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TEST OF H-20 SEPTUM WIRES

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February 1990

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

TEST OF H-20 SEPTUM WIRES

BOOSTER TECHNICAL NOTE
NO. 157

E. RODGER and V. BADEA

FEBRUARY 28, 1990

ALTERNATING GRADIENT SYNCHROTRON DEPARTMENT
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973

Description of Tests

During the months of October and November 1989 tests of 0.002 in dia x 4 in length tungsten wires were performed.

a) The wires were taken out from H-20 electrostatic septum after being exposed to the beam. Residual radiation level was 0.8 m R/HR @ 12 in. Location of wires removed was as follows:

1. One piece from upstream (specimen 1)
2. One piece from the middle (specimen 2)
3. One piece from downstream (specimen 3)

b) In addition a number of 6 samples of virgin wires was tested under similar conditions to determine whether any changes occurred due to the beam exposure.

c) The tests performed followed the General Tensile Test Procedure of: Automated Materials Testing system U4.05a (see annexes # 1 & 2).

d) Several attempts were made to determine whether changes took place in the structure of tungsten wire after being exposed to the beam. To accomplish that, the wire samples were photographed as follows: (see annexes A, B, C, D & E).

- wire unmounted - mag. 400x, photo A (photo taken ≈ 3/4" from end of wire of an untouched area by the beam.)

- wire unmounted - mag 400x, photo B, C & D (photos taken ≈ at center, area touched by the beam)

- wire mounted and polished - mag 400x, photo E. (Photo taken 1 1/2" from end).

The wires were then tensile tested to destruction.

Results

I. Breaking stress was higher for tungsten wires exposed to beam than unexposed (virgin) wire as follows:

Stress for exposed wire:
- upstream = 461,600 PSI mean
- middle = 444,400 PSI 453,000 PSI

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- upstream = 461,600 PSI mean
- middle = 444,400 PSI 453,000 PSI

Stress for virgin wire:
- max = 427,200 PSI mean
- min = 324,700 PSI 384,484 PSI

Variation → + 17.8% (higher stress for exposed wire)

II. Displacement at peak was higher for virgin wire than for exposed wire as follows:

Displacement for exposed wire:

- upstream = .03900 in mean
- middle = .04000 in .0395 in

Displacement for virgin wire:

- max = .05300 in mean for 6
- min = .03800 in samples = .048 in

variation - 21.5% (greater displacement for virgin wire)

III. No reliable results were obtained regarding the structure because mounting and polishing with present methods were unrealistic and for initial viewing the photos taken don't show the real shape of wire because the wires were not flat (see metallography report #3).

Conclusion

The energy at break decreased for exposed wire by 30% from:

.024650 Lbs-in (mean value for virgin wire) to
.018895 Lbs-in (mean value for exposed wire)

This change is probably not significant in that the wires are suspected to break as a result of high temperature induced by direct impingement of the beam. The temperature reached is unknown at this time. The stress induced from the mounting spring tension is 115,000 ± 10,000 psi., therefore, the room temperature safety margin is 3.34 for the virgin wire and 3.94 for the exposed wire. It may be possible to reduce the mounting spring tension but an estimate or measurement of the maximum temperature, the wire reaches when hit by the beam is needed to determine if it can withstand the spring tension at high temperature.

Finally, in order to determine a lower value for the spring tension, one has to further investigate the field variation when the wires tend to bow due to reduced tension.

ANNEX I A

DEPARTMENT OF APPLIED SCIENCE
Materials Science Division
Test Report # 2058

General Tensile Test - US Customary Units

Test type: Tungsten wire exposed to beam.

Instron Corporation
Series IX Automated Materials Testing System v4.05a

Operator name: Don Horne

Test Date: October 3,1989

Sample Identification: 1EXWIRES

Sample Type: wire

Interface Type: 4200 Series
Machine Parameters of test:
Sample Rate (pts/sec): 10.00

Humidity (%): 50

Crosshead Speed (in/min): .500

Temperature (deg. F): 73

Tested for Viorel Badea
Acc't # 08455
ILR #

Dimensions:

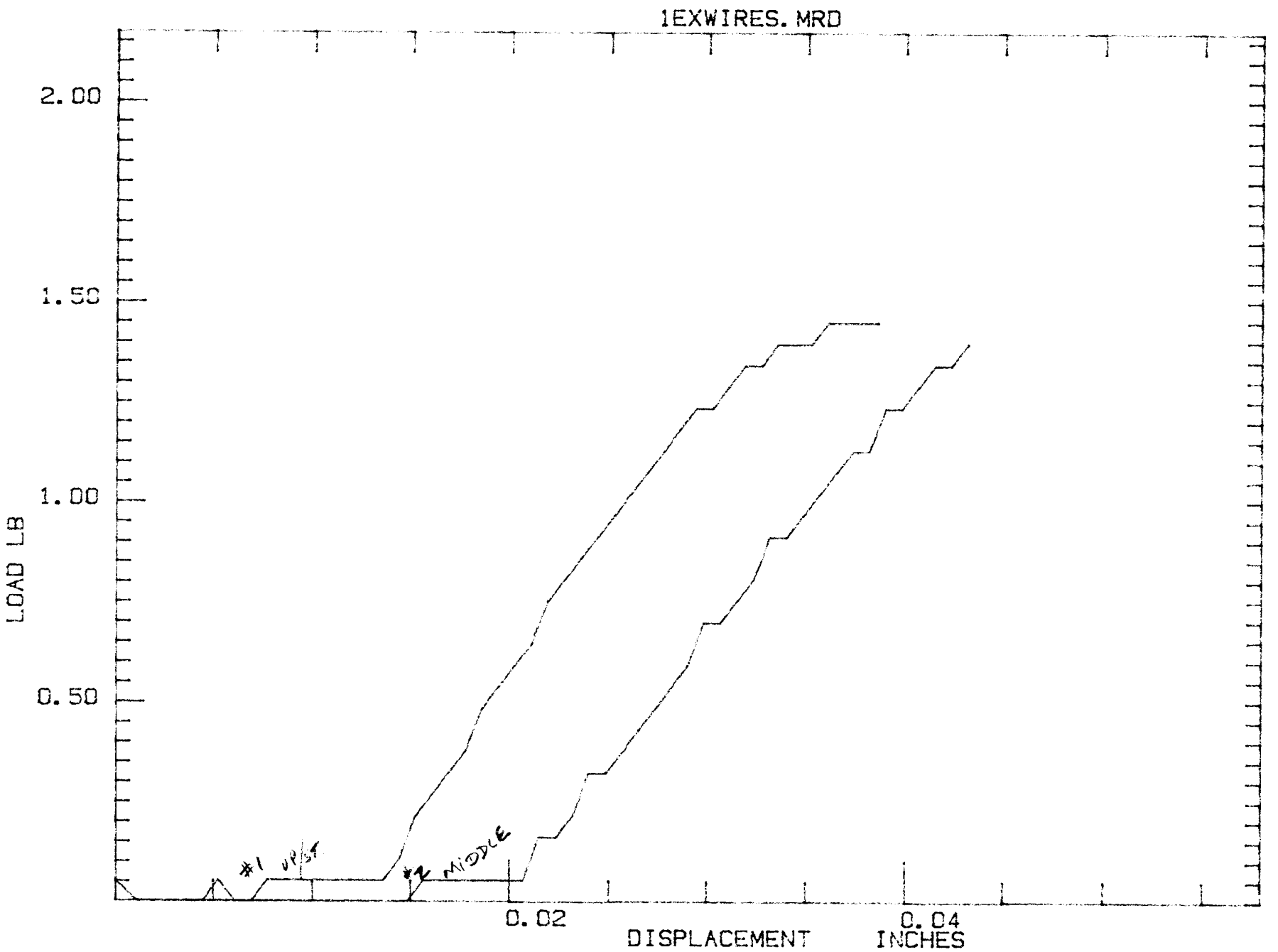
	Spec. 1	Spec. 2
Diameter (in)	.002000	.002000
Gauge length (in)	2.0000	2.0000

Sample comments: Both samples broke away from grips.

Specimen Number	lexwires	Load at 0.2% Yield (lbs)	Stress at 0.2% Yield (psi)	Displcment at 0.2% Yield (in)	% Strain at 0.2% Yield (%)	Load at Peak (lbs)	Stress at Peak (psi)	Displcment at Peak (in)	% Strain at Peak (%)	Load at Break (lbs)
1/D/ST 1		1.396	444400.	.03443	1.721	1.450	461600.	.03900	1.950	1.450
MIDDLE 2		----------	----------	----------	----------	1.396	444400.	.04000	2.000	1.396

Specimen Number	Stress at Break (psi)	Displcment at Break (in)	% Strain at Break (%)	Energy at Yield (lbs-in)	Energy at Break (lbs-in)
1	461500.	.03610	1.805	.01775	.02011
2	444400.	.04028	2.014	.01768	.01768

ANNEX 1B


1EXWIRES.MRD
2.00
1.50
1.00
0.50
LOAD LB
#1 UPST
#2 MIDDLE
0.02
0.04
DISPLACEMENT
INCHES

DEPARTMENT OF APPLIED SCIENCE
Materials Science Division
Test Report # 2057

ANNEX 2 A

General Tensile Test - US Customary Units

Test type: Tungsten wire

Instron Corporation
Series IX Automated Materials Testing System v4.05a

Operator name: Don Horne

Test Date: September 19,1989

Sample Identification: 1WWIRE

Sample Type: wire

Interface Type: 4200 Series
Machine Parameters of test:
Sample Rate (pts/sec): 10.00
Crosshead Speed (in/min): .500

Humidity (%): 50
Temperature (deg. F): 73

Tested for Viorel Badea
Acc't #
ILR #

Dimensions:

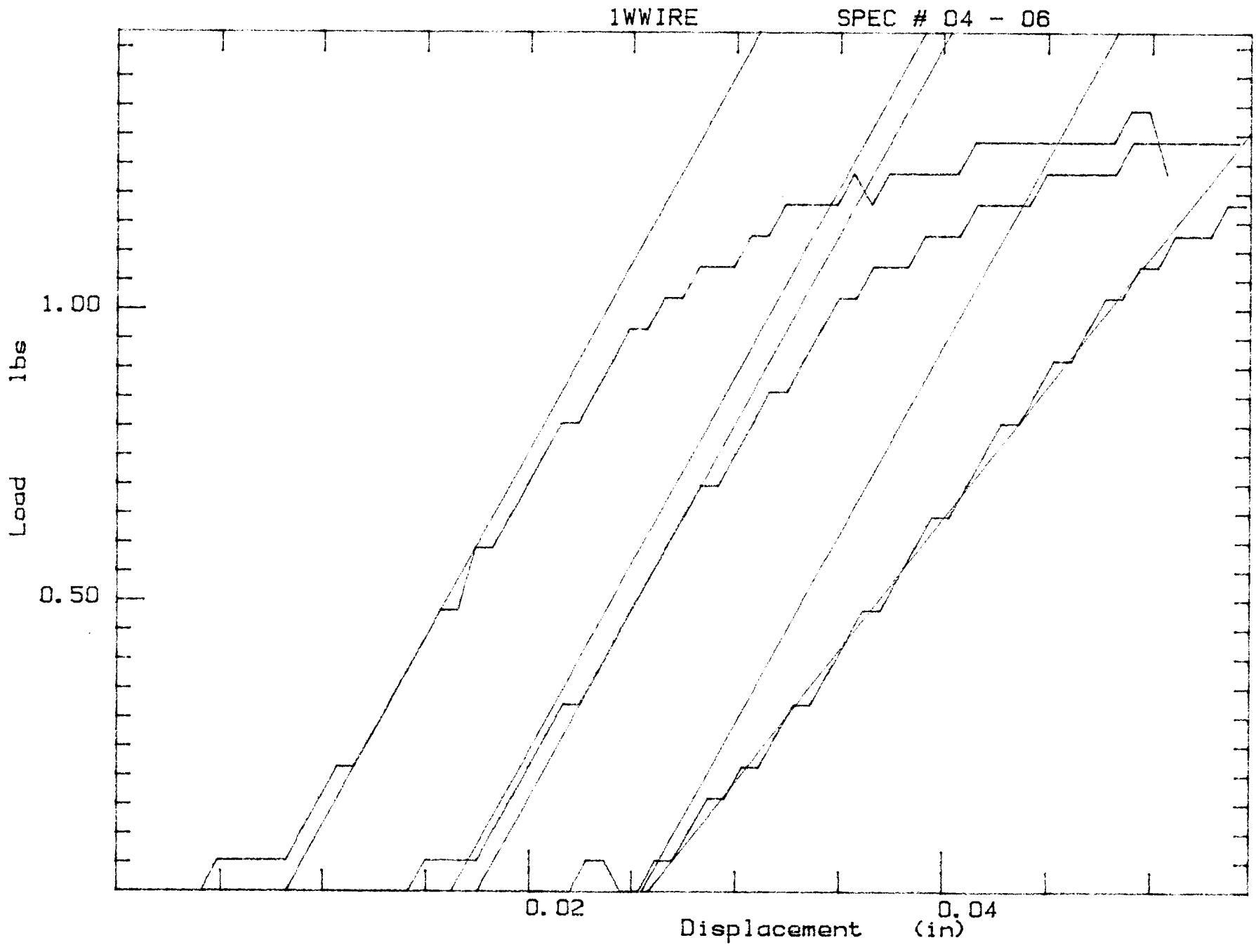
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6
Diameter (in)	.002000	.002000	.002000	.002000	.002000	.002000
Gauge length (in)	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000

Out of 6 specimens, 0 excluded.

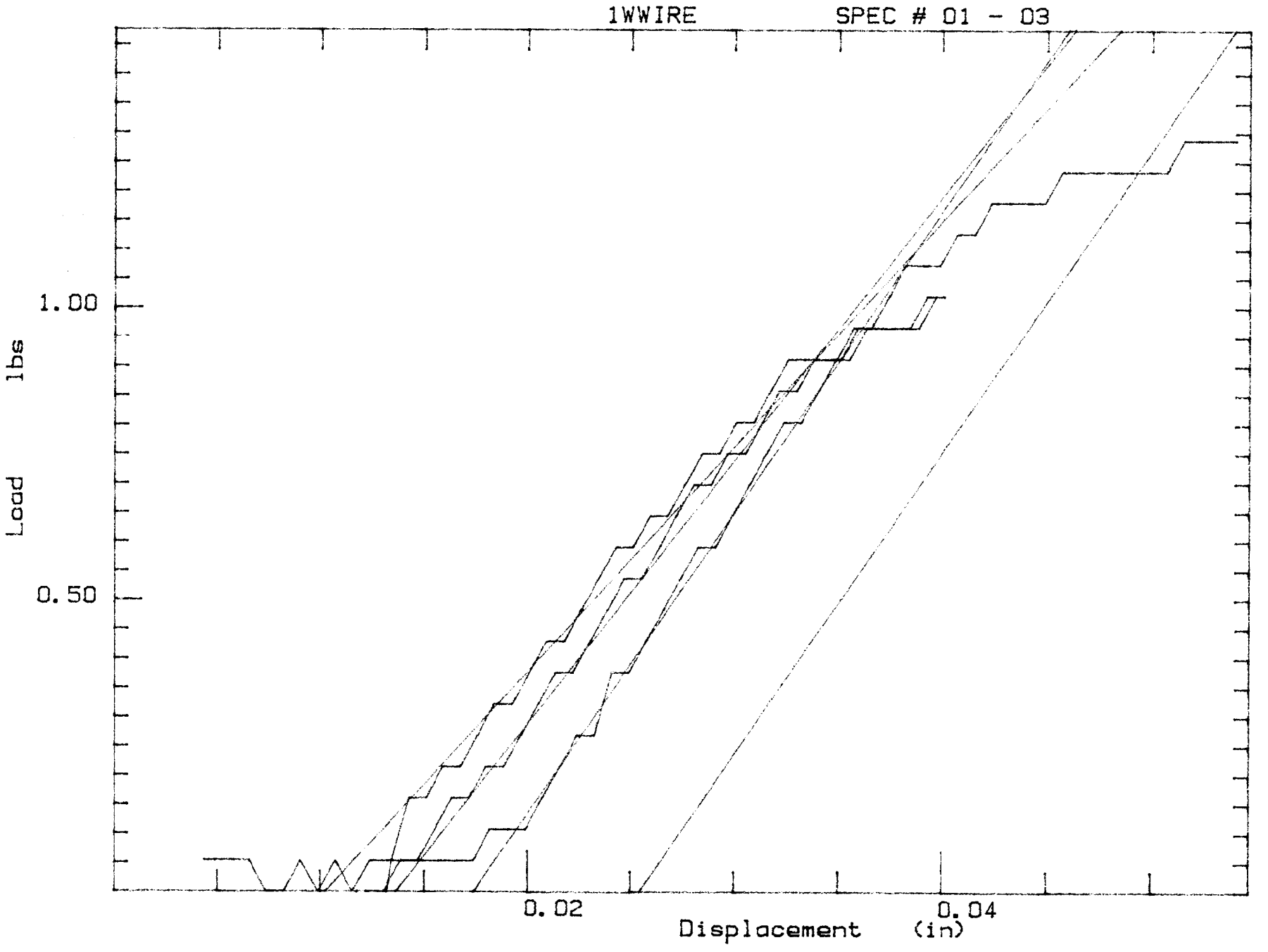
Specimen Number 1Wwire	Load at 0.2% Yield (lbs)	Stress at 0.2% Yield (psi)	Displcment at 0.2% Yield (in)	% Strain at 0.2% Yield (%)	Load at Peak (lbs)	Stress at Peak (psi)	Displcment at Peak (in)	% Strain at Peak (%)	Load at Break (lbs)
1	----------	----------	----------	----------	1.020	324700.	.04000	1.0000	1.020
2	----------	----------	----------	----------	1.020	324700.	.03800	.9500	1.020
3	1.235	393100.	.04553	1.1380	1.342	427200.	.05500	1.3750	1.342
4	1.181	376000.	.03488	.8720	1.342	427200.	.05000	1.2500	1.342
5	1.181	376000.	.04195	1.0490	1.342	427200.	.05300	1.3250	1.289
6	----------	----------	----------	----------	1.181	375900.	.05200	1.3000	1.181
Mean:	----------	----------	----------	----------	1.208	384500.	.04800	1.2000	1.199
Standard Deviation:	----------	----------	----------	----------	.158	50390.	.00718	.1796	.151

Specimen Number	Stress at Break (psi)	Displcment at Break (in)	% Strain at Break (%)	~~Young's Modulus~~ (ksi)	Energy at Yield (lbs-in)	Energy at Break (lbs-in)
1	324700.	.03928	.9820	49150.	.01449	.01449
2	324700.	.03751	.9378	51460.	.01382	.01382
3	427300.	.05220	1.3050	63690.	.02558	.03413
4	427300.	.04905	1.2260	82070.	.01964	.03752
5	410200.	.05028	1.2570	82060.	.01996	.03043
6	376000.	.04926	1.2310	~~57450.~~	.01754	.01754
Mean:	381700.	.04626	1.1570	~~68550.~~	.01851	.02465
Standard Deviation:	47930.	.00622	.1555	~~13760.~~	.00430	.01058

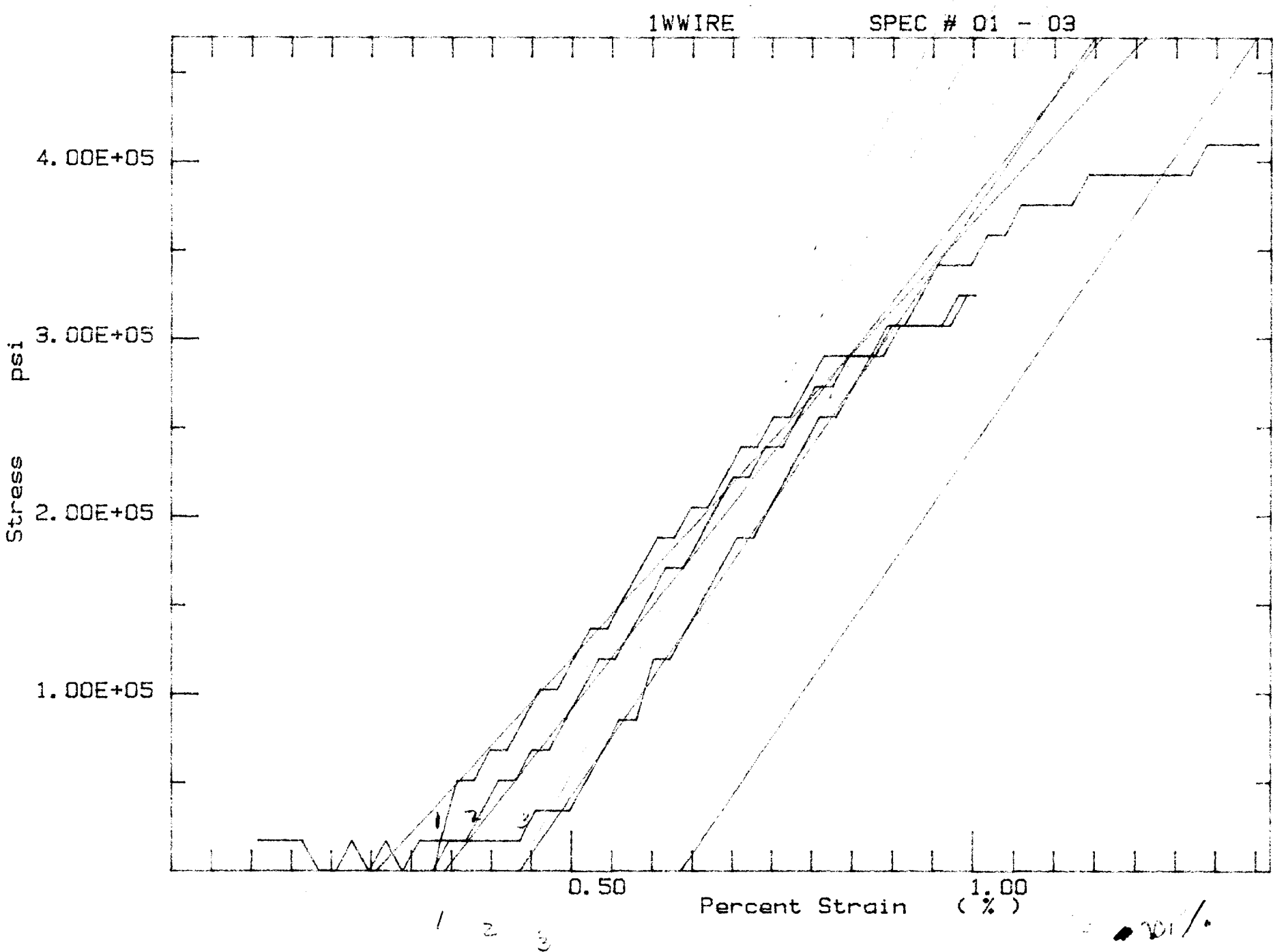
ANNEX 2 B



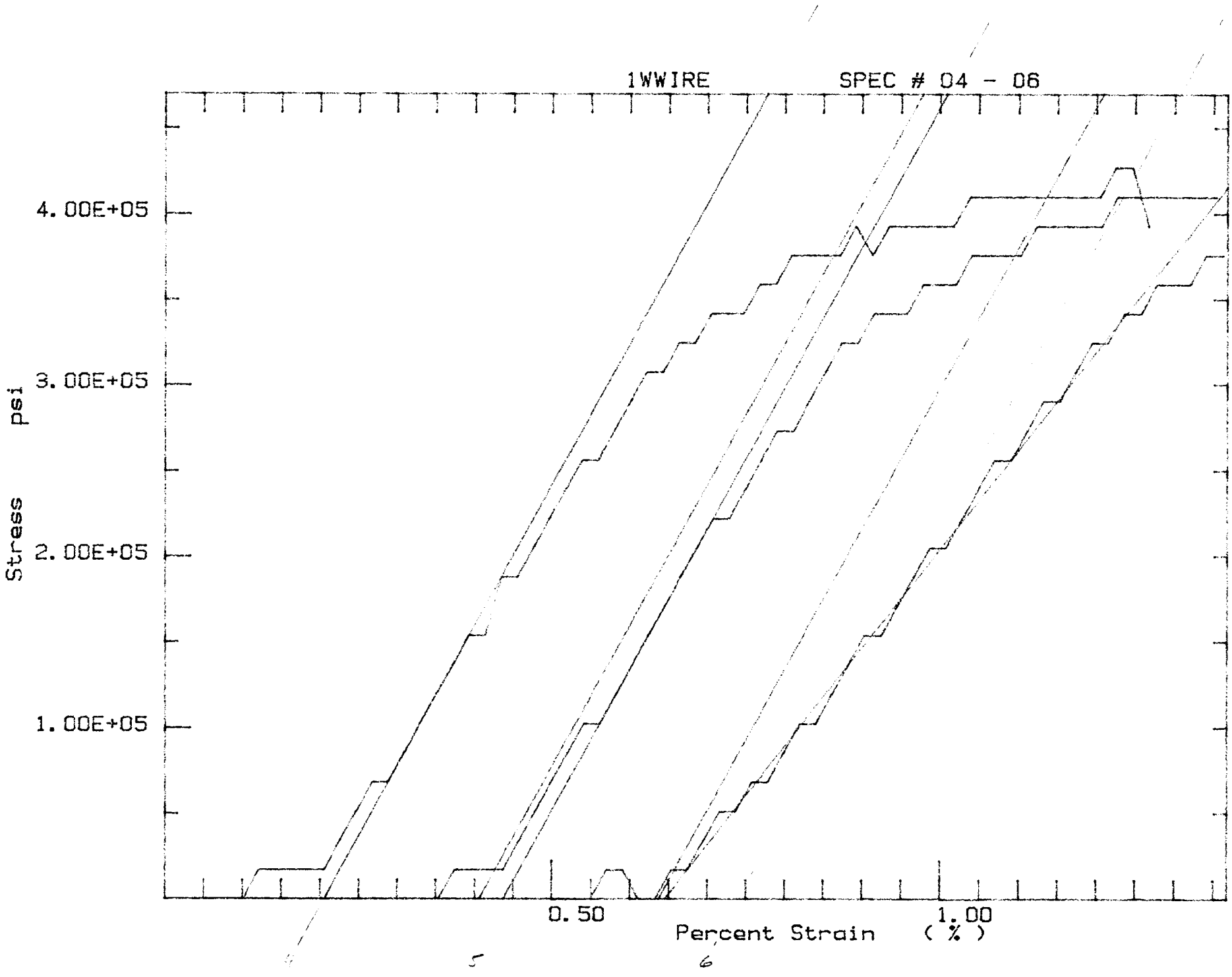
ANNEX 2 C



ANNEX 2D


1WWIRE
SPEC # 01 - 03
4.00E+05
3.00E+05
2.00E+05
1.00E+05
Stress psi
0.50
1.00
Percent Strain (%)
1
2
3

ANNEX 2 E


1WWIRE
SPEC # 04 - 06
4.00E+05
3.00E+05
2.00E+05
1.00E+05
Stress psi
0.50
1.00
Percent Strain (%)

5 6

ANNEX 3

METALLOGRAPHY REPORT

Requested by: Viorel Badea Date 12-15-89

DESCRIPTION Tungsten Wire 0.002 in Dia
H-20 Septum Wires radiation level 0 8mR/hr @ 12in

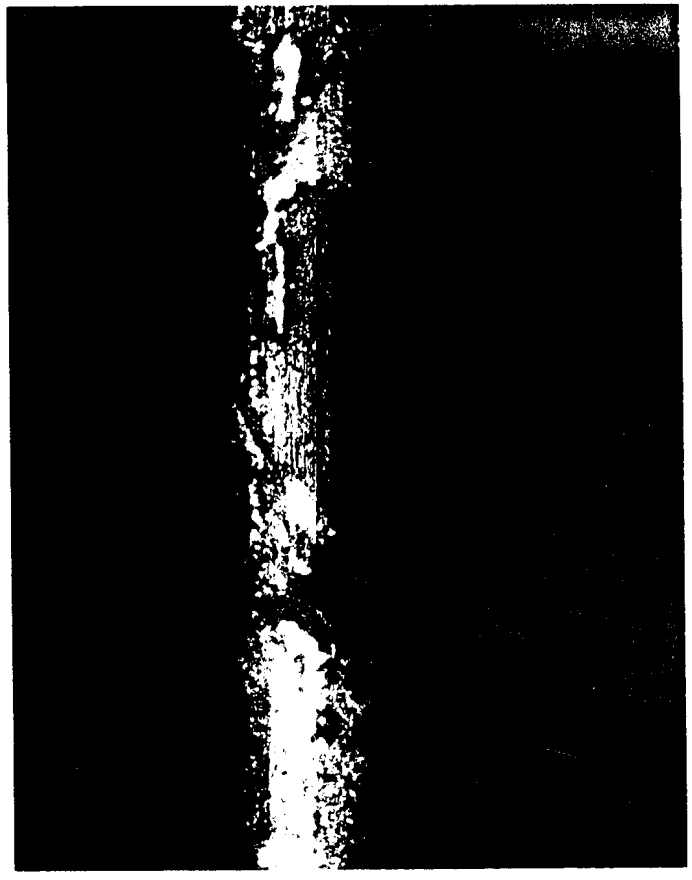
EXAMINATION photographed wire (initial viewing)
mounted wire to enable polishing, etching,
longitudinal cross-section viewing

OBSERVATIONS Initial viewing was difficult because wire
was not flat. Took several photos (A B C D)

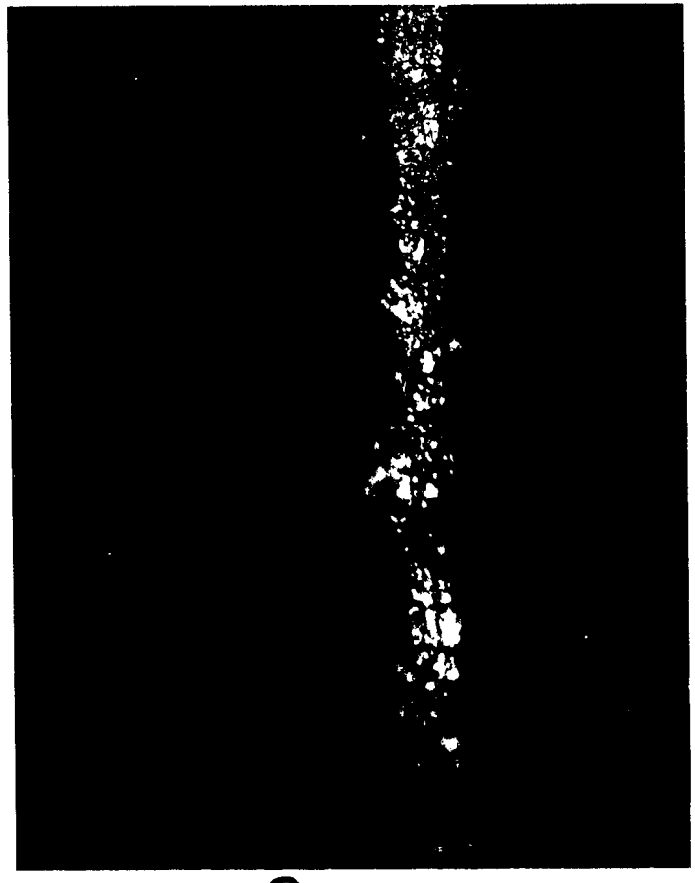
Mounting and polishing unrealistic with present methods. Procedure followed, but due to small diameter wire, polishing caused wire to pull out of mount. One Photo was taken (E)

PHOTO	Description	Mag
A	Wire, unmounted Photo taken ≈ 3/4 inch from end	400 x
B, C, D	Wire, unmounted Photos taken ≈ at center	400 x
E	Wire, mounted & polished Photo taken ≈ 1½ inch from end	400 x

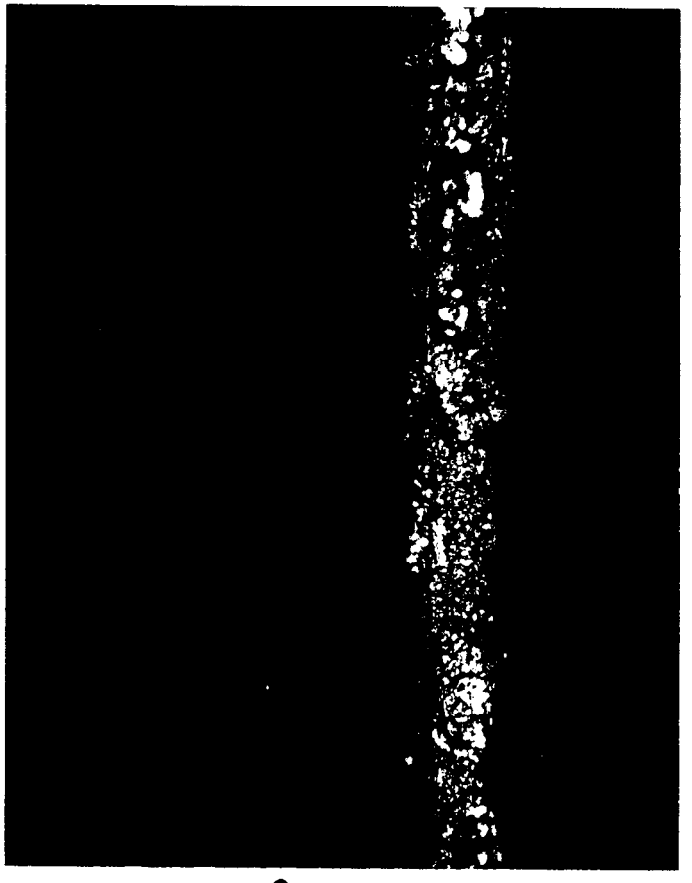
Prepared by: K. Warburton



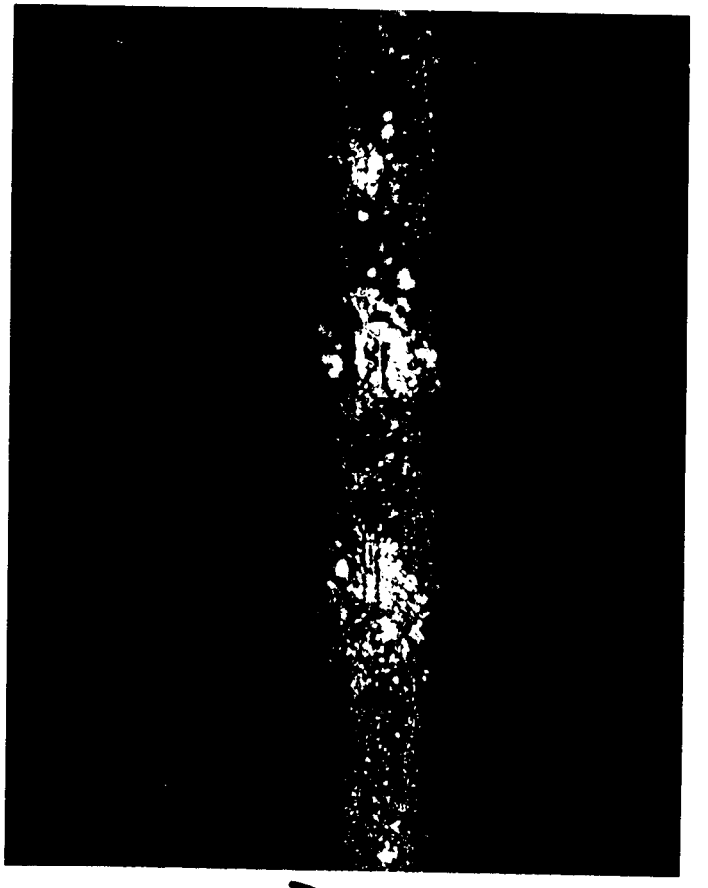
ANNEX - A



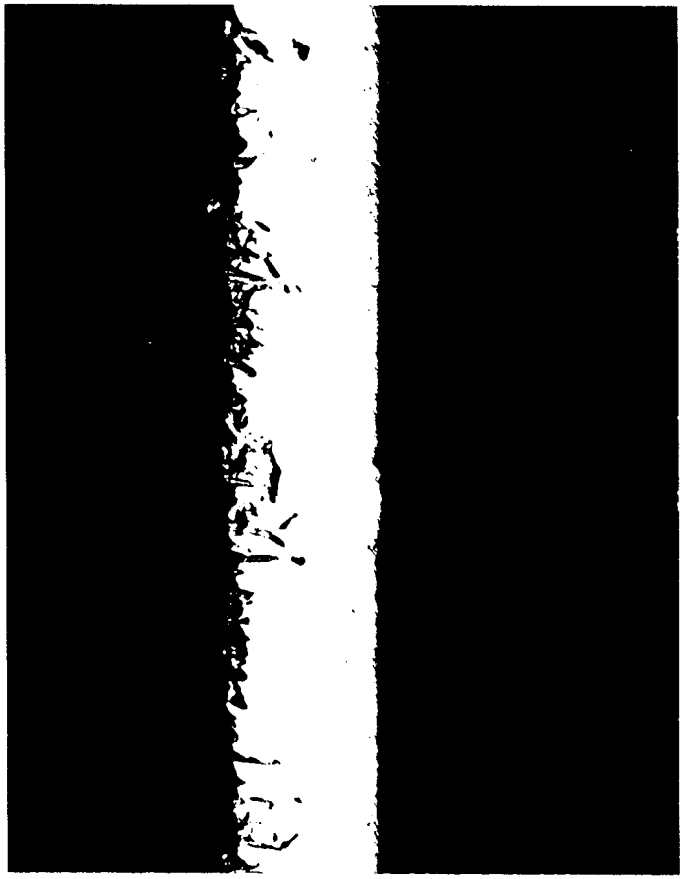
ANNEX - B



ANNEX - C



ANNEX - D



ANNEX-E