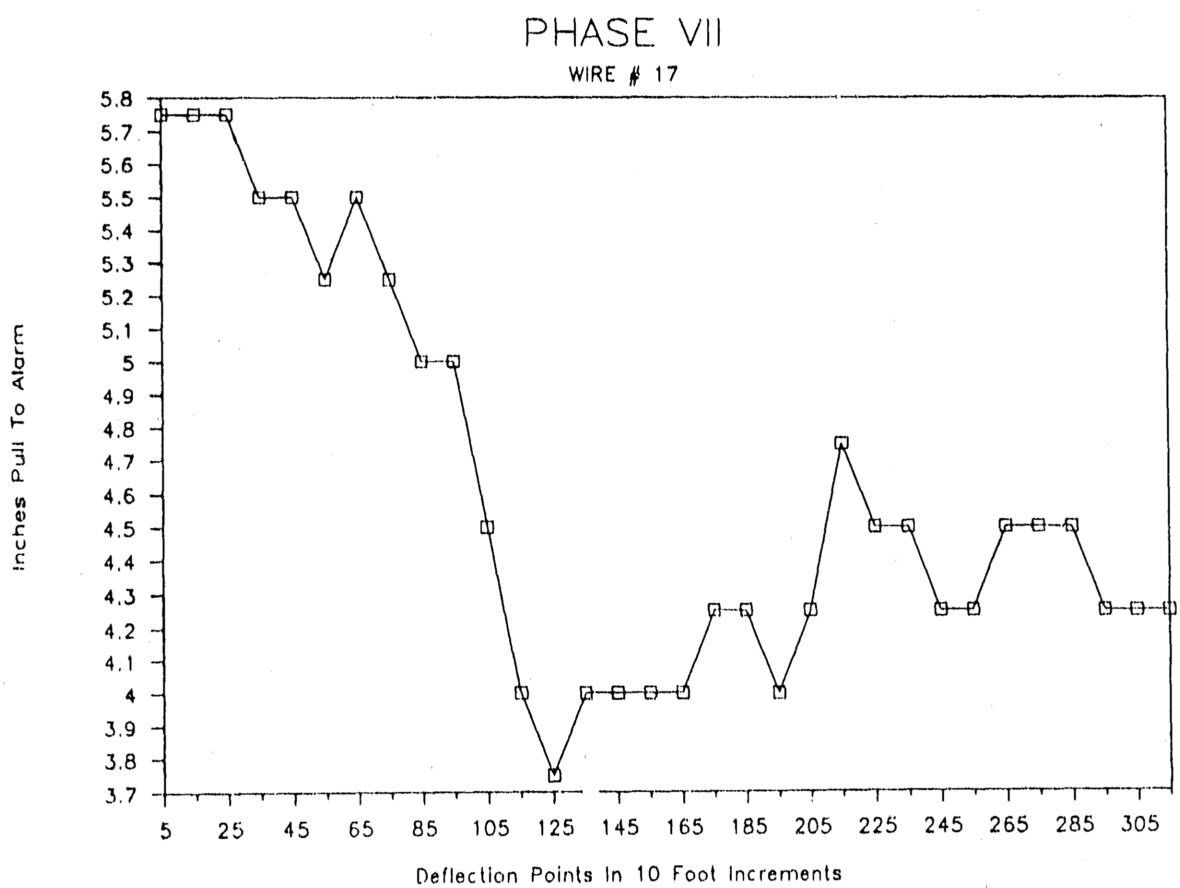




FUNCTIONAL TEST REPORT
PHASE VII

WIRE #	TENSION	POINT A DEFL	POINT A PULL	POINT B DEFL	POINT B PULL	POINT C DEFL	POINT C PULL	POINT D DEFL	POINT D PULL
1	92 LBS	4 IN	20 LBS	3.5IN	17 LBS	4 IN	15 LBS	3.75IN	12 LBS
2	85 LBS	4.25IN	22 LBS	3.5IN	15 LBS	4 IN	13 LBS	4.5IN	17 LBS
3	94 LBS	3.5 IN	18 LBS	3.25IN	15 LBS	4 IN	12 LBS	4.5IN	17 LBS
4	94 LBS	3.75IN	20 LBS	3.5IN	15 LBS	3.75IN	16 LBS	3.75IN	18 LBS
5	94 LBS	4 IN	20 LBS	3.75IN	13 LBS	4.25IN	16 LBS	3.75IN	18 LBS
6	92 LBS	3.5 IN	19 LBS	3.5IN	15 LBS	3.75IN	13 LBS	3.75IN	15 LBS
7	90 LBS	4 IN	20 LBS	3.75IN	16 LBS	4 IN	14 LBS	4.5IN	16 LBS
8	90 LBS	4.25IN	20 LBS	3.5IN	14 LBS	4 IN	13 LBS	4.75IN	16 LBS
9	94 LBS	3.5 IN	17 LBS	3.25IN	15 LBS	4 IN	14 LBS	4.5IN	15 LBS
10	94 LBS	4 IN	17 LBS	3.25IN	15 LBS	4 IN	15 LBS	4.5IN	17 LBS
11	90 LBS	4.25IN	21 LBS	4 IN	16 LBS	3.5IN	12 LBS	5 IN	16 LBS
12	86 LBS	4 IN	17 LBS	3.25IN	14 LBS	4.25IN	13 LBS	4.75IN	14 LBS
13	94 LBS	4.5 IN	18 LBS	3.25IN	12 LBS	4.25IN	12 LBS	5 IN	14 LBS
14	92 LBS	4.25IN	18 LBS	4 IN	12 LBS	4.25IN	11 LBS	4.5IN	13 LBS
15	92 LBS	5 IN	21 LBS	4.5IN	15 LBS	3.75IN	9 LBS	5 IN	14 LBS
16	87 LBS	4.5 IN	16 LBS	4 IN	12 LBS	4.25IN	12 LBS	5 IN	15 LBS
17	90 LBS	4.25IN	16 LBS	4 IN	12 LBS	3.75IN	10 LBS	5.5IN	17 LBS
18	92 LBS	5.25IN	22 LBS	3.75IN	11 LBS	4 IN	12 LBS	5.5IN	17 LBS
19	86 LBS	5.5 IN	23 LBS	4.25IN	15 LBS	4 IN	12 LBS	4.75IN	13 LBS
20	92 LBS	5 IN	20 LBS	4 IN	13 LBS	3.75IN	10 LBS	6 IN	18 LBS
21	86 LBS	4 IN	18 LBS	4.5IN	16 LBS	3.5IN	10 LBS	4 IN	13 LBS


PHASE VII
WIRE # 7
6.5
6
5.5
5
4.5
4
3.5
3
Inches Pull To Alarm
5 25 45 65 85 105 125 145 165 185 205 225 245 265 285 305
Deflection Points In 10 Foot Increments

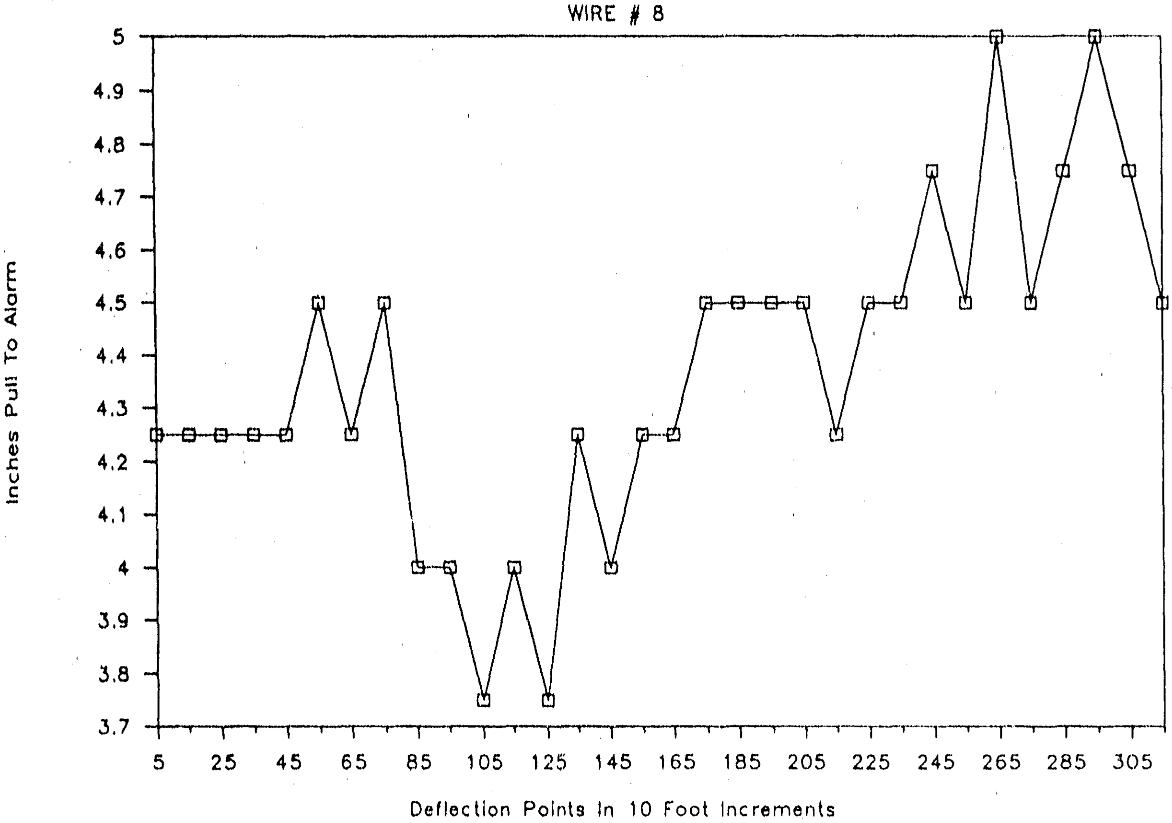

PHASE VII
WIRE # 17
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
Inches Pull To Alarm
5 25 45 65 85 105 125 145 165 185 205 225 245 265 285 305
Deflection Points In 10 Foot Increments

FUNCTIONAL TEST REPORT
PHASE VIII - 75 LBS

IRE #	TENSION	POINT A DEFL	POINT A PULL	POINT B DEFL	POINT B PULL	POINT C DEFL	POINT C PULL	POINT D DEFL	POINT D PULL
1	75 LBS	4 IN	12 LBS	3.5IN	12 LBS	3.75IN	13 LBS	4.5IN	15 LBS
2	80 LBS	4.5 IN	16 LBS	3.5IN	13 LBS	4 IN	15 LBS	4.5IN	16 LBS
3	72 LBS	4.5 IN	17 LBS	3.5IN	12 LBS	4.25IN	13 LBS	4.25IN	17 LBS
4	80 LBS	4.5 IN	16 LBS	4.5IN	17 LBS	4.25IN	13 LBS	4.5IN	14 LBS
5	75 LBS	4.5 IN	15 LBS	4 IN	13 LBS	3.75IN	12 LBS	4.25IN	17 LBS
6	77 LBS	4.75 IN	15 LBS	4 IN	8 LBS	3.5IN	11 LBS	4.25IN	17 LBS
7	79 LBS	5 IN	15 LBS	5 IN	15 LBS	4.5IN	13 LBS	5.25IN	15 LBS
8	79 LBS	5.5 IN	15 LBS	4.25IN	12 LBS	4.5IN	13 LBS	5 IN	15 LBS
9	73 LBS	6 IN	17 LBS	4 IN	9 LBS	4.5IN	13 LBS	5 IN	14 LBS
10	80 LBS	6 IN	20 LBS	4 IN	12 LBS	4.5IN	12 LBS	5 IN	15 LBS
11	76 LBS	6 IN	20 LBS	4.25IN	14 LBS	4.5IN	15 LBS	5.5IN	20 LBS
12	79 LBS	6 IN	20 LBS	4 IN	13 LBS	4.75IN	15 LBS	5.5IN	16 LBS
13	80 LBS	6 IN	17 LBS	4.25IN	12 LBS	4.25IN	15 LBS	5.5IN	14 LBS
14	80 LBS	6.5 IN	17 LBS	4.25IN	13 LBS	3.75IN	13 LBS	5.25IN	13 LBS
15	78 LBS	7 IN	20 LBS	4.5IN	12 LBS	4 IN	9 LBS	5.25IN	12 LBS
16	79 LBS	6 IN	15 LBS	4 IN	8 LBS	4.5IN	10 LBS	4.75IN	11 LBS
17	78 LBS	6 IN	16 LBS	4.5IN	8 LBS	4.25IN	15 LBS	4.25IN	14 LBS
18	80 LBS	6 IN	17 LBS	4.5IN	13 LBS	3.75IN	10 LBS	5.5IN	15 LBS
19	80 LBS	6 IN	15 LBS	4.5IN	12 LBS	4.5IN	12 LBS	4.5IN	11 LBS
20	80 LBS	6 IN	15 LBS	4 IN	9 LBS	4.5IN	11 LBS	4.5IN	13 LBS
21	78 LBS	6 IN	17 LBS	4.5IN	12 LBS	4.5IN	15 LBS	4.5IN	13 LBS

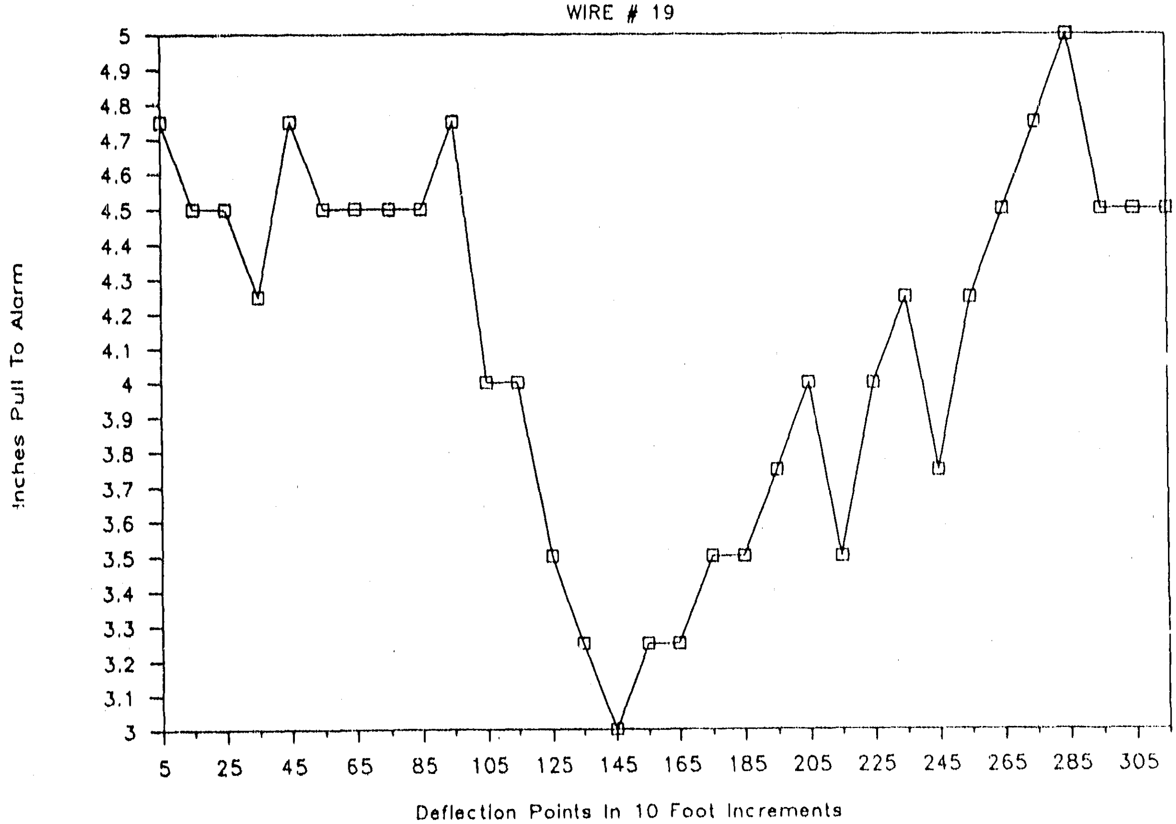
PHASE VIII — 75 LBS.

WIRE # 8



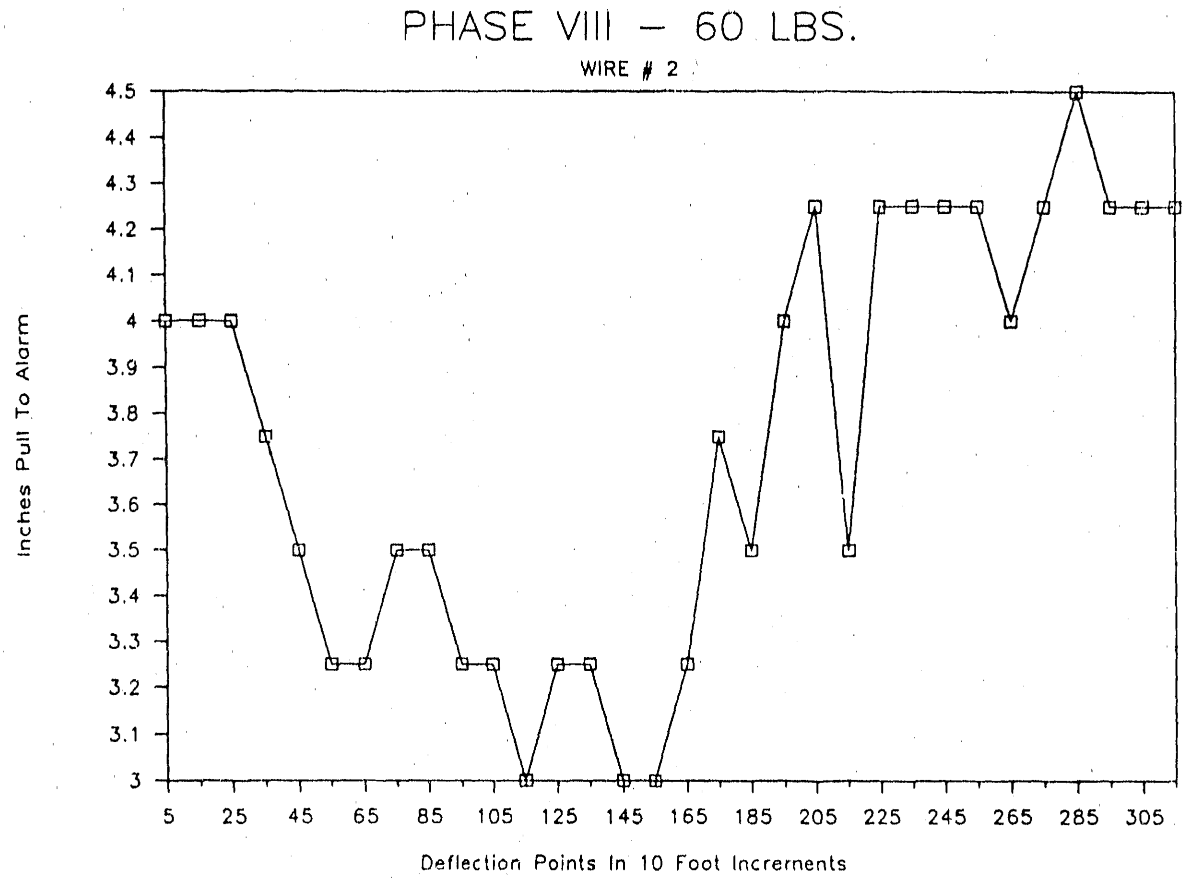
PHASE VIII — 75 LBS.

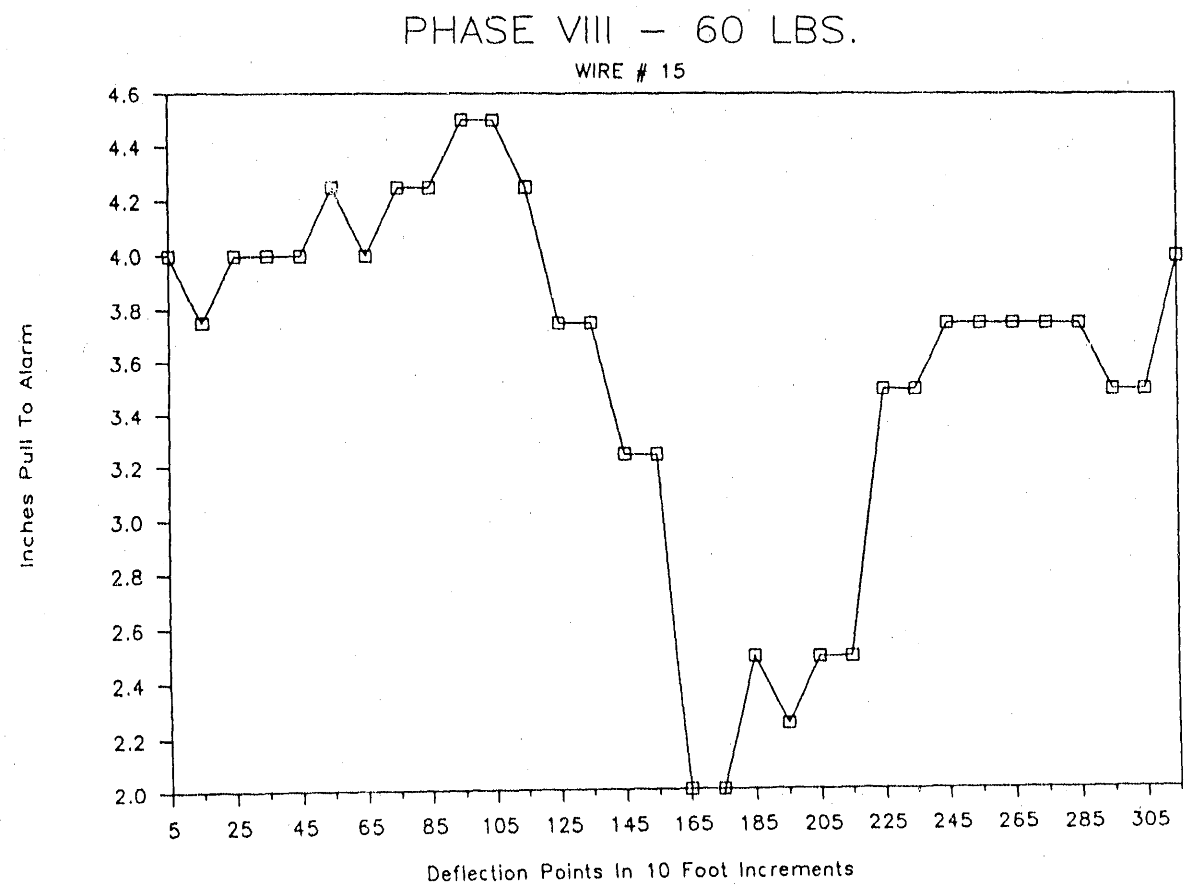
WIRE # 19



FUNCTIONAL TEST REPORT
PHASE VIII - 60 LBS

WIRE #	TENSION	POINT A DEFL	POINT A PULL	POINT B DEFL	POINT B PULL	POINT C DEFL	POINT C PULL	POINT D DEFL	POINT D PULL
1	58 LBS	4.5 IN	11 LBS	3 IN	7 LBS	4 IN	10 LBS	4.75 IN	13 LBS
2	56 LBS	4.5 IN	12 LBS	4 IN	9 LBS	4.25 IN	10 LBS	4.75 IN	12 LBS
3	58 LBS	4.75 IN	13 LBS	3.75 IN	9 LBS	3.75 IN	10 LBS	4.5 IN	13 LBS
4	54 LBS	4.75 IN	12 LBS	4.25 IN	10 LBS	4.5 IN	10 LBS	5 IN	13 LBS
5	58 LBS	4.75 IN	11 LBS	4.25 IN	9 LBS	4.25 IN	10 LBS	4.75 IN	13 LBS
6	64 LBS	4.75 IN	12 LBS	4 IN	10 LBS	4.25 IN	37 LBS	4.75 IN	13 LBS
7	62 LBS	5.5 IN	14 LBS	5 IN	13 LBS	4.75 IN	15 LBS	5.5 IN	14 LBS
8	64 LBS	5.5 IN	15 LBS	4.75 IN	13 LBS	4 IN	10 LBS	5.25 IN	13 LBS
9	58 LBS	5 IN	13 LBS	3.5 IN	6 LBS	5 IN	13 LBS	5.25 IN	12 LBS
10	60 LBS	7 IN	19 LBS	3.5 IN	10 LBS	5 IN	13 LBS	6 IN	15 LBS
11	58 LBS	4.5 IN	11 LBS	3 IN	7 LBS	4 IN	11 LBS	4.5 IN	13 LBS
12	60 LBS	4.5 IN	14 LBS	2.75 IN	7 LBS	4 IN	10 LBS	4.25 IN	12 LBS
13	62 LBS	4.75 IN	10 LBS	3.75 IN	9 LBS	4.5 IN	10 LBS	4.75 IN	13 LBS
14	60 LBS	4.75 IN	9 LBS	3.5 IN	6 LBS	4.25 IN	10 LBS	4.75 IN	13 LBS
15	60 LBS	4.75 IN	9 LBS	4 IN	6 LBS	4.25 IN	11 LBS	4.75 IN	9 LBS
16	60 LBS	4.75 IN	8 LBS	3.75 IN	6 LBS	4.75 IN	10 LBS	4.5 IN	7 LBS
17	62 LBS	4.75 IN	10 LBS	3.25 IN	5 LBS	4.25 IN	10 LBS	4 IN	9 LBS
18	60 LBS	5 IN	10 LBS	3.75 IN	6 LBS	4.75 IN	9 LBS	4.5 IN	10 LBS
19	62 LBS	5 IN	10 LBS	4 IN	8 LBS	4.5 IN	9 LBS	4.5 IN	10 LBS
20	62 LBS	5 IN	10 LBS	3.5 IN	6 LBS	4.5 IN	8 LBS	4.5 IN	9 LBS
21	64 LBS	4.75 IN	8 LBS	3.75 IN	7 LBS	4.25 IN	11 LBS	4.5 IN	12 LBS


PHASE VIII — 60 LBS.
WIRE # 2
Inches Pull To Alarm
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
5 25 45 65 85 105 125 145 165 185 205 225 245 265 285 305
Deflection Points In 10 Foot Increments


PHASE VIII — 60 LBS.
WIRE # 15
Inches Pull To Alarm
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
5 25 45 65 85 105 125 145 165 185 205 225 245 265 285 305
Deflection Points In 10 Foot Increments

1/1/88 thru 12/31/88

ALARM ANALYSIS DATA LISTING

FROM BEGINNING OF DATA BASE TO END OF DATA BASE

CHAN	ASSESSMENT	TYPE	DATE	TIME	TEMP	WS	WD
69	unkn	UF	10-27-1988	1:23:58	60	5	284
69	unkn	UF	10-27-1988	1:29:29	60	5	113
69	unkn	UF	10-27-1988	1:29:41	60	5	203
69	test	UF	10-28-1988	7:46:41	54	0	270
69	unkn	UF	10-31-1988	20: 4:30	64	1	90
69	test	UF	11-18-1988	10:13:16	40	7	315
69	test	UF	11-18-1988	10:13:38	40	10	293
69	test	UF	11-18-1988	10:14:14	41	8	293
69	test	UF	11-21-1988	14:58: 2	52	0	248
69	test	UF	11-21-1988	14:58:22	52	0	248
69	test	UF	11-21-1988	15:10:48	52	8	332
69	test	UF	11-21-1988	15:10:59	52	6	332
69	test	UF	11-21-1988	15:11:15	52	8	0
69	test	UF	11-21-1988	15:11:28	52	6	315
69	test	UF	11-21-1988	15:12:39	52	2	0
69	test	UF	11-21-1988	15:38:28	52	6	293

ALARMS FOUND IN CHANNEL 69 = 16

DATA COLLECTION 1947.29 HOURS TOTAL

1/1/89 thru 9/30/89

ALARM ANALYSIS DATA LISTING

FROM BEGINNING OF DATA BASE TO END OF DATA BASE

CHN	ASSESSMENT	TYPE	DATE	TIME	TEMP	WS	WD
69	test	UF	2- 3-1989	8:26: 5	46	2	180
69	test	UF	2-10-1989	15:31:34	59	3	293
69	unknown	UF	2-10-1989	16: 9:[illegible]	59	5	332
69	unknown	UF	2-10-1989	16: 9:43	59	5	332
69	unknown	UF	2-10-1989	16: 9:[illegible]	59	2	332
69	constnt	UF	5- 9-1989	16: 4:29	29	20	113
69	constnt	UF	5-10-1989	15:59:52	22	18	180
69	unknown	UF	7-13-1989	16:27:51	94	12	90
69	unknown	UF	7-15-1989	15:53:13	91	10	0
69	unknown	UF	7-23-1989	15:21:42	74	14	180
69	unknown	UF	7-23-1989	15:26:27	22	21	158
69	unknown	UF	7-23-1989	15:34:28	22	15	158
69	unknown	UF	7-23-1989	15:34:48	22	12	180
69	unknown	UF	7-23-1989	15:34:54	22	16	158
69	unknown	UF	7-23-1989	15:34:56	22	15	158
69	unknown	UF	7-23-1989	15:35:23	22	14	158
69	unknown	UF	7-23-1989	15:35:42	22	13	158
69	unknown	UF	7-23-1989	15:43:13	22	9	180
69	unknown	UF	7-23-1989	15:43:25	22	11	158
69	unknown	UF	7-23-1989	15:43:35	22	11	158
69	unknown	UF	7-23-1989	15:43:38	22	10	158
69	unknown	UF	7-25-1989	17:28:33	68	11	113
69	test	UF	9- 2-1989	9: 5:16	25	9	203
69	test	UF	9- 7-1989	9: 5:17	25	9	225

ALARMS FOUND IN CHANNEL 69 = 24

DATA COLLECTION 4357.69 HOURS TOTAL

END

DATE FILMED

11 / 06 / 90