UC-38
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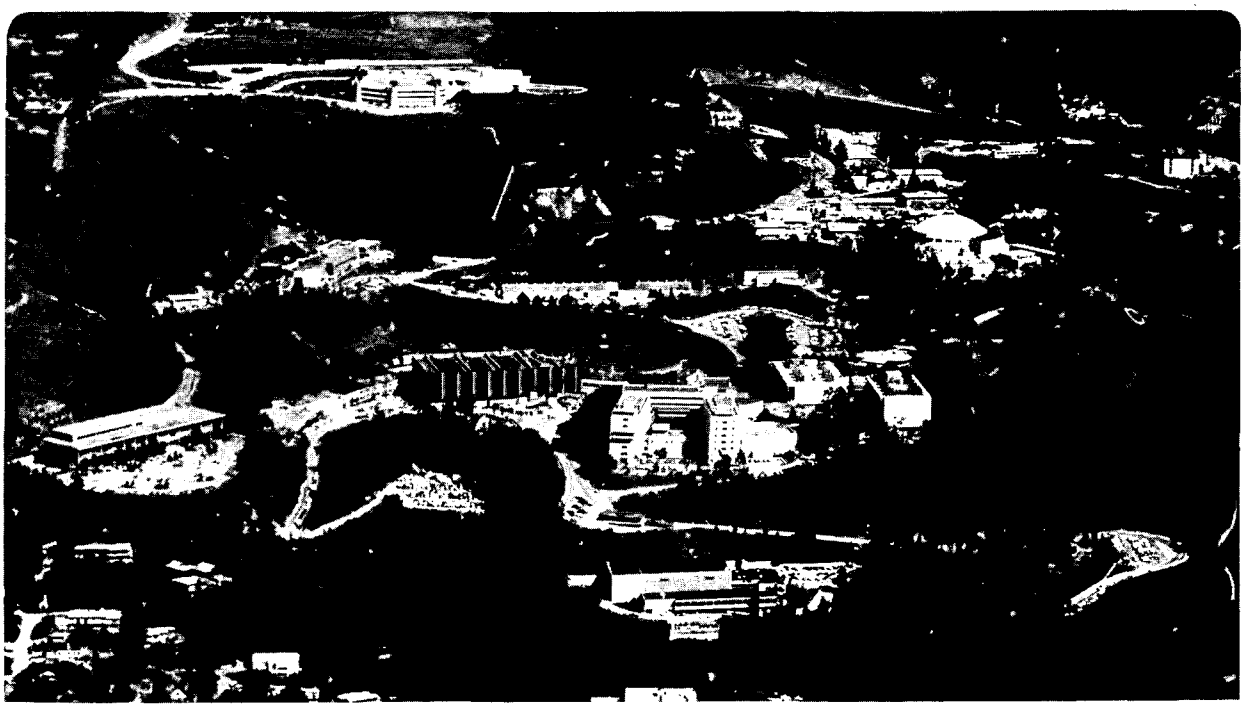

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LAWRENCE RADIATION LABORATORY - UNIVERSITY OF CALIFORNIA ENGINEERING NOTE	CODE BW/4350	SERIAL M5511	PAGE 1 OF 80
AUTHOR ROBERT YAMAMOTO / DEPARTMENT MECHANICAL ENGIN.	LOCATION BERKELEY	DATE APRIL 21, 1980	

PROGRAM — PROJECT — JOB

HEAVY ION SPECTROMETER SYSTEM — HISS

MAGNET CRYOSTAT

TITLE

SUPPORT CYLINDER

SUMMARY:

KEEPING HEAT LOAD TO A MINIMUM WHILE STILL MAINTAINING STRUCTURAL STRENGTH & INTEGRITY ARE THE MAIN CONSIDERATIONS USED IN THE DESIGN OF THE SUPPORT CYLINDER FOR THE HISS MAGNET CRYOSTAT. MATERIALS CONTEMPLATED FOR USE WERE 304 LN STAINLESS STEEL & TITANIUM 6AL-4V. BECAUSE OF THE NON-LINEARITY OF YIELD STRESS & THERMAL CONDUCTIVITY AS A FUNCTION OF TEMP., A HEWLETT PACKARD SYSTEM 45B DESKTOP COMPUTER WAS USED TO ANALYZE THIS PROBLEM.

THE TEMPERATURE GRADIENT ALONG THE SUPPORT CYLINDER'S LENGTH WAS COMPUTED USING INTEGRATION TECHNIQUES. BY KEEPING THE DESIGN STRESS OF THE CYLINDER CONSTANT THROUGHOUT THE TEMPERATURE GRADIENT, THE CROSS-SECTIONAL AREA (i.e. WALL THICKNESS) OF THE SUPPORT CYLINDER AS A FUNCTION OF CYLINDER LENGTH COULD BE DETERMINED FOR A GIVEN TEMPERATURE RANGE. HENCE, THE OPTIMUM DESIGN OF MINIMUM AREA (i.e. MINIMUM HEAT LOAD) VS. MATERIAL STRESS IS ACHEIVED.

THIS ENGINEERING NOTE COMPUTES & PRESENTS THE FOLLOWING DATA FOR BOTH MATERIALS FOR THE TWO TEMPERATURE RANGES NEEDED; 4.2°K TO 80°K & 82°K TO 290°K:

1. TOTAL CYLINDER HEAT LOAD AS A FUNCTION OF TEMPERATURE RANGE **
2. GRAPH OF MATERIAL YIELD STRESS VS. TEMPERATURE * 1.
3. GRAPH OF THERMAL CONDUCTIVITY VS. TEMPERATURE * 2.
4. GRAPH OF THERMAL CONDUCTIVITY / YIELD STRESS VS. TEMPERATURE **

* INPUT DATA

** CALCULATED DATA

5. GRAPH OF $\int_{T_1}^{T_2} \frac{\text{THERMAL COND.}}{\text{YIELD STRESS}}$ VS. TEMPERATURE **

6. GRAPH OF SUPPORT CYLINDER LENGTH VS. TEMP. **

7. GRAPH OF DESIGN STRESS IN SUPPORT CYLINDER VS. SUPPORT CYLINDER LENGTH. **

8. GRAPH OF CROSS-SECTIONAL AREA OF SUPPORT CYLINDER VS. SUPPORT CYLINDER LENGTH.**

** CALCULATED DATA

CALCULATIONS: 3.

THE FOLLOWING DERIVATION WAS USED TO CALCULATE THE ABOVE PARAMETERS:

BASIC CONDUCTION HEAT TRANSFER EQUATION:

$$Q = KA \frac{dT}{dx}$$

where Q = HEAT LOAD (watts)
K = THERMAL CONDUCTIVITY (watts / in - °K)
A = CROSS-SECTIONAL AREA $(in)^2$
$\frac{dT}{dx}$ = TEMPERATURE GRADIENT IN DIRECTION OF HEAT FLOW (°K / in.)

BASIC STRESS EQUATION:

$$\sigma = \frac{F}{A}$$

where σ = STRESS (lbs / in^2)
F = FORCE (lbs)
A = CROSS-SECTIONAL AREA $(in)^2$

SINCE THERMAL CONDUCTIVITY & YIELD STRESS ARE A FUNCTION OF TEMPERATURE, THE ABOVE EQUATIONS ARE AS FOLLOWS:

$$Q = K(T)\, A \frac{dT}{dx} \qquad \sigma(T) = \frac{F}{A}, \quad A = \frac{F}{\sigma(T)}$$

SUBSTITUTING FOR CROSS SECTIONAL AREA:

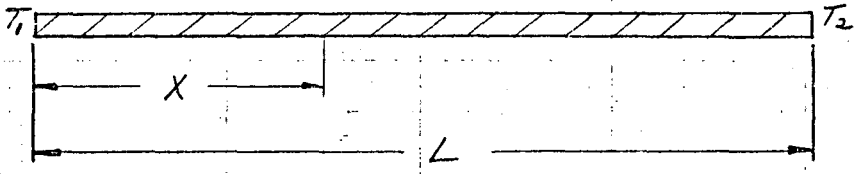
$$Q = F \frac{K(T)}{\sigma(T)} \frac{dT}{dx}$$

$$Q\,dx = F \frac{K(T)}{\sigma(T)}\, dT$$

INTEGRATING WITH RESPECT TO 'X' (LENGTH) & 'T' (TEMP.)

$$Q \int_0^X dx = F \int_{T_1}^{T_2} \frac{K(T)}{\sigma(T)}\, dT \quad \text{OR}$$

$$QL = F \int_{T_1}^{T_2} \frac{K(T)}{\sigma(T)}\, dT \quad \text{where } L = \text{TOTAL LENGTH OF SUPPORT CYLINDER (in.)}$$



TOTAL HEAT LOAD $Q = \frac{F}{L} \int_{T_1}^{T_2} \frac{K(T)}{\sigma(T) \cdot Z}\, dT$ OR

$$Q = \frac{F}{L \cdot Z} \int_{T_1}^{T_2} \frac{K(T)}{\sigma(T)}\, dT \quad \text{where } Z = \text{STRESS FACTOR}$$

$Z = 0.666666$ FOR 304 LN STAINLESS STEEL

$Z = 0.333333$ FOR TITANIUM 6AL-4V

TEMPERATURE DISTRIBUTION ALONG THE SUPPORT CYLINDER LENGTH :

$$\int_0^X dx = \frac{F}{Q} \int_{T_1}^{T_2} \frac{K(T)}{\sigma(T)\cdot Z}\, dT$$

$$X(T) = \frac{F}{Q} \int_{T_1}^{T_2} \frac{K(T)}{\sigma(T)\cdot Z}\, dT$$

SUBSTITUTING IN FOR Q :

$$X(T) = \frac{F \int_{4.2°K}^{T_2} \frac{K(T)}{\sigma(T)\cdot Z}\, dT}{\frac{F}{L\cdot Z} \int_{4.2°K}^{80°K} \frac{K(T)}{\sigma(T)}\, dT} \quad \text{OR}$$

$$\boxed{X(T) = \frac{L \int_{4.2°K}^{T_2} \frac{K(T)}{\sigma(T)}\, dT}{\int_{4.2°K}^{80°K} \frac{K(T)}{\sigma(T)}\, dT}}$$

FINALLY, THE CROSS-SECTIONAL AREA OF THE SUPPORT CYLINDER IS:

$$\boxed{A(T) = \frac{F}{\sigma(T)\cdot Z}}$$

AUTHOR R. YAMAMOTO | DEPARTMENT MECHANICAL ENGIN. | LOCATION BERKELEY | DATE APRIL 21, 1980

DATA:

TOTAL CYLINDER HEAT LOAD AS A FUNCTION OF TEMPERATURE RANGE: $T_1 = 4.2°K$ (see graph)

T_2 (°K)	304 LN STAINLESS STEEL	TITANIUM 6AL-4V
77	29.33 WATTS	13.73 WATTS
78	30.12	14.06
79	30.92	14.40
80	31.73	14.75
81	32.54	15.09
82	33.37	15.44
83	34.20	15.79
84	35.04	16.15
85	35.89	16.51
86	36.76	16.88
87	37.62	17.25
88	38.50	17.62
89	39.39	17.99
90	40.29 WATTS	18.37 WATTS

RESULTS & CONCLUSIONS:

MATERIAL	HEAT LOAD (watts)	TEMP. RANGE	STRESS FACTOR η
304 LN STAINLESS STEEL	31.73	4.2°K → 80°K	0.666666
TITANIUM 6AL-4V	14.75	4.2°K → 80°K	0.333333
304 LN STAINLESS STEEL	1369	82°K → 290°K	0.666666
TITANIUM 6AL-4V	547	82°K → 290°K	0.333333

304 LN STAINLESS STEEL WAS CHOSEN AS THE SUPPORT CYLINDER MATERIAL FOR THE FOLLOWING REASONS:

1. 304 LN STAINLESS STEEL HEAT LOAD JUDGED BARELY ACCEPTABLE.
2. 304 LN STAINLESS STEEL MATERIAL IS AVALIABLE FROM LIVERMORE LAB.
3. TITANIUM 6 AL-4V PLATE HAS A LEAD TIME WHICH IS UNACCEPTABLE TO THE SCHEDULE.
4. TITANIUM 6AL-4V HAS POTENTIAL WELDING PROBLEMS.
5. TITANIUM 6AL-4V HAS FRACTURE TOUGHNESS PROBLEMS AT CRYOGENIC TEMPERATURES.

THE SUPPORT CYLINDER IS APPROXIMATELY 92 IN. IN DIAMETER & 19 IN. IN LENGTH. WALL THICKNESS WILL BE TAPPERED FOLLOWING THE GRAPHS OF CROSS-SECTIONAL AREA OF SUPPORT CYLINDER VS. SUPPORT CYLINDER LENGTH. A LN COOLING TUBE WILL BE WELDED (OR BRAZED) ONTO THE SUPPORT CYLINDER AT A DISTANCE OF ABOUT 11 IN. FROM THE LIQUID HELIUM END OF THE CYLINDER TO REDUCE THE HEAT LOAD. (i.e. LIQUID HELIUM CONSUMPTION) HENCE, THE TEMPERATURE RANGES WILL BE FROM LHe (4.2°K) TO LN TEMP (80°K) & FROM LN TEMP (82°K; CONDUCTION LOSES) TO ROOM TEMP. (290°K)

REFERENCES

1. YIELD STRESS VS. TEMPERATURE DATA FOR 304 LN STAINLESS STEEL SUPPLIED BY DICK REIMERS. (FROM LLL)

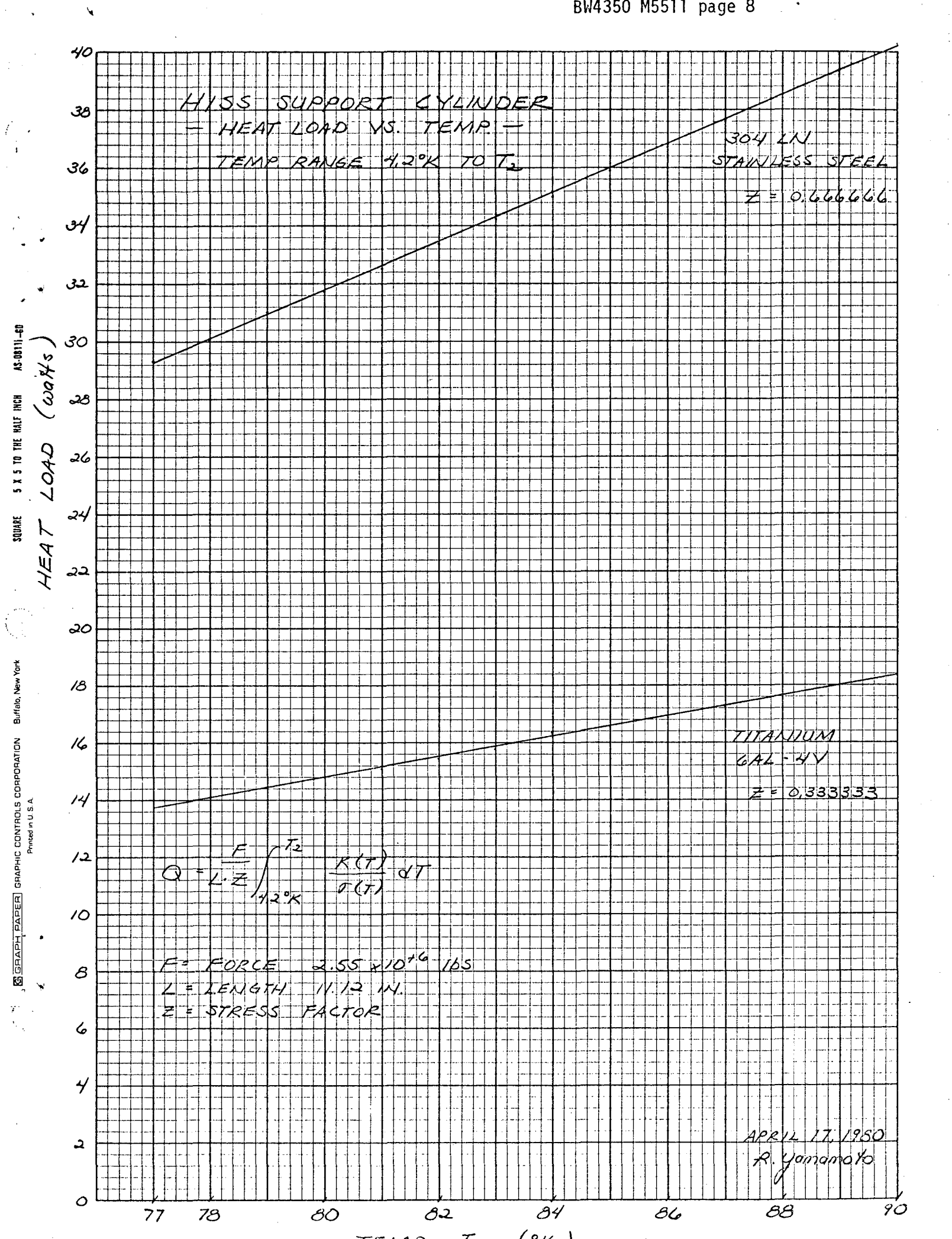
YIELD STRESS VS. TEMPERATURE DATA FOR TITANIUM 6AL-4V SUPPLIED BY YOICHI KAJIYAMA.

2. THERMAL CONDUCTIVITY VS. TEMPERATURE DATA FOR 304 STAINLESS STEEL SUPPLIED BY ROBERT YAMAMOTO

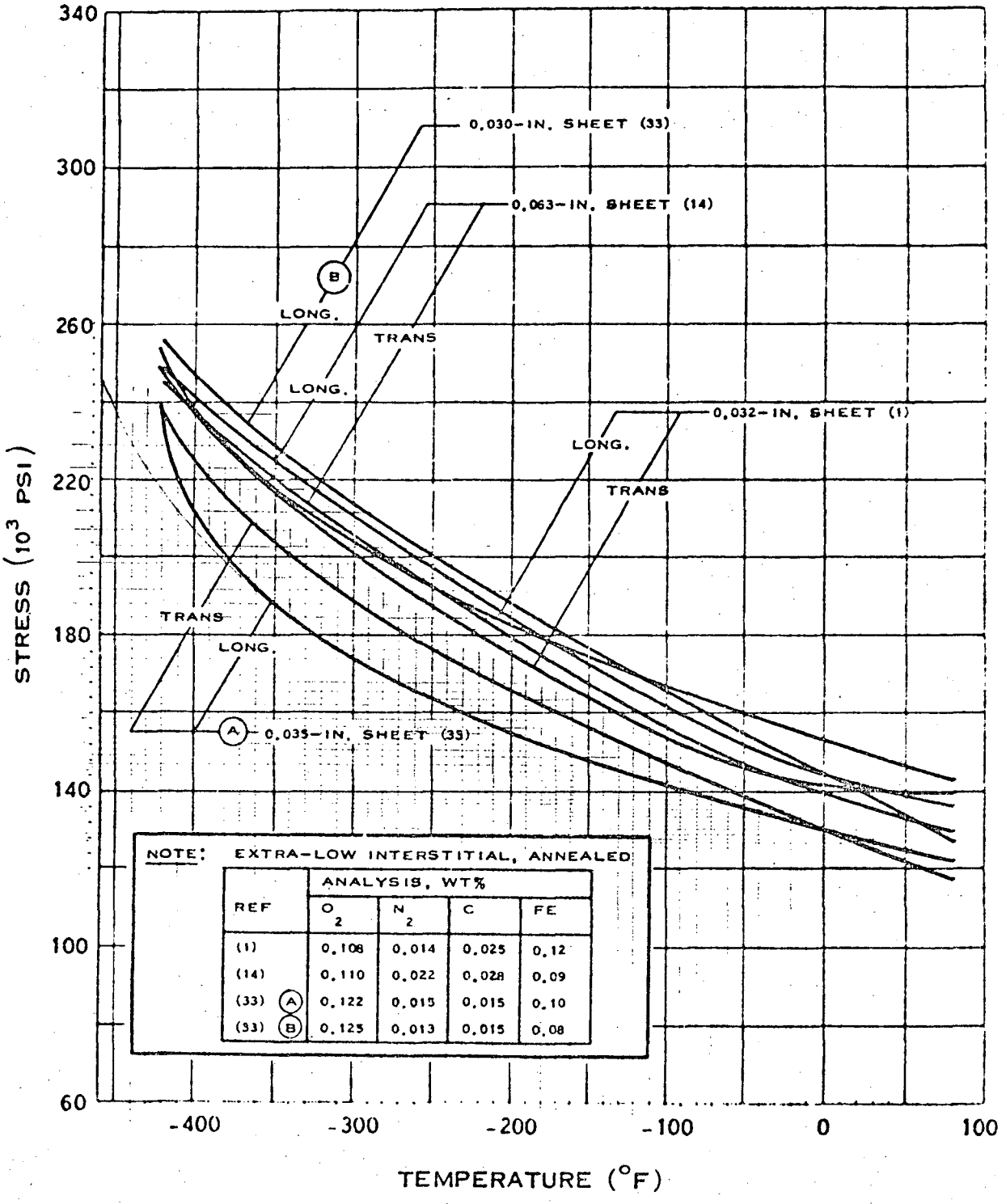
THERMAL CONDUCTIVITY VS. TEMPERATURE DATA FOR TITANIUM 6AL-4V SUPPLIED BY DICK WOLGAST.

3. DERIVATION OF FORMULAS FROM COMMUNICATIONS WITH JACK TANABE.

4. SEE LBL DRAWING # 19F7886



C.7.a



YIELD STRENGTH OF 6AI-4V TITANIUM

13.301

THERMAL CONDUCTIVITY INTEGRALS

for FERROUS ALLOYS

Source of Data: Data Sheet 3.301: Thermal Conductivity of Ferrous Alloys.

Comments: In the table of values below, all the thermal conductivity curves for Ferrous Alloys, with the exception of Stainless, have been extrapolated. Of the extrapolated curves, all have been extrapolated to 4°K, and all except SAE 1020 and SAE 4130 have been extrapolated to 300°K. It is estimated that the extrapolated values deviate no more than 10% from the probable values.

$$Q = \frac{A}{L} \int_{T_o}^{T_L} \lambda \, dT; \qquad Q \frac{L}{A} = \int_{T_o}^{T_L} \lambda \, dT$$

Where:

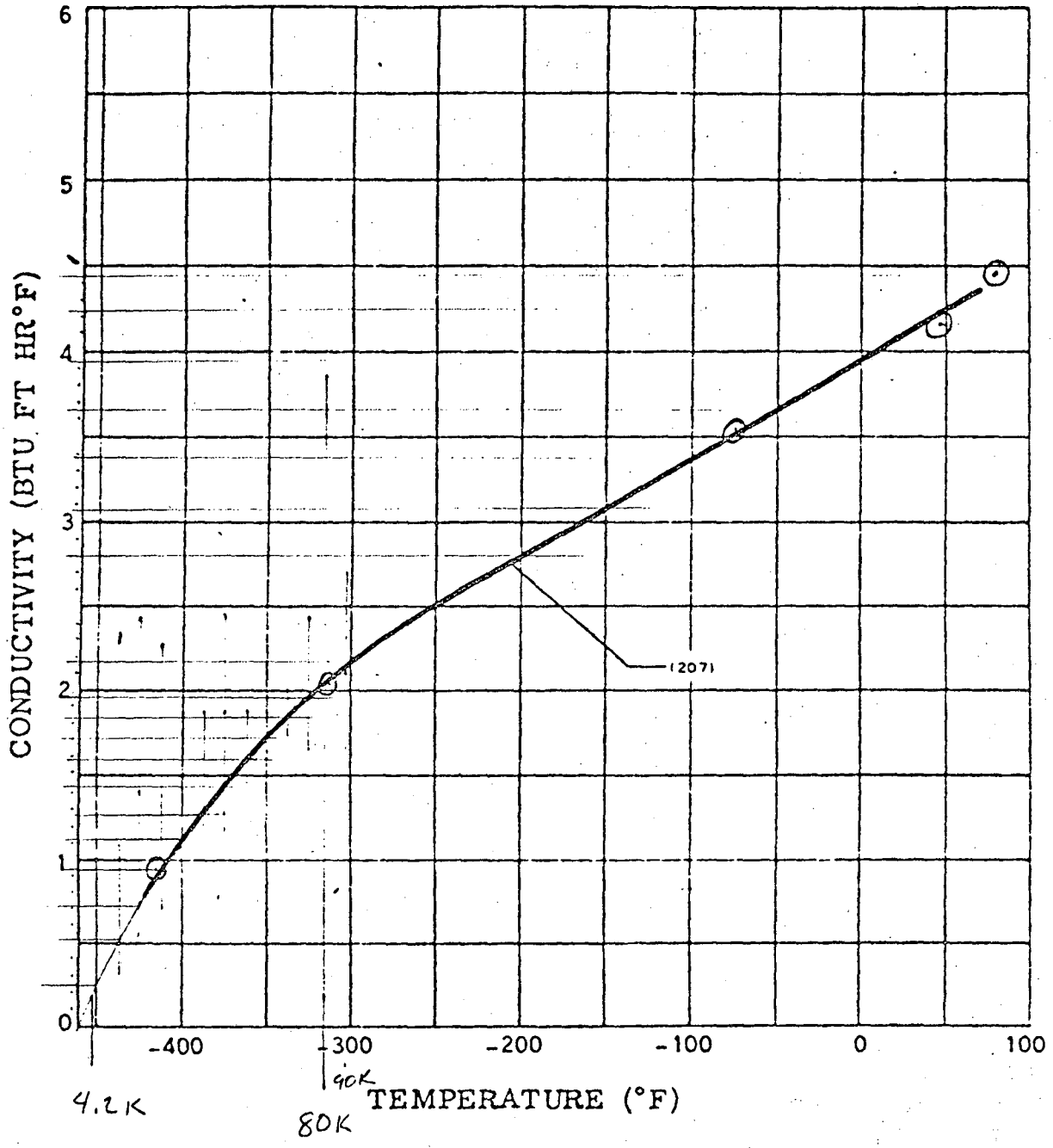
- Q = heat of flow in watts
- A = cross sectional area in cm^2
- L = length in cm
- λ = thermal conductivity in watts/cm-°K
- T = temperature in °K
- T_o = initial temperature (4°K)

Thermal Conductivity Integrals are on the following page.

Temp. °K	Thermal Conductivity watts/cm-°K								
	SAE 1020	MILD 0.1% C	SAE 1095	SAE 4130	410	4% Al	13% Cr Quenched	Stainless	24% Ni
4	.030*	.025*	.011*	.0075*	.0045*	.0045*	.0032*	.0024	.0018*
6	.058*	.050*	.019*	.013 *	.0070*	.0070*	.0055*	.0039	.0033*
8	.085*	.073*	.027*	.018 *	.010 *	.010 *	.0080*	.0057	.0050*
10	.115*	.100*	.035*	.023 *	.013 *	.013 *	.010 *	.0077	.0067*
15	.180*	.157	.060*	.040 *	.020 *	.020	.0165	.0132	.0115
20	.24 *	.22	.080*	.060 *	.035 *	.033	.024	.0195	.0165
25	.28	.27	.108	.078	.050	.045	.032	.026	.021
30	.32	.31	.130	.100	.070	.054	.040	.033	.025
35	.37	.34	.157	.120	.090	.060	.048	.040	.029
40	.40	.37	.180	.137	.108	.066	.056	.047	.032
50	.48	.42	.22	.170	.135	.080	.070	.058	.039
60	.53	.48	.26	.195	.157	.092	.082	.068	.045
70	.57	.51	.29	.22	.177	.103	.095	.076	.051
76	.59	.53	.30	.23	.183	.115	.100	.080	.054
80	.60	.54	.31	.24	.19	.120	.105	.083	.057
90	.61	.57	.33	.27	.20	.135	.113	.090	.062
100	.63	.59*	.34	.27	.21	.150	.120	.095	.068
120	.65	.60*	.37	.30	.23	.160*	.140*	.103	.077*
140	.65	.60*	.38	.32	.24	.180*	.150*	.110	.085*
160	.65	.60*	.40	.33	.25	.190*	.160*	.120	.090*
180	.65	.60*	.41	.34	.255	.20 *	.165*	.123	.100*
200	.65	.60*	.43	.35	.26	.21 *	.17 *	.13	.107*
250	.65	.60*	.45	.35	.27	.22 *	.18 *	.14	.120*
300	.65	.60*	.45*	.35	.28*	.23 *	.19 *	.15	.130*

* Extrapolated Values

C.7.v



THERMAL CONDUCTIVITY OF 6AI-4V TITANIUM

POINTS FROM ACE 8

16-6A)

INPUT PARAMETERS AND RESULTS:
APRIL 21, 07:12 and 55 sec.

THIS OUTPUT IS FOR 304 LN STAINLESS STEEL

THE TEMPERATURE RANGE IS BETWEEN 4.2 deg K AND 80 deg K

THE FORCE EXERTED ON THE SUPPORT IS 2550000 LBS

THE LENGTH OF THE SUPPORT IS 11.12 INCHES

THE YIELD STRESS FACTOR IS .666666

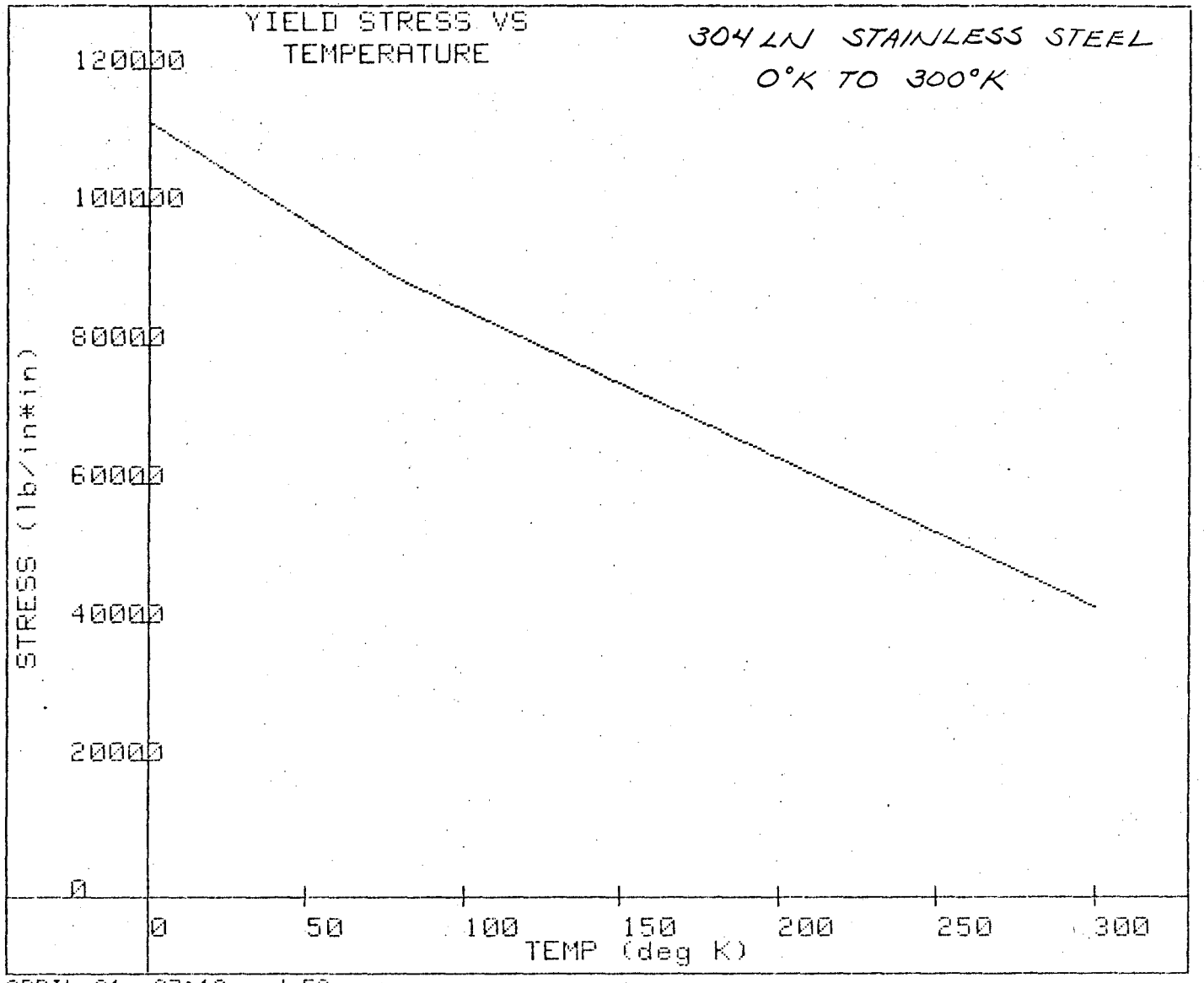
THE NUMBER OF YIELD STRESS INPUT POINTS IS 3

THE NUMBER OF THERMAL CONDUCTIVITY INPUT POINTS IS 18

THE TEMPERATURE INCREMENT IS .765656565657

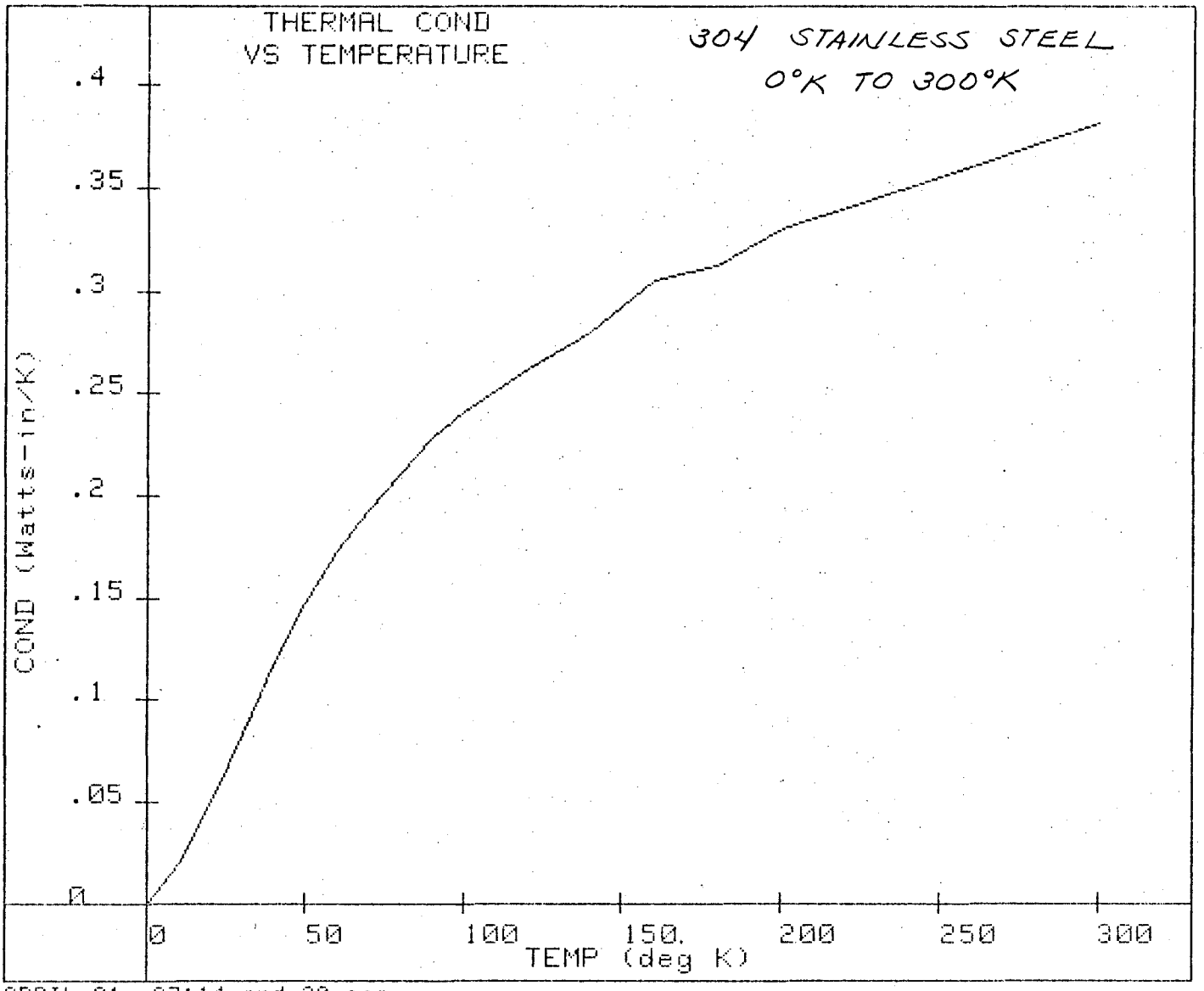
THE FINAL INTEGRAL FROM 4.2 TO 80 deg K IS 9.22347949517E-05

THE HEAT LOAD ON THE SUPPORT IS 31.726478731 watts



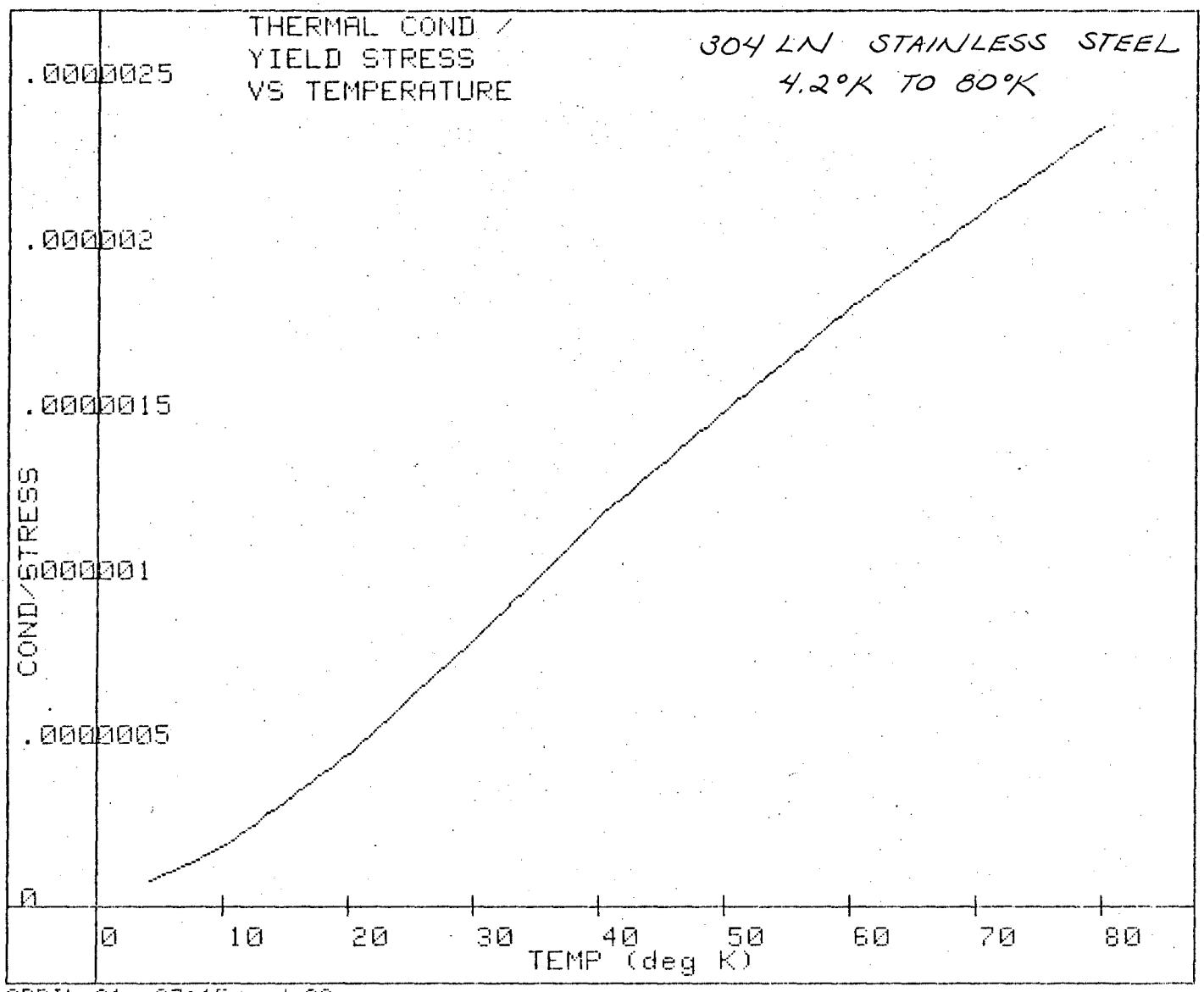
APRIL 21, 07:13 and 50 sec.
INPUT DATA:

TEMPERATURE deg K	YIELD STRESS lb/in*in
0.00	112000.000
77.00	90000.000
300.00	42000.000



APRIL 21, 07:14 and 30 sec.
INPUT DATA:

TEMPERATURE deg K	THERMAL COND watts-in/deg K
0.00	0.00000000
10.00	.01960000
20.00	.04950000
30.00	.08380000
40.00	.11940000
50.00	.14730000
60.00	.17270000
70.00	.19300000
80.00	.21080000
90.00	.22860000
100.00	.24130000
120.00	.26160000
140.00	.27940000
160.00	.30480000
180.00	.31240000
200.00	.33020000
250.00	.35560000
300.00	.38100000



APRIL 21, 07:15 and 28 sec.
CALCULATED DATA:

TEMPERATURE deg K	THERMAL COND / YIELD STRESS watts-in/lb deg K
4.2000000000	.0000000743
4.9656565657	.0000000880
5.7313131313	.0000001018
6.4969696970	.0000001156
7.2626262626	.0000001295
8.0282828283	.0000001434
8.7939393939	.0000001574
9.5595959596	.0000001715
10.3252525253	.0000001887
11.0909090909	.0000002101
11.8565656566	.0000002316
12.6222222222	.0000002532
13.3878787879	.0000002748
14.1535353535	.0000002966
14.9191919192	.0000003184
15.6848484849	.0000003404
16.4505050505	.0000003624
17.2161616162	.0000003845
17.9818181818	.0000004067
18.7474747475	.0000004290
19.5131313131	.0000004514

20.2787878788	.0000004751
21.0444444445	.0000005008
21.8101010101	.0000005267
22.5757575758	.0000005527
23.3414141414	.0000005788
24.1070707071	.0000006049
24.8727272727	.0000006312
25.6383838384	.0000006577
26.4040404041	.0000006842
27.1696969697	.0000007108
27.9353535354	.0000007375
28.7010101010	.0000007644
29.4666666667	.0000007914
30.2323232323	.0000008187
30.9979797980	.0000008469
31.7636363637	.0000008752
32.5292929293	.0000009036
33.2949494950	.0000009321
34.0606060606	.0000009608
34.8262626263	.0000009895
35.5919191919	.0000010184
36.3575757576	.0000010474
37.1232323233	.0000010766
37.8888888889	.0000011059
38.6545454546	.0000011353
39.4202020202	.0000011648
40.1858585859	.0000011930
40.9515151515	.0000012169
41.7171717172	.0000012409
42.4828282829	.0000012650
43.2484848485	.0000012892
44.0141414142	.0000013136
44.7797979798	.0000013380
45.5454545455	.0000013625
46.3111111111	.0000013872
47.0767676768	.0000014119
47.8424242424	.0000014368
48.6080808081	.0000014618
49.3737373738	.0000014869
50.1393939394	.0000015117
50.9050505051	.0000015350
51.6707070707	.0000015585
52.4363636364	.0000015821
53.2020202020	.0000016057
53.9676767677	.0000016295
54.7333333334	.0000016534
55.4989898990	.0000016774
56.2646464647	.0000017015
57.0303030303	.0000017257
57.7959595960	.0000017500
58.5616161616	.0000017744
59.3272727273	.0000017990
60.0929292930	.0000018231
60.8585858586	.0000018438
61.6242424243	.0000018645
62.3898989899	.0000018853
63.1555555556	.0000019063
63.9212121212	.0000019273
64.6868686869	.0000019484
65.4525252526	.0000019697
66.2181818182	.0000019910
66.9838383839	.0000020124
67.7494949495	.0000020340
68.5151515152	.0000020556
69.2808080808	.0000020773

70.0464646465	.0000020990
70.8121212122	.0000021189
71.5777777778	.0000021388
72.3434343435	.0000021589
73.1090909091	.0000021790
73.8747474748	.0000021993
74.6404040404	.0000022196
75.4060606061	.0000022400
76.1717171718	.0000022606
76.9373737374	.0000022812
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79.2343434344	.0000023396
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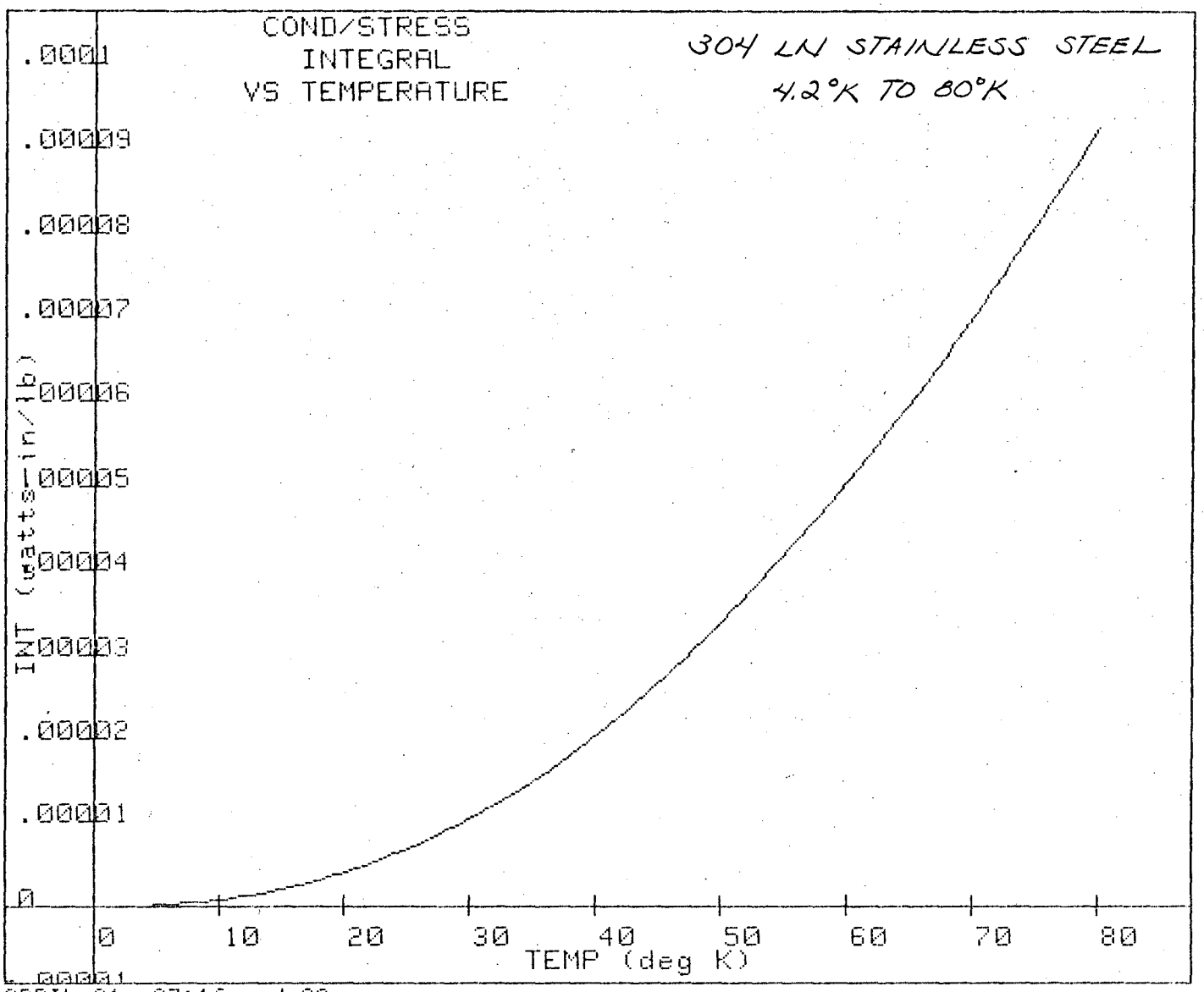
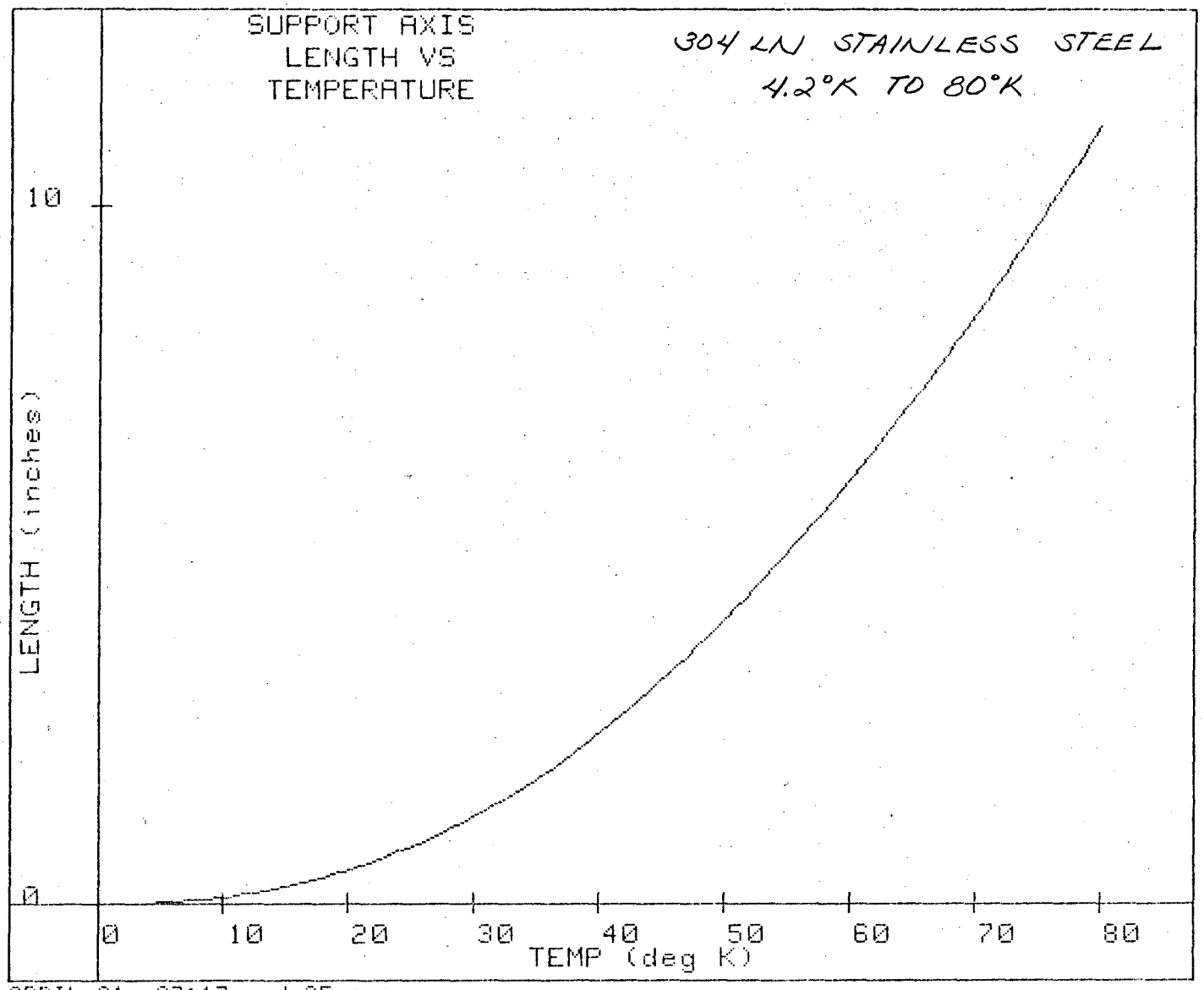


APRIL 21, 07:16 and 38 sec.
CALCULATED DATA:

TEMPERATURE deg K	INTEGRAL watts-in/lb
4.2000000000	0.0000000000
4.9656565657	.0000000621
5.7313131313	.0000001348
6.4969696970	.0000002180
7.2626262626	.0000003119
8.0282828283	.0000004163
8.7939393939	.0000005315
9.5595959596	.0000006574
10.3252525253	.0000007953
11.0909090909	.0000009479
11.8565656566	.0000011170
12.6222222222	.0000013026
13.3878787879	.0000015047
14.1535353535	.0000017235
14.9191919192	.0000019589
15.6848484849	.0000022111
16.4505050505	.0000024802
17.2161616162	.0000027661
17.9818181818	.0000030691
18.7474747475	.0000033890

19.5131313131	.0000037261
20.2787878788	.0000040808
21.0444444445	.0000044544
21.8101010101	.0000048478
22.5757575758	.0000052610
23.3414141414	.0000056941
24.1070707071	.0000061473
24.8727272727	.0000066205
25.6383838384	.0000071140
26.4040404041	.0000076277
27.1696969697	.0000081617
27.9353535354	.0000087162
28.7010101010	.0000092911
29.4666666667	.0000098867
30.2323232323	.0000105031
30.9979797980	.0000111408
31.7636363637	.0000118001
32.5292929293	.0000124810
33.2949494950	.0000131838
34.0606060606	.0000139084
34.8262626263	.0000146551
35.5919191919	.0000154238
36.3575757576	.0000162146
37.1232323233	.0000170278
37.8888888889	.0000178633
38.6545454546	.0000187212
39.4202020202	.0000196018
40.1858585859	.0000205044
40.9515151515	.0000214270
41.7171717172	.0000223679
42.4828282829	.0000233272
43.2484848485	.0000243051
44.0141414142	.0000253015
44.7797979798	.0000263166
45.5454545455	.0000273504
46.3111111111	.0000284030
47.0767676768	.0000294746
47.8424242424	.0000305652
48.6080808081	.0000316748
49.3737373738	.0000328036
50.1393939394	.0000339516
50.9050505051	.0000351179
51.6707070707	.0000363022
52.4363636364	.0000375045
53.2020202020	.0000387249
53.9676767677	.0000399634
54.7333333334	.0000412202
55.4989898990	.0000424953
56.2646464647	.0000437888
57.0303030303	.0000451008
57.7959595960	.0000464314
58.5616161616	.0000477807
59.3272727273	.0000491487
60.0929292930	.0000505353
60.8585858586	.0000519391
61.6242424243	.0000533588
62.3898989899	.0000547943
63.1555555556	.0000562459
63.9212121212	.0000577135
64.6868686869	.0000591972
65.4525252526	.0000606972
66.2181818182	.0000622134
66.9838383839	.0000637461
67.7494949495	.0000652951
68.5151515152	.0000668607

69.2808080808	.0000684429
70.0464646465	.0000700417
70.8121212122	.0000716565
71.5777777778	.0000732864
72.3434343435	.0000749317
73.1090909091	.0000765924
73.8747474748	.0000782685
74.6404040404	.0000799602
75.4060606061	.0000816674
76.1717171718	.0000833904
76.9373737374	.0000851291
77.7030303031	.0000868832
78.4686868687	.0000886521
79.2343434344	.0000904360
80.0000000000	.0000922348

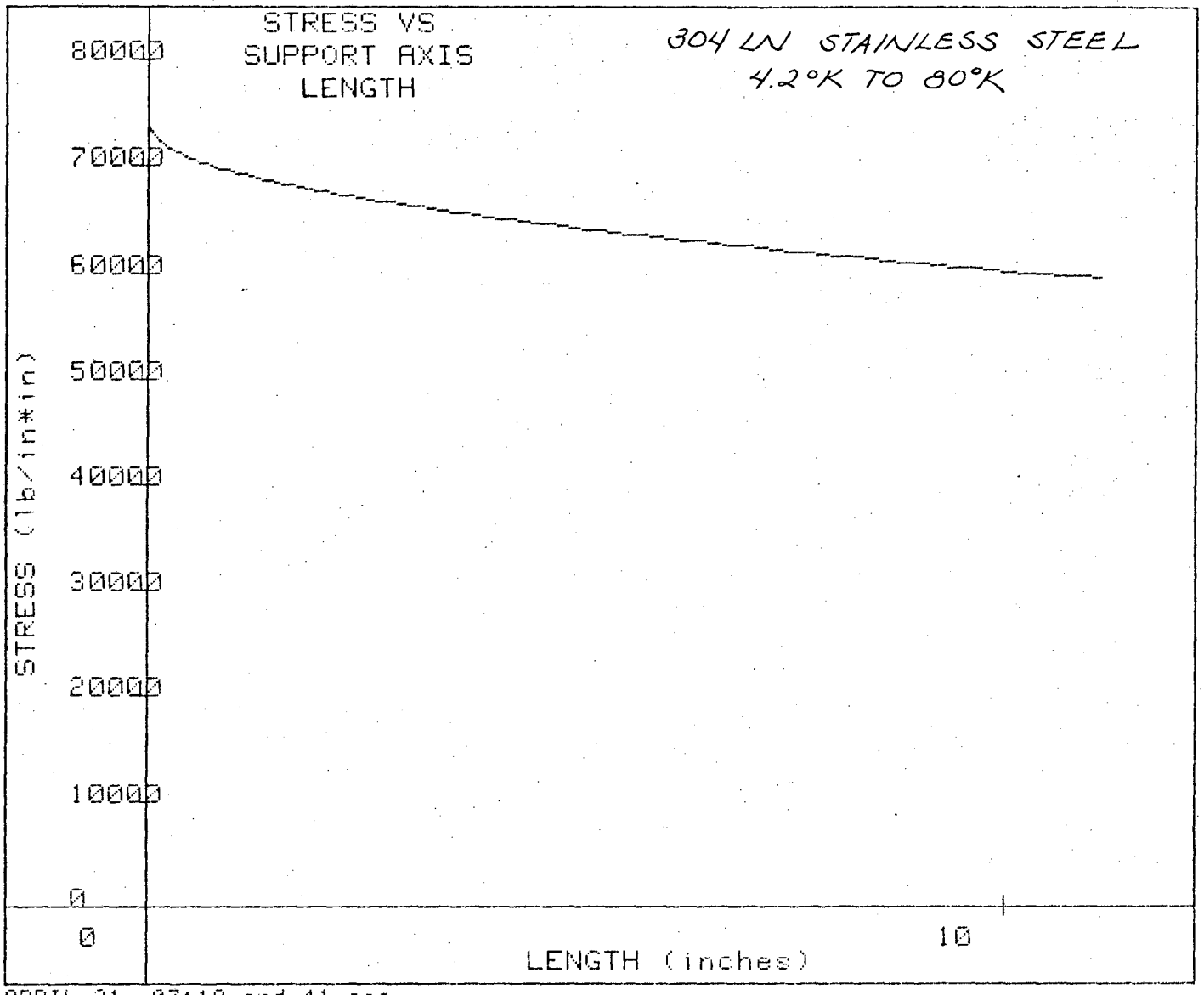


APRIL 21, 07:17 and 35 sec.
CALCULATED DATA:

TEMPERATURE deg K	SUPPORT AXIS LENGTH inches
4.2000000000	0.000000
4.9656565657	.007491
5.7313131313	.016251
6.4969696970	.026285
7.2626262626	.037598
8.0282828283	.050195
8.7939393939	.064081
9.5595959596	.079261
10.3252525253	.095883
11.0909090909	.114285
11.8565656566	.134669
12.6222222222	.157041
13.3878787879	.181410
14.1535353535	.207784
14.9191919192	.236170
15.6848484849	.266578
16.4505050505	.299016
17.2161616162	.333491
17.9818181818	.370012
18.7474747475	.408587

19.5131313131	.449226
20.2787878788	.491989
21.0444444445	.537031
21.8101010101	.584457
22.5757575758	.634275
23.3414141414	.686496
24.1070707071	.741129
24.8727272727	.798185
25.6383838384	.857673
26.4040404041	.919605
27.1696969697	.983989
27.9353535354	1.050837
28.7010101010	1.120158
29.4666666667	1.191964
30.2323232323	1.266278
30.9979797980	1.343155
31.7636363637	1.422637
32.5292929293	1.504736
33.2949494950	1.589462
34.0606060606	1.676827
34.8262626263	1.766842
35.5919191919	1.859519
36.3575757576	1.954868
37.1232323233	2.052901
37.8888888889	2.153631
38.6545454546	2.257068
39.4202020202	2.363224
40.1858585859	2.472046
40.9515151515	2.583274
41.7171717172	2.696713
42.4828282829	2.812373
43.2484848485	2.930263
44.0141414142	3.050393
44.7797979798	3.172773
45.5454545455	3.297414
46.3111111111	3.424324
47.0767676768	3.553515
47.8424242424	3.684995
48.6080808081	3.818777
49.3737373738	3.954868
50.1393939394	4.093265
50.9050505051	4.233886
51.6707070707	4.376666
52.4363636364	4.521617
53.2020202020	4.668748
53.9676767677	4.818068
54.7333333334	4.969587
55.4989898990	5.123316
56.2646464647	5.279265
57.0303030303	5.437443
57.7959595960	5.597861
58.5616161616	5.760529
59.3272727273	5.925457
60.0929292930	6.092634
60.8585858586	6.261878
61.6242424243	6.433032
62.3898989899	6.606105
63.1555555556	6.781106
63.9212121212	6.958044
64.6868686869	7.136927
65.4525252526	7.317765
66.2181818182	7.500568
66.9838383839	7.685344
67.7494949495	7.872102
68.5151515152	8.060853

69.2808080808	8.251605
70.0464646465	8.444362
70.8121212122	8.639037
71.5777777778	8.835550
72.3434343435	9.033909
73.1090909091	9.234122
73.8747474748	9.436199
74.6404040404	9.640149
75.4060606061	9.845981
76.1717171718	10.053704
76.9373737374	10.263326
77.7030303031	10.474800
78.4686868687	10.688068
79.2343434344	10.903132
80.0000000000	11.120000

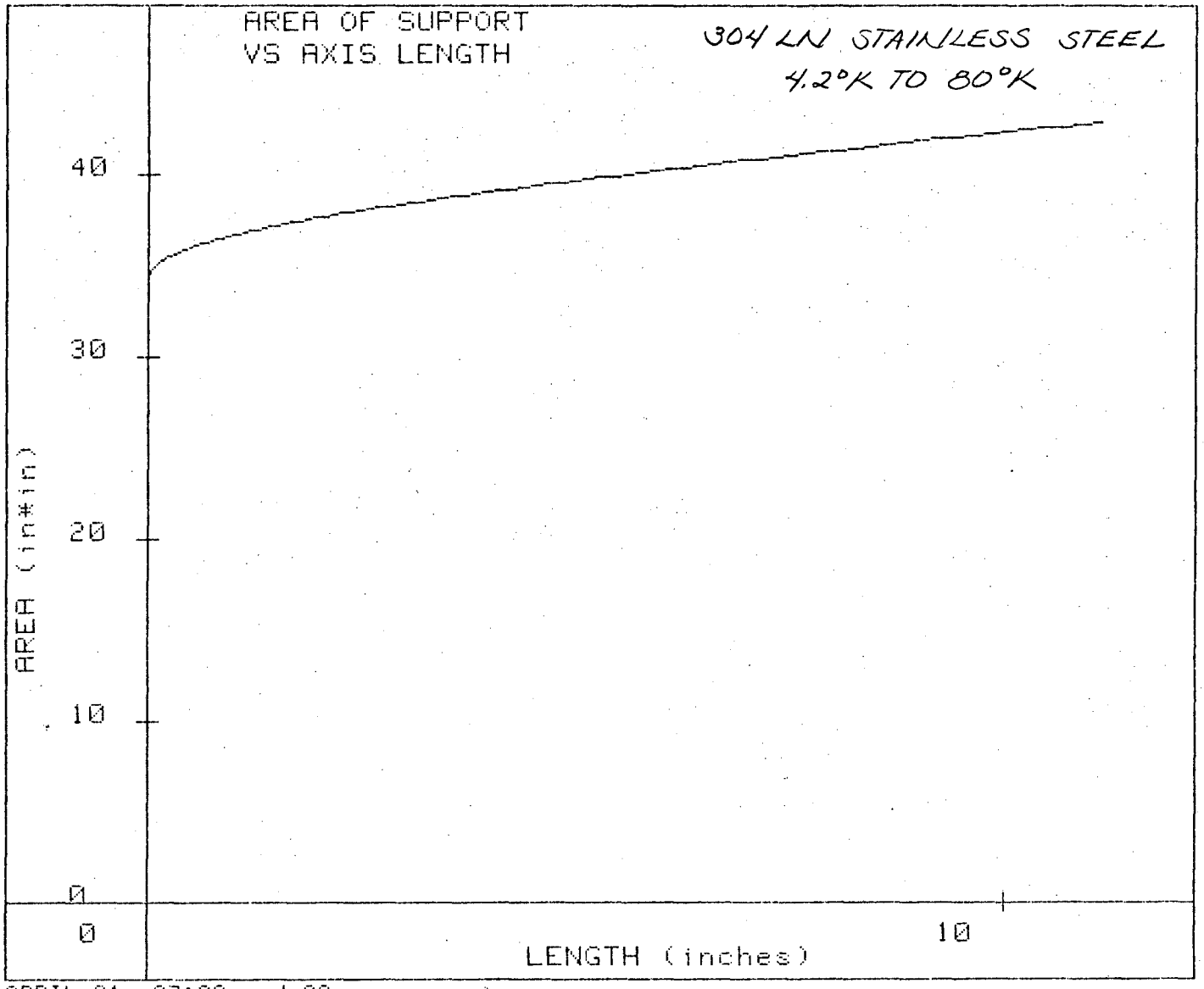


APRIL 21, 07:18 and 41 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	STRESS lb/in*in
0.000000	73866.5928
.007491	73720.7536
.016251	73574.9144
.026285	73429.0752
.037598	73283.2360
.050195	73137.3968
.064081	72991.5576
.079261	72845.7184
.095883	72699.8792
.114285	72554.0400
.134669	72408.2008
.157041	72262.3616
.181410	72116.5224
.207784	71970.6832
.236170	71824.8440
.266578	71679.0048
.299016	71533.1656
.333491	71387.3264
.370012	71241.4872
.408587	71095.6480

.449226	70949.8088
.491989	70803.9696
.537031	70658.1304
.584457	70512.2912
.634275	70366.4520
.686496	70220.6128
.741129	70074.7736
.798185	69928.9344
.857673	69783.0952
.919605	69637.2560
.983989	69491.4168
1.050837	69345.5776
1.120158	69199.7384
1.191964	69053.8992
1.266278	68908.0600
1.343155	68762.2208
1.422637	68616.3816
1.504736	68470.5424
1.589462	68324.7032
1.676827	68178.8640
1.766842	68033.0248
1.859519	67887.1856
1.954868	67741.3464
2.052901	67595.5072
2.153631	67449.6680
2.257068	67303.8288
2.363224	67157.9896
2.472046	67012.1504
2.583274	66866.3112
2.696713	66720.4720
2.812373	66574.6328
2.930263	66428.7936
3.050393	66282.9544
3.172773	66137.1152
3.297414	65991.2760
3.424324	65845.4368
3.553515	65699.5976
3.684995	65553.7584
3.818777	65407.9192
3.954868	65262.0800
4.093265	65116.2408
4.233886	64970.4016
4.376666	64824.5624
4.521617	64678.7232
4.668748	64532.8840
4.818068	64387.0448
4.969587	64241.2056
5.123316	64095.3664
5.279265	63949.5272
5.437443	63803.6880
5.597861	63657.8488
5.760529	63512.0096
5.925457	63366.1704
6.092634	63220.3312
6.261878	63074.4920
6.433032	62928.6528
6.606105	62782.8136
6.781106	62636.9744
6.958044	62491.1352
7.136927	62345.2960
7.317765	62199.4568
7.500568	62053.6176
7.685344	61907.7784
7.872102	61761.9392
8.060853	61616.1000

8.251605	61470.2608
8.444362	61324.4216
8.639037	61178.5824
8.835550	61032.7432
9.033909	60886.9040
9.234122	60741.0648
9.436199	60595.2256
9.640149	60449.3864
9.845981	60303.5472
10.053704	60157.7080
10.263326	60011.8688
10.474800	59899.0568
10.689068	59789.1869
10.903132	59679.3170
11.120000	59569.4472



APRIL 21, 07:22 and 23 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	AREA OF SUPPORT in*in
0.00000	34.521695
.00749	34.589988
.01625	34.658552
.02629	34.727388
.03760	34.796498
.05020	34.865884
.06408	34.935547
.07926	35.005489
.09588	35.075712
.11429	35.146217
.13467	35.217005
.15704	35.288080
.18141	35.359442
.20778	35.431093
.23617	35.503036
.26658	35.575271
.29902	35.647800
.33349	35.720626
.37001	35.793750
.40859	35.867174

.44923	35.940900
.49199	36.014930
.53703	36.089265
.58446	36.163908
.63428	36.238860
.68650	36.314123
.74113	36.389700
.79818	36.465592
.85767	36.541801
.91960	36.618330
.98399	36.695179
1.05084	36.772352
1.12016	36.849850
1.19196	36.927676
1.26628	37.005831
1.34315	37.084317
1.42264	37.163137
1.50474	37.242293
1.58946	37.321787
1.67683	37.401621
1.76684	37.481797
1.85952	37.562317
1.95487	37.643184
2.05290	37.724401
2.15363	37.805968
2.25707	37.887889
2.36322	37.970166
2.47205	38.052801
2.58327	38.135796
2.69671	38.219154
2.81237	38.302877
2.93026	38.386968
3.05039	38.471429
3.17277	38.556263
3.29741	38.641471
3.42432	38.727057
3.55351	38.813023
3.68500	38.899371
3.81878	38.986105
3.95487	39.073226
4.09326	39.160737
4.23389	39.248641
4.37667	39.336941
4.52162	39.425639
4.66875	39.514738
4.81807	39.604240
4.96959	39.694149
5.12332	39.784467
5.27926	39.875197
5.43744	39.966342
5.59786	40.057904
5.76053	40.149887
5.92546	40.242293
6.09263	40.335126
6.26188	40.428387
6.43303	40.522082
6.60611	40.616211
6.78111	40.710779
6.95804	40.805788
7.13693	40.901241
7.31777	40.997143
7.50057	41.093495
7.68534	41.190301
7.87210	41.287564
8.06085	41.385287

8.25160	41.483475
8.44436	41.582129
8.63904	41.681253
8.83555	41.780852
9.03391	41.880927
9.23412	41.981483
9.43620	42.082523
9.64015	42.184051
9.84598	42.286070
10.05370	42.388583
10.26333	42.491595
10.47480	42.571622
10.68807	42.649852
10.90313	42.728371
11.12000	42.807179

INPUT PARAMETERS AND RESULTS:
APRIL 21, 07:24 and 41 sec.

THIS OUTPUT IS FOR 304 LN STAINLESS STEEL

THE TEMPERATURE RANGE IS BETWEEN 82 deg K AND 290 deg K

THE FORCE EXERTED ON THE SUPPORT IS 2550000 LBS

THE LENGTH OF THE SUPPORT IS 2.908 INCHES

THE YIELD STRESS FACTOR IS .666666

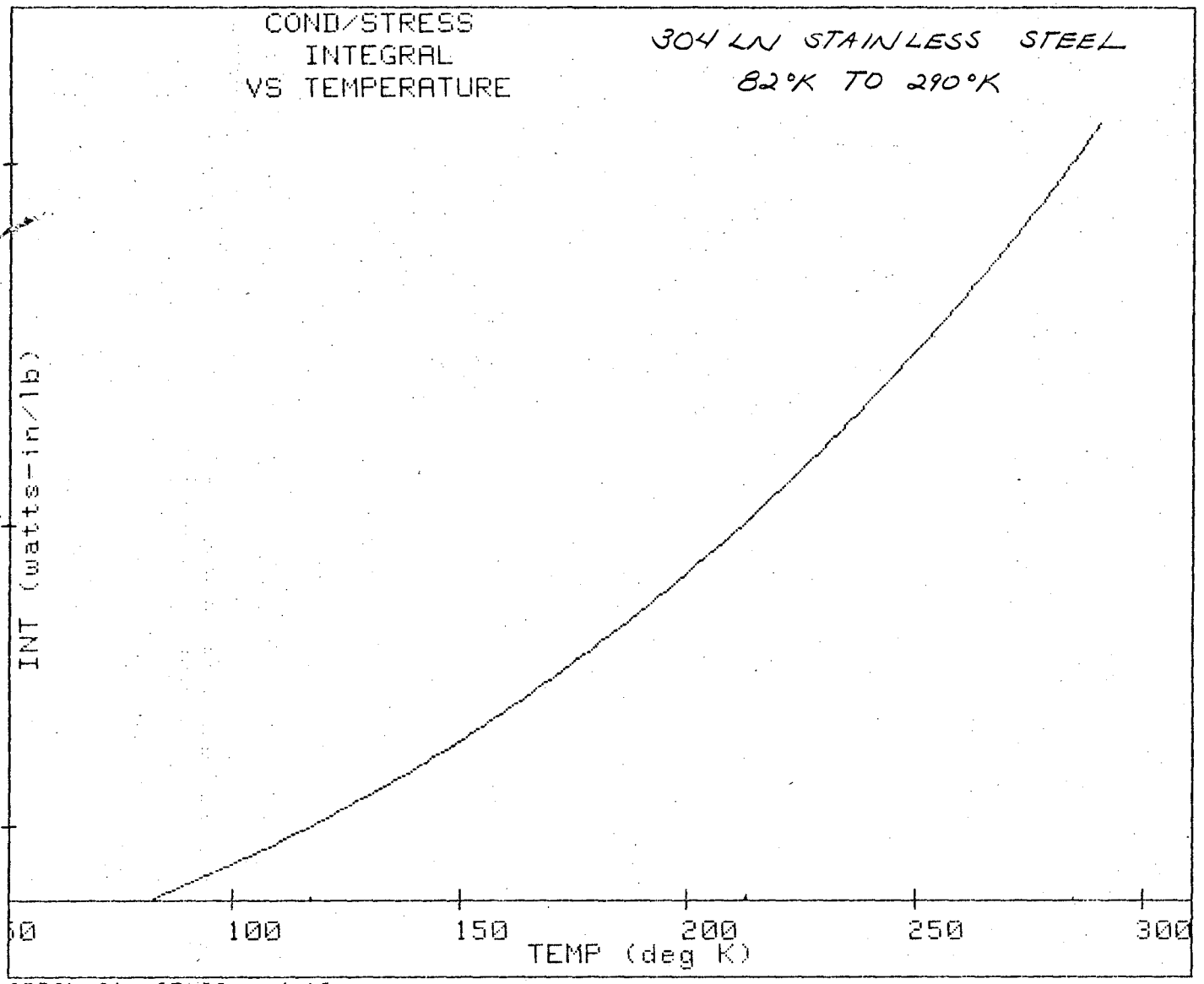
THE NUMBER OF YIELD STRESS INPUT POINTS IS 3

THE NUMBER OF THERMAL CONDUCTIVITY INPUT POINTS IS 18

THE TEMPERATURE INCREMENT IS 2.10101010101

THE FINAL INTEGRAL FROM 82 TO 290 deg K IS 1.04086149458E-03

THE HEAT LOAD ON THE SUPPORT IS 1369.08500621 watts

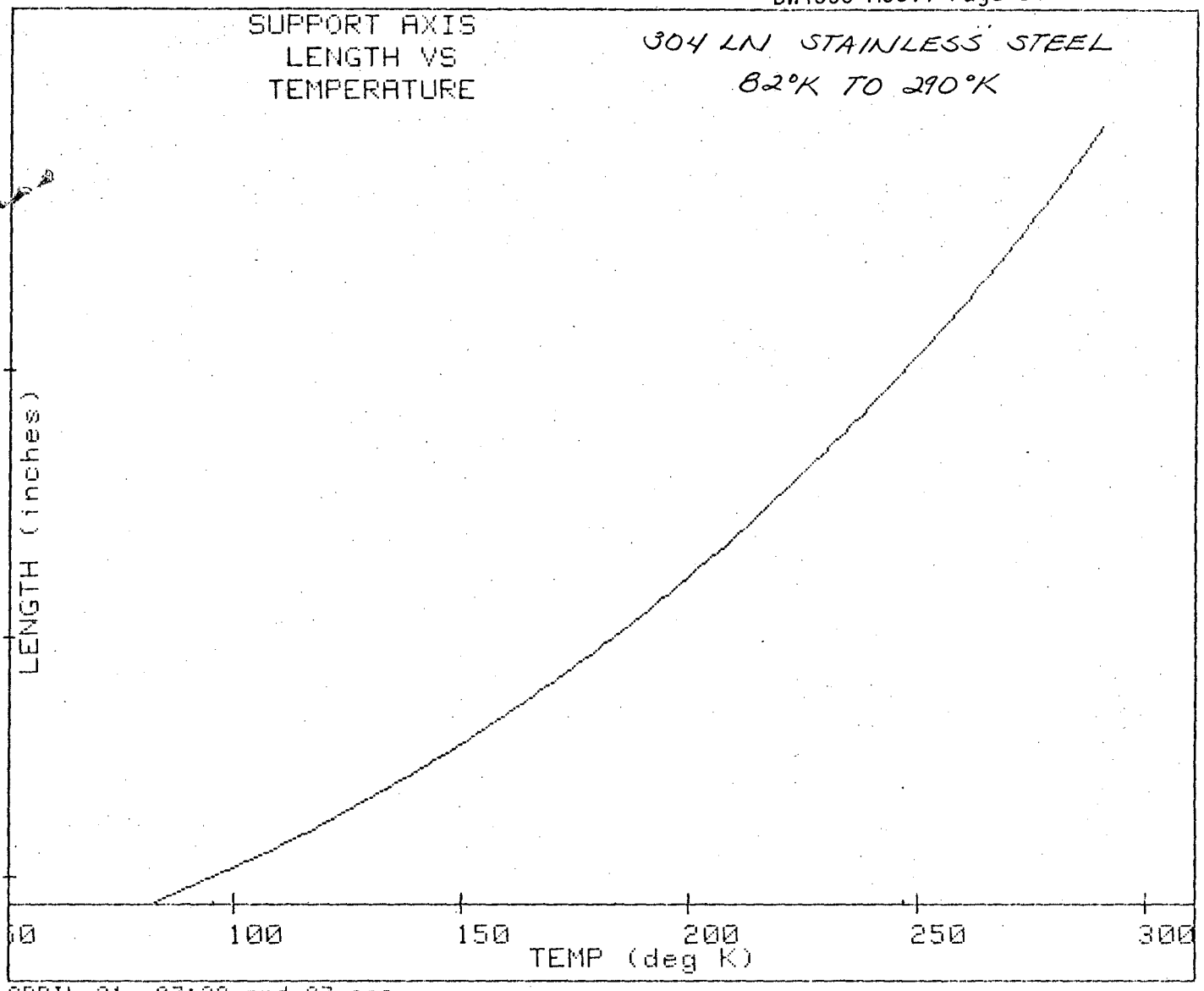


APRIL 21, 07:28 and 10 sec.
CALCULATED DATA:

TEMPERATURE deg K	INTEGRAL watts-in/lb
82.0000000000	0.0000000000
84.1010101010	.0000051221
86.2020202020	.0000103594
88.3030303030	.0000157132
90.4040404040	.0000211822
92.5050505051	.0000267547
94.6060606061	.0000324212
96.7070707071	.0000381826
98.8080808081	.0000440401
100.9090909090	.0000499917
103.0101010100	.0000560319
105.1111111110	.0000621577
107.2121212120	.0000683701
109.3131313130	.0000746701
111.4141414140	.0000810586
113.5151515150	.0000875365
115.6161616160	.0000941049
117.7171717170	.0001007648
119.8181818180	.0001075172
121.9191919190	.0001143599

124.0202020200	.0001212906
126.1212121210	.0001283100
128.2222222220	.0001354191
130.3232323230	.0001426189
132.4242424240	.0001499105
134.5252525250	.0001572949
136.6262626260	.0001647732
138.7272727270	.0001723466
140.8282828280	.0001800204
142.9292929290	.0001878069
145.0303030300	.0001957142
147.1313131310	.0002037437
149.2323232320	.0002118969
151.3333333330	.0002201753
153.4343434340	.0002285804
155.5353535350	.0002371139
157.6363636360	.0002457772
159.7373737370	.0002545721
161.8383838380	.0002634762
163.9393939390	.0002724634
166.0404040400	.0002815315
168.1414141410	.0002906814
170.2424242420	.0002999142
172.3434343430	.0003092310
174.4444444440	.0003186328
176.5454545460	.0003281208
178.6464646470	.0003376961
180.7474747480	.0003473659
182.8484848480	.0003571480
184.9494949490	.0003670548
187.0505050510	.0003770880
189.1515151520	.0003872493
191.2525252530	.0003975405
193.3535353540	.0004079633
195.4545454550	.0004185197
197.5555555560	.0004292114
199.6565656570	.0004400405
201.7575757580	.0004509977
203.8585858590	.0004620715
205.9595959600	.0004732613
208.0606060610	.0004845689
210.1616161620	.0004959960
212.2626262630	.0005075443
214.3636363640	.0005192157
216.4646464650	.0005310120
218.5656565660	.0005429352
220.6666666670	.0005549871
222.7676767680	.0005671697
224.8686868690	.0005794850
226.9696969700	.0005919352
229.0707070710	.0006045223
231.1717171720	.0006172485
233.2727272730	.0006301160
235.3737373740	.0006431272
237.4747474750	.0006562843
239.5757575760	.0006695897
241.6767676770	.0006830460
243.7777777780	.0006966555
245.8787878790	.0007104209
247.9797979800	.0007243447
250.0808080810	.0007384298
252.1818181820	.0007526789
254.2828282830	.0007670949
256.3838383840	.0007816805
258.4848484850	.0007964390

260.5858585860	.0008113733
262.6868686870	.0008264866
264.7878787880	.0008417822
266.8888888890	.0008572633
268.9898989900	.0008729335
271.0909090910	.0008887963
273.1919191920	.0009048553
275.2929292930	.0009211142
277.3939393940	.0009375768
279.4949494950	.0009542472
281.5959595960	.0009711293
283.6969696970	.0009882275
285.7979797980	.0010055459
287.8989898990	.0010230890
290.0000000000	.0010408615

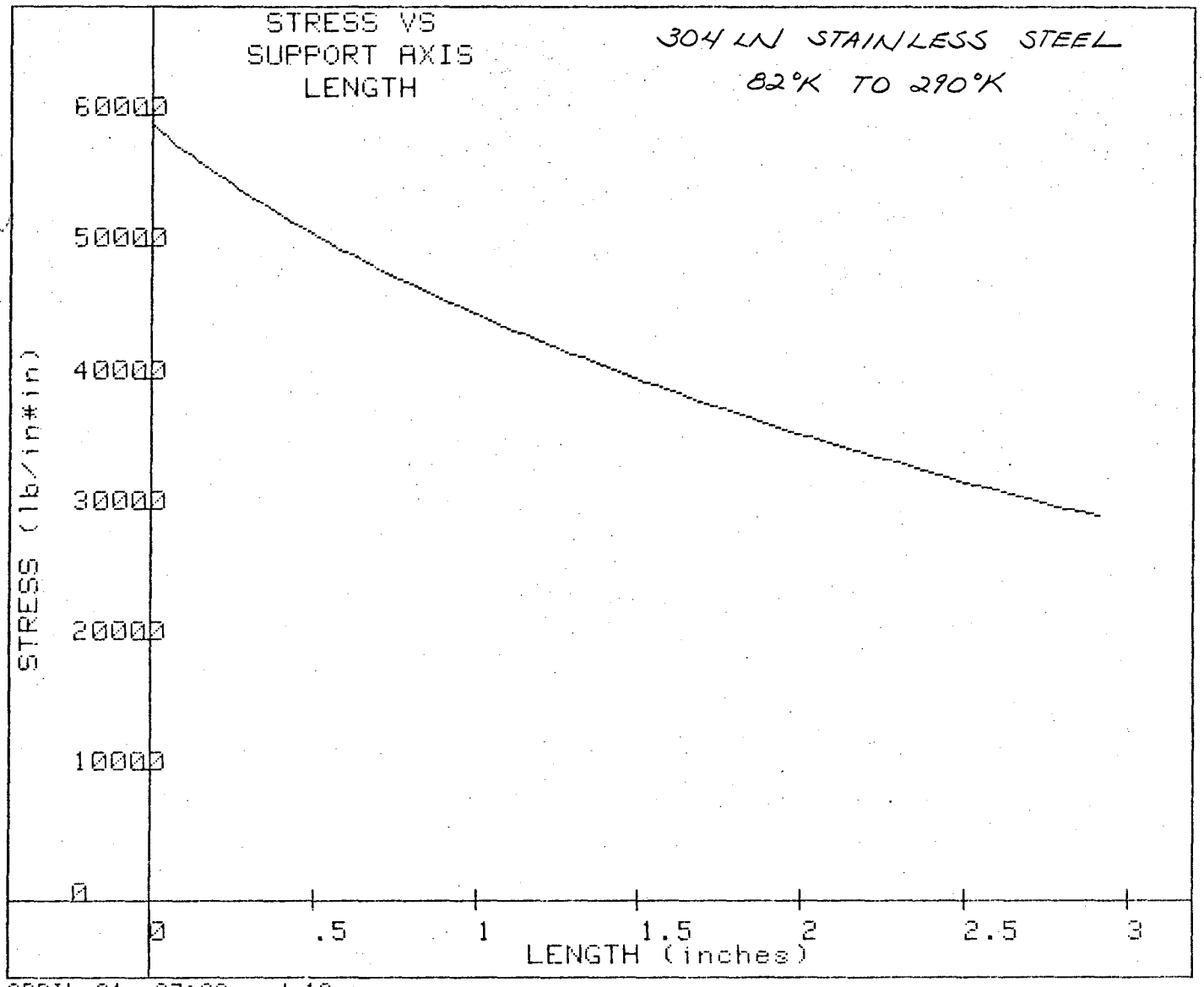


APRIL 21, 07:29 and 07 sec.
CALCULATED DATA:

TEMPERATURE deg K	SUPPORT AXIS LENGTH inches
82.0000000000	0.000000
84.1010101010	.014310
86.2020202020	.028942
88.3030303030	.043900
90.4040404040	.059180
92.5050505051	.074748
94.6060606061	.090579
96.7070707071	.106676
98.8080808081	.123041
100.9090909090	.139669
103.0101010100	.156544
105.1111111110	.173659
107.2121212120	.191015
109.3131313130	.208616
111.4141414140	.226465
113.5151515150	.244563
115.6161616160	.262914
117.7171717170	.281521
119.8181818180	.300386
121.9191919190	.319503

124.0202020200	.338867
126.1212121210	.359478
128.2222222220	.378339
130.3232323230	.398454
132.4242424240	.418826
134.5252525250	.439457
136.6262626260	.460350
138.7272727270	.481509
140.8282828280	.502948
142.9292929290	.524702
145.0303030300	.546794
147.1313131310	.569227
149.2323232320	.592006
151.3333333330	.615134
153.4343434340	.638617
155.5353535350	.662458
157.6363636360	.686662
159.7373737370	.711234
161.8383838380	.736110
163.9393939390	.761219
166.0404040400	.786554
168.1414141410	.812117
170.2424242420	.837912
172.3434343430	.863942
174.4444444440	.890209
176.5454545460	.916717
178.6464646470	.943469
180.7474747480	.970485
182.8484848480	.997814
184.9494949490	1.025492
187.0505050510	1.053523
189.1515151520	1.081912
191.2525252530	1.110664
193.3535353540	1.139784
195.4545454550	1.169277
197.5555555560	1.199148
199.6565656570	1.229403
201.7575757580	1.260015
203.8585858590	1.290954
205.9595959600	1.322216
208.0606060610	1.353808
210.1616161620	1.385733
212.2626262630	1.417997
214.3636363640	1.450605
216.4646464650	1.483562
218.5656565660	1.516874
220.6666666670	1.550545
222.7676767680	1.584581
224.8686868690	1.618988
226.9696969700	1.653772
229.0707070710	1.688938
231.1717171720	1.724493
233.2727272730	1.760443
235.3737373740	1.796794
237.4747474750	1.833553
239.5757575760	1.870726
241.6767676770	1.908321
243.7777777780	1.946344
245.8787878790	1.984802
247.9797979800	2.023703
250.0808080810	2.063054
252.1818181820	2.102864
254.2828282830	2.143140
256.3838383840	2.183890
258.4848484850	2.225123

260.5858585860	2.266847
262.6868686870	2.309071
264.7878787880	2.351804
266.8888888890	2.395056
268.9898989900	2.438836
271.0909090910	2.483154
273.1919191920	2.528020
275.2929292930	2.573445
277.3939393940	2.619439
279.4949494950	2.666014
281.5959595960	2.713180
283.6969696970	2.760949
285.7979797980	2.809334
287.8989898990	2.858347
290.0000000000	2.908000

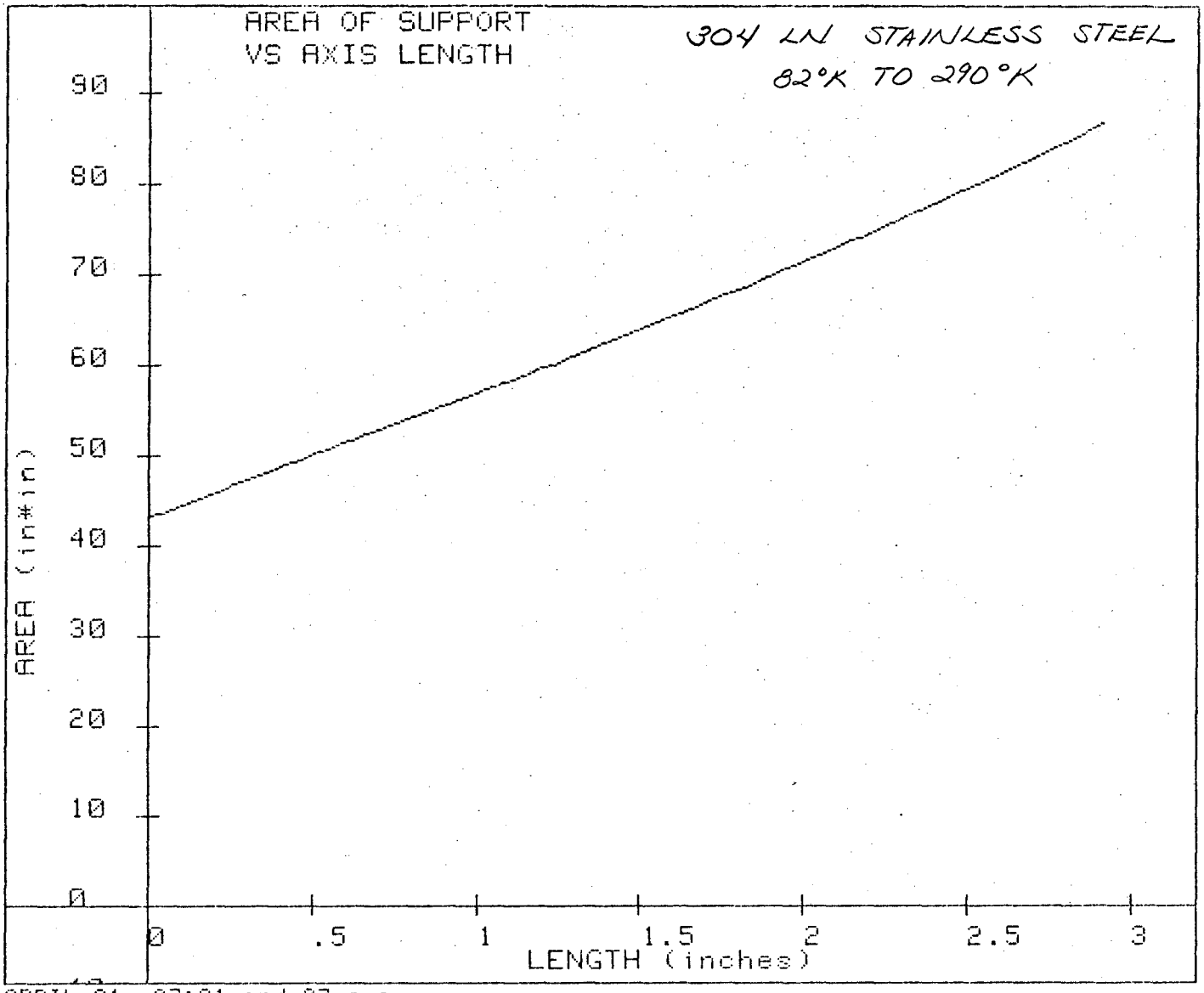


APRIL 21, 07:30 and 12 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	STRESS lb/in*in
0.000000	59282.4519
.014310	58980.9620
.028942	58679.4721
.043900	58377.9821
.059180	58076.4922
.074748	57775.0022
.090579	57473.5123
.106676	57172.0224
.123041	56870.5324
.139669	56569.0425
.156544	56267.5526
.173659	55966.0626
.191015	55664.5727
.208616	55363.0827
.226465	55061.5928
.244563	54760.1029
.262914	54458.6129
.281521	54157.1230
.300386	53855.6331
.319503	53554.1431

.338867	53252.6532
.358478	52951.1632
.378339	52649.6733
.398454	52348.1834
.418826	52046.6934
.439457	51745.2035
.460350	51443.7136
.481509	51142.2236
.502948	50840.7337
.524702	50539.2437
.546794	50237.7538
.569227	49936.2639
.592006	49634.7739
.615134	49333.2840
.638617	49031.7941
.662458	48730.3041
.686662	48428.8142
.711234	48127.3243
.736110	47825.8343
.761219	47524.3444
.786554	47222.8544
.812117	46921.3645
.837912	46619.8746
.863942	46318.3846
.890209	46016.8947
.916717	45715.4048
.943469	45413.9148
.970485	45112.4249
.997814	44810.9349
1.025492	44509.4450
1.053523	44207.9551
1.081912	43906.4651
1.110664	43604.9752
1.139784	43303.4853
1.169277	43001.9953
1.199148	42700.5054
1.229403	42399.0154
1.260015	42097.5255
1.290954	41796.0356
1.322216	41494.5456
1.353808	41193.0557
1.385733	40891.5658
1.417997	40590.0758
1.450605	40288.5859
1.483562	39987.0959
1.516874	39685.6060
1.550545	39384.1161
1.584581	39082.6261
1.618988	38781.1362
1.653772	38479.6463
1.688938	38178.1563
1.724493	37876.6664
1.760443	37575.1764
1.796794	37273.6865
1.833553	36972.1966
1.870726	36670.7066
1.908321	36369.2167
1.946344	36067.7268
1.984802	35766.2368
2.023703	35464.7469
2.063054	35163.2570
2.102864	34861.7670
2.143140	34560.2771
2.183890	34258.7871
2.225123	33957.2972

2.266847	33655.8073
2.309071	33354.3173
2.351804	33052.8274
2.395056	32751.3375
2.438836	32449.8475
2.483154	32148.3576
2.528020	31846.8676
2.573445	31545.3777
2.619439	31243.8878
2.666014	30942.3978
2.713180	30640.9079
2.760949	30339.4180
2.809334	30037.9280
2.858347	29736.4381
2.908000	29434.9481



APRIL 21, 07:31 and 07 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	AREA OF SUPPORT in*in
0.00000	43.014415
.01431	43.234290
.02894	43.456424
.04390	43.680852
.05918	43.907611
.07475	44.136736
.09058	44.368265
.10668	44.602235
.12304	44.838687
.13967	45.077659
.15654	45.319192
.17366	45.563327
.19102	45.810106
.20862	46.059574
.22646	46.311773
.24456	46.566750
.26291	46.824549
.28152	47.085219
.30039	47.348807
.31950	47.615364

.33887	47.884938
.35848	48.157582
.37834	48.433349
.39845	48.712292
.41883	48.994467
.43946	49.279930
.46035	49.568739
.48151	49.860953
.50295	50.156633
.52470	50.455840
.54679	50.758639
.56923	51.065094
.59201	51.375272
.61513	51.689241
.63862	52.007071
.66246	52.328834
.68666	52.654603
.71123	52.984454
.73611	53.318463
.76122	53.656711
.78655	53.999277
.81212	54.346246
.83791	54.697702
.86394	55.053733
.89021	55.414430
.91672	55.779885
.94347	56.150191
.97048	56.525447
.99781	56.905753
1.02549	57.291211
1.05352	57.681926
1.08191	58.078007
1.11066	58.479565
1.13978	58.886715
1.16928	59.299574
1.19915	59.718263
1.22940	60.142906
1.26002	60.573632
1.29095	61.010571
1.32222	61.453860
1.35381	61.903638
1.38573	62.360048
1.41800	62.823238
1.45061	63.293361
1.48356	63.770572
1.51687	64.255035
1.55054	64.746915
1.58458	65.246383
1.61899	65.753618
1.65377	66.268800
1.68894	66.792120
1.72449	67.323771
1.76044	67.863953
1.79679	68.412873
1.83355	68.970747
1.87073	69.537793
1.90832	70.114240
1.94634	70.700325
1.98480	71.296290
2.02370	71.902388
2.06305	72.518880
2.10286	73.146034
2.14314	73.784131
2.18389	74.433458
2.22512	75.094316

2.26685	75.767013
2.30907	76.451872
2.35180	77.149224
2.39506	77.859416
2.43884	78.582804
2.48315	79.319760
2.52802	80.070669
2.57345	80.835932
2.61944	81.615963
2.66601	82.411196
2.71318	83.222077
2.76095	84.049074
2.80933	84.892673
2.85835	85.753377
2.90800	86.631714

INPUT PARAMETERS AND RESULTS:
APRIL 21, 07:35 and 15 sec.

THIS OUTPUT IS FOR TITANIUM 6AL-4V

THE TEMPERATURE RANGE IS BETWEEN 4.2 deg K AND 80 deg K

THE FORCE EXERTED ON THE SUPPORT IS 2550000 LBS

THE LENGTH OF THE SUPPORT IS 11.12 INCHES

THE YIELD STRESS FACTOR IS .333333

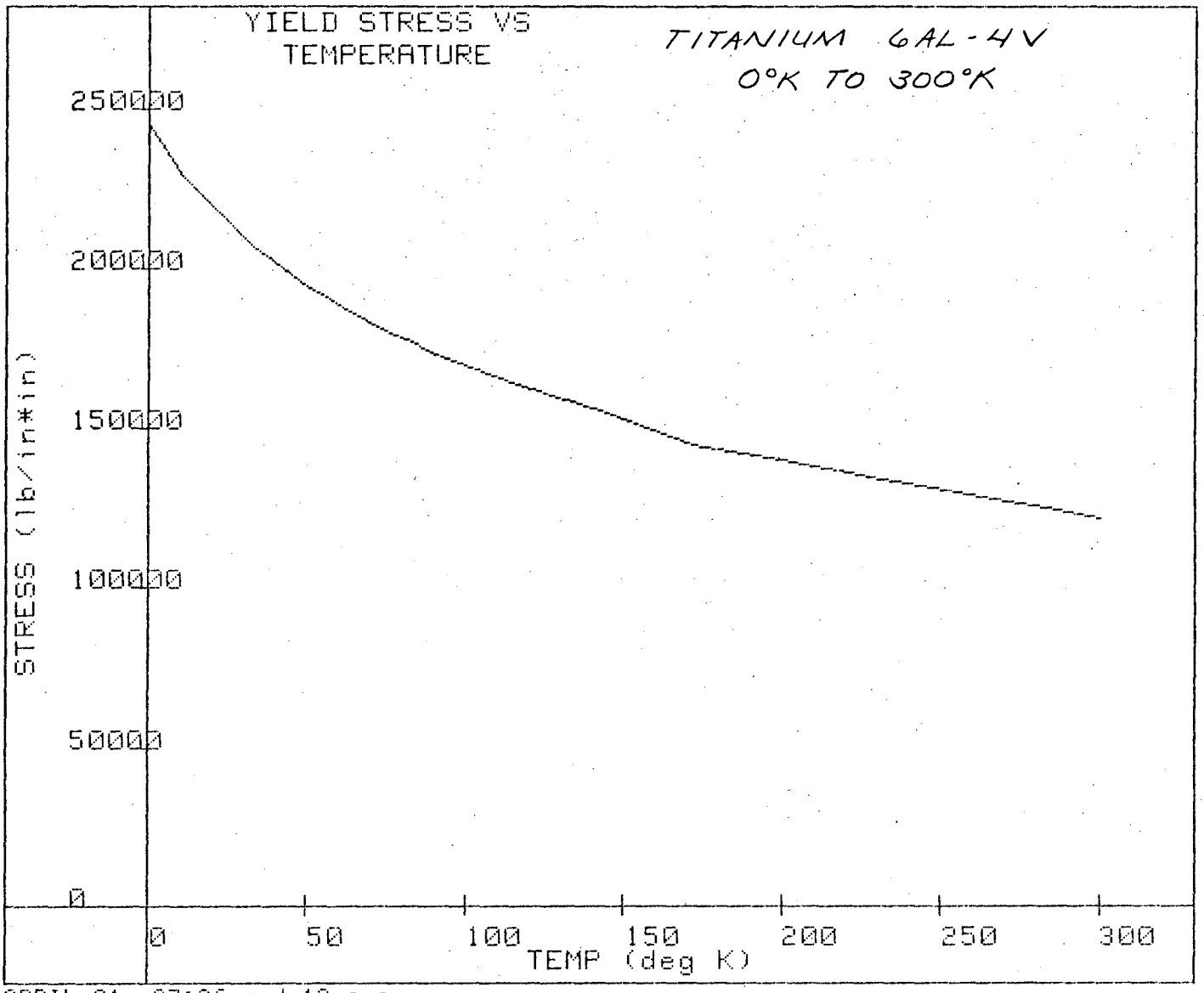
THE NUMBER OF YIELD STRESS INPUT POINTS IS 25

THE NUMBER OF THERMAL CONDUCTIVITY INPUT POINTS IS 21

THE TEMPERATURE INCREMENT IS .765656565657

THE FINAL INTEGRAL FROM 4.2 TO 80 deg K IS 2.14332426733E-05

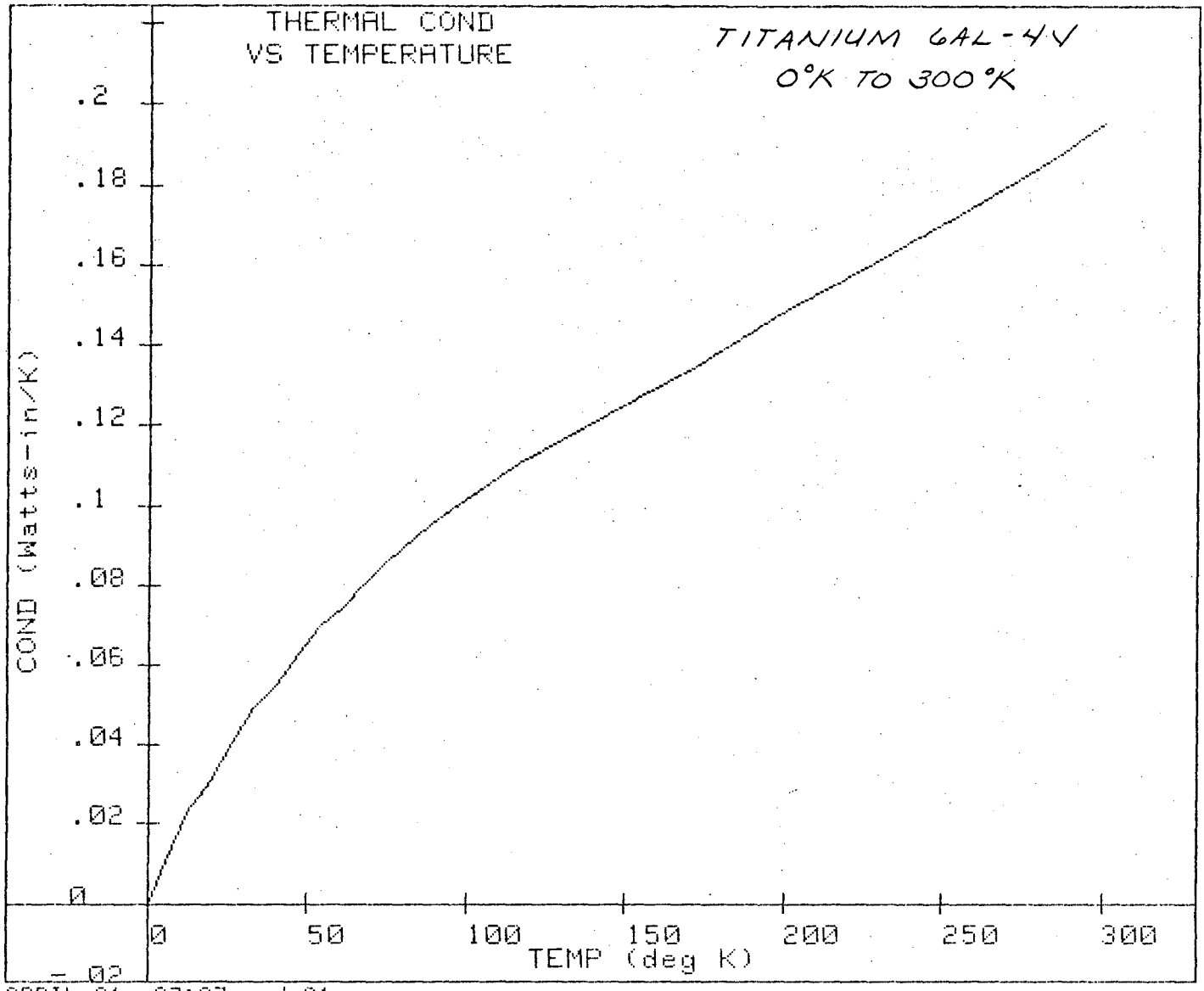
THE HEAT LOAD ON THE SUPPORT IS 14.7450063323 watts



APRIL 21, 07:36 and 12 sec.
INPUT DATA:

TEMPERATURE deg K	YIELD STRESS lb/in*in
0.00	245000.000
5.38	237000.000
10.94	229000.000
16.49	223000.000
22.05	218000.000
27.60	212000.000
33.16	207000.000
38.72	203000.000
44.27	199000.000
49.83	195000.000
55.38	192000.000
60.94	188000.000
66.49	185000.000
72.05	182000.000
77.60	179000.000
83.16	177000.000
88.72	174000.000
116.49	164000.000
144.27	155000.000
172.05	145000.000

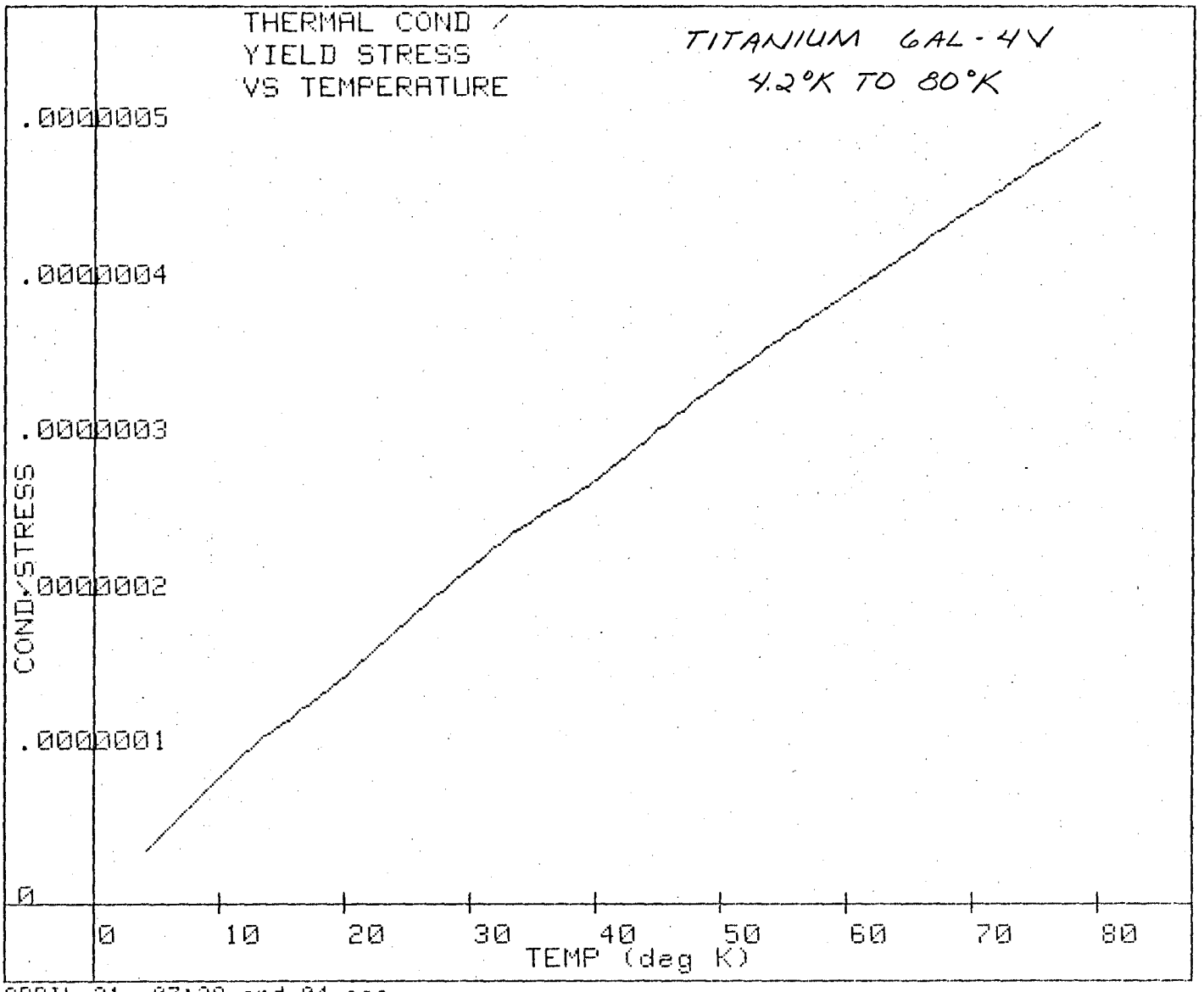
199.83	140000.000
227.60	135000.000
255.38	130000.000
283.16	125000.000
300.00	122000.000



APRIL 21, 07:37 and 01 sec.
INPUT DATA:

TEMPERATURE deg K	THERMAL COND watts-in/deg K
0.00	0.00000000
5.38	.01050000
12.33	.02290000
19.27	.03120000
26.22	.04090000
33.16	.04920000
40.10	.05540000
47.05	.06280000
53.99	.06940000
60.94	.07470000
67.88	.08040000
74.83	.08570000
88.72	.09540000
116.49	.11030000
144.27	.12310000
172.05	.13490000
199.83	.14850000
227.60	.16040000
255.38	.17270000
283.16	.18630000

300.00 .19510000

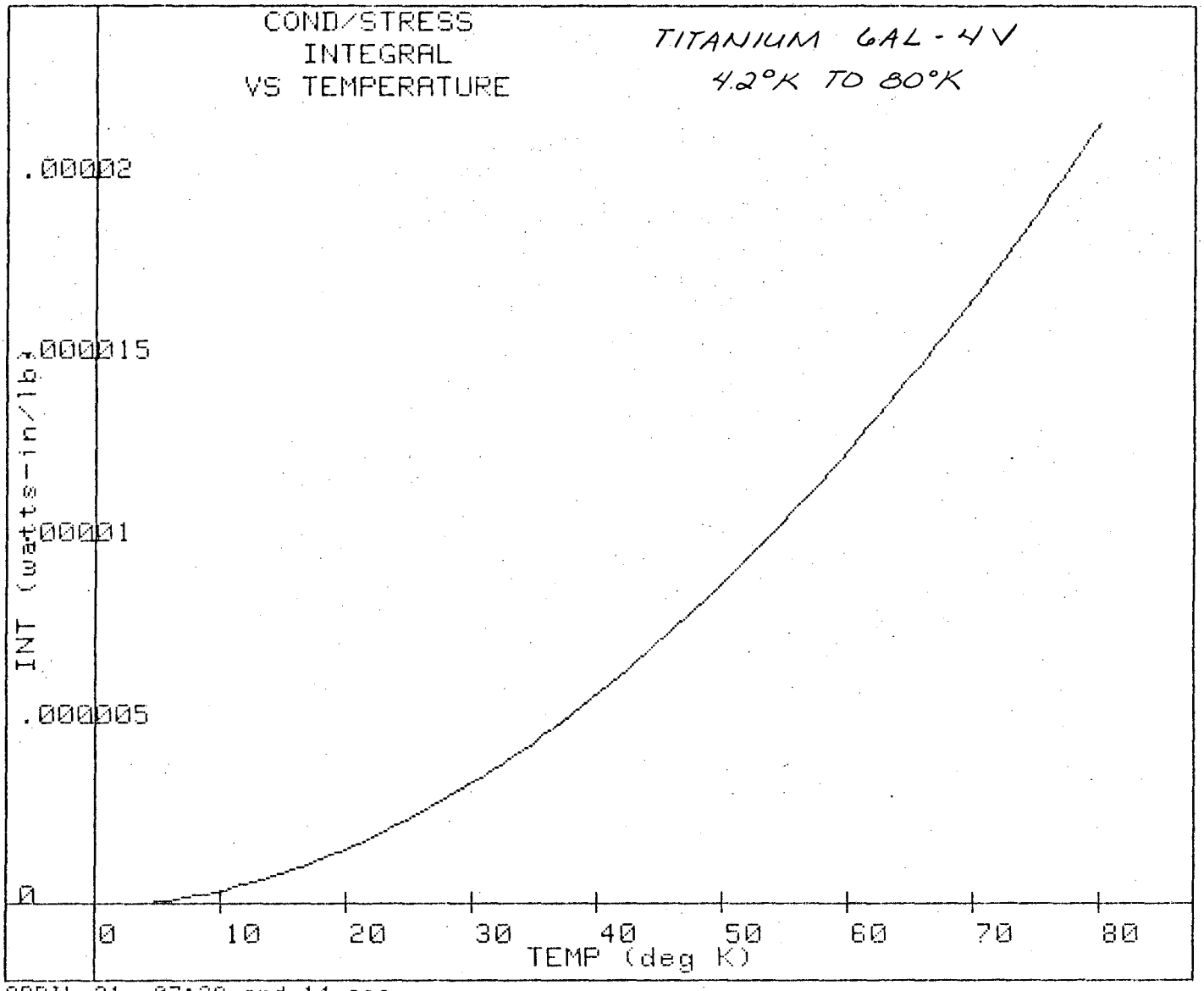


APRIL 21, 07:38 and 04 sec.
CALCULATED DATA:

TEMPERATURE deg K	THERMAL COND / YIELD STRESS watts-in/lb deg K
4.2000000000	.0000000343
4.9656565657	.0000000408
5.7313131313	.0000000470
6.4969696970	.0000000531
7.2626262626	.0000000592
8.0282828283	.0000000653
8.7939393939	.0000000715
9.5595959596	.0000000777
10.3252525253	.0000000841
11.0909090909	.0000000904
11.8565656566	.0000000967
12.6222222222	.0000001023
13.3878787879	.0000001068
14.1535353535	.0000001112
14.9191919192	.0000001157
15.6848484849	.0000001202
16.4505050505	.0000001248
17.2161616162	.0000001293
17.9818181818	.0000001338
18.7474747475	.0000001384

19.5131313131	.0000001432
20.2787878788	.0000001485
21.0444444445	.0000001538
21.8101010101	.0000001592
22.5757575758	.0000001647
23.3414141414	.0000001703
24.1070707071	.0000001759
24.8727272727	.0000001815
25.6383838384	.0000001872
26.4040404041	.0000001928
27.1696969697	.0000001978
27.9353535354	.0000002029
28.7010101010	.0000002079
29.4666666667	.0000002129
30.2323232323	.0000002180
30.9979797980	.0000002231
31.7636363637	.0000002282
32.5292929293	.0000002334
33.2949494950	.0000002384
34.0606060606	.0000002423
34.8262626263	.0000002463
35.5919191919	.0000002503
36.3575757576	.0000002543
37.1232323233	.0000002583
37.8888888889	.0000002624
38.6545454546	.0000002665
39.4202020202	.0000002706
40.1858585859	.0000002748
40.9515151515	.0000002796
41.7171717172	.0000002844
42.4828282829	.0000002893
43.2484848485	.0000002941
44.0141414142	.0000002991
44.7797979798	.0000003040
45.5454545455	.0000003090
46.3111111111	.0000003139
47.0767676768	.0000003189
47.8424242424	.0000003235
48.6080808081	.0000003282
49.3737373738	.0000003328
50.1393939394	.0000003374
50.9050505051	.0000003419
51.6707070707	.0000003464
52.4363636364	.0000003509
53.2020202020	.0000003554
53.9676767677	.0000003599
54.7333333334	.0000003637
55.4989898990	.0000003676
56.2646464647	.0000003717
57.0303030303	.0000003759
57.7959595960	.0000003800
58.5616161616	.0000003842
59.3272727273	.0000003884
60.0929292930	.0000003926
60.8585858586	.0000003969
61.6242424243	.0000004011
62.3898989899	.0000004054
63.1555555556	.0000004096
63.9212121212	.0000004139
64.6868686869	.0000004182
65.4525252526	.0000004225
66.2181818182	.0000004269
66.9838383839	.0000004312
67.7494949495	.0000004356
68.5151515152	.0000004398

69.2808080808	.0000004440
70.0464646465	.0000004482
70.8121212122	.0000004524
71.5777777778	.0000004566
72.3434343435	.0000004609
73.1090909091	.0000004651
73.8747474748	.0000004694
74.6404040404	.0000004737
75.4060606061	.0000004779
76.1717171718	.0000004819
76.9373737374	.0000004860
77.7030303031	.0000004901
78.4686868687	.0000004938
79.2343434344	.0000004976
80.0000000000	.0000005014

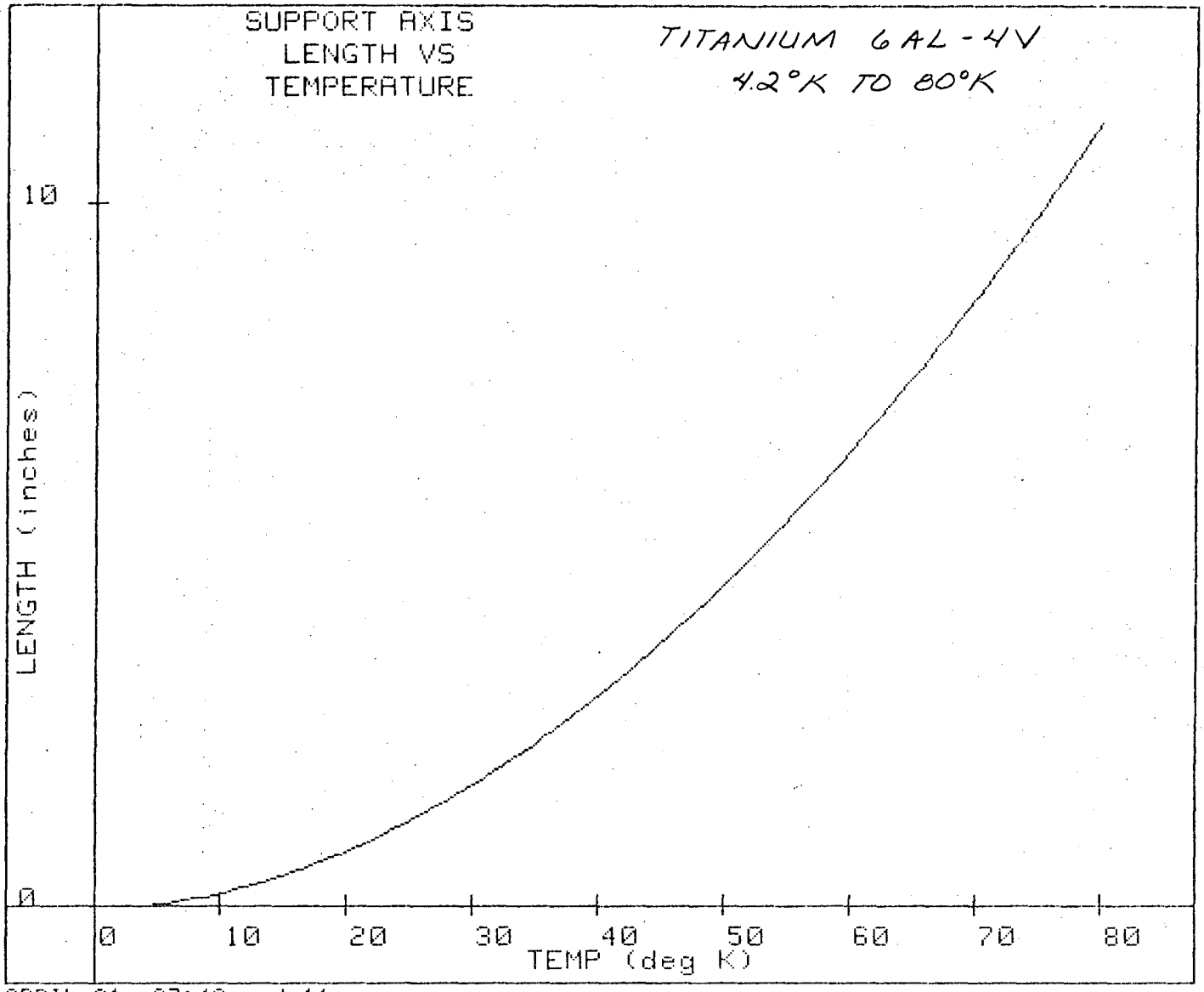


APRIL 21, 07:39 and 14 sec.
CALCULATED DATA:

TEMPERATURE deg K	INTEGRAL watts-in/lb
4.2000000000	0.0000000000
4.9656565657	.0000000288
5.7313131313	.0000000624
6.4969696970	.0000001007
7.2626262626	.0000001437
8.0282828283	.0000001913
8.7939393939	.0000002437
9.5595959596	.0000003008
10.3252525253	.0000003627
11.0909090909	.0000004295
11.8565656566	.0000005012
12.6222222222	.0000005774
13.3878787879	.0000006574
14.1535353535	.0000007409
14.9191919192	.0000008277
15.6848484849	.0000009181
16.4505050505	.0000010118
17.2161616162	.0000011091
17.9818181818	.0000012098
18.7474747475	.0000013140

19.5131313131	.0000014218
20.2787878788	.0000015335
21.0444444445	.0000016492
21.8101010101	.0000017690
22.5757575758	.0000018931
23.3414141414	.0000020213
24.1070707071	.0000021538
24.8727272727	.0000022906
25.6383838384	.0000024318
26.4040404041	.0000025773
27.1696969697	.0000027268
27.9353535354	.0000028803
28.7010101010	.0000030375
29.4666666667	.0000031986
30.2323232323	.0000033636
30.9979797980	.0000035324
31.7636363637	.0000037052
32.5292929293	.0000038819
33.2949494950	.0000040626
34.0606060606	.0000042466
34.8262626263	.0000044336
35.5919191919	.0000046237
36.3575757576	.0000048169
37.1232323233	.0000050132
37.8888888889	.0000052125
38.6545454546	.0000054150
39.4202020202	.0000056206
40.1858585859	.0000058294
40.9515151515	.0000060416
41.7171717172	.0000062575
42.4828282829	.0000064772
43.2484848485	.0000067005
44.0141414142	.0000069276
44.7797979798	.0000071585
45.5454545455	.0000073931
46.3111111111	.0000076316
47.0767676768	.0000078739
47.8424242424	.0000081198
48.6080808081	.0000083693
49.3737373738	.0000086224
50.1393939394	.0000088790
50.9050505051	.0000091390
51.6707070707	.0000094025
52.4363636364	.0000096694
53.2020202020	.0000099398
53.9676767677	.0000102136
54.7333333334	.0000104906
55.4989898990	.0000107706
56.2646464647	.0000110537
57.0303030303	.0000113399
57.7959595960	.0000116292
58.5616161616	.0000119218
59.3272727273	.0000122176
60.0929292930	.0000125166
60.8585858586	.0000128188
61.6242424243	.0000131243
62.3898989899	.0000134331
63.1555555556	.0000137451
63.9212121212	.0000140603
64.6868686869	.0000143789
65.4525252526	.0000147008
66.2181818182	.0000150259
66.9838383839	.0000153545
67.7494949495	.0000156863
68.5151515152	.0000160214

69.2808080808	.0000163598
70.0464646465	.0000167013
70.8121212122	.0000170461
71.5777777778	.0000173941
72.3434343435	.0000177453
73.1090909091	.0000180998
73.8747474748	.0000184576
74.6404040404	.0000188186
75.4060606061	.0000191829
76.1717171718	.0000195504
76.9373737374	.0000199209
77.7030303031	.0000202946
78.4686868687	.0000206713
79.2343434344	.0000210508
80.0000000000	.0000214332

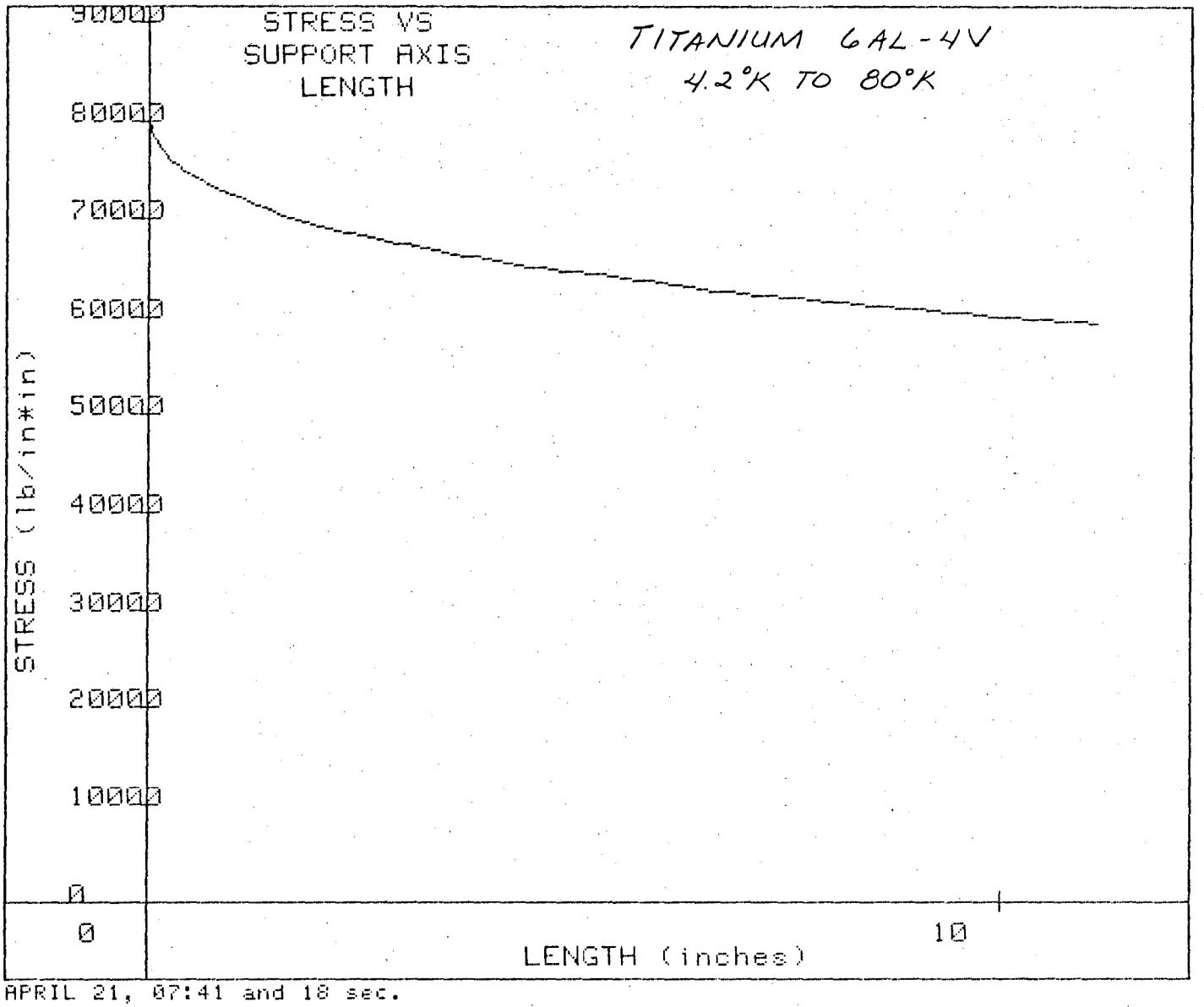


APRIL 21, 07:40 and 11 sec.
CALCULATED DATA:

TEMPERATURE deg K	SUPPORT AXIS LENGTH inches
4.2000000000	0.000000
4.9656565657	.014920
5.7313131313	.032366
6.4969696970	.052252
7.2626262626	.074542
8.0282828283	.099258
8.7939393939	.126425
9.5595959596	.156064
10.3252525253	.188200
11.0909090909	.222852
11.8565656566	.260022
12.6222222222	.299561
13.3878787879	.341092
14.1535353535	.384384
14.9191919192	.429452
15.6848484849	.476308
16.4505050505	.524966
17.2161616162	.575423
17.9818181818	.627676
18.7474747475	.681735

19.5131313131	.737655
20.2787878788	.795586
21.0444444445	.855636
21.8101010101	.917816
22.5757575758	.982156
23.3414141414	1.048692
24.1070707071	1.117445
24.8727272727	1.188434
25.6383838384	1.261675
26.4040404041	1.337152
27.1696969697	1.414740
27.9353535354	1.494334
28.7010101010	1.575923
29.4666666667	1.659506
30.2323232323	1.745094
30.9979797980	1.832703
31.7636363637	1.922344
32.5292929293	2.014032
33.2949494950	2.107735
34.0606060606	2.203212
34.8262626263	2.300262
35.5919191919	2.398895
36.3575757576	2.499118
37.1232323233	2.600940
37.8888888889	2.704370
38.6545454546	2.809417
39.4202020202	2.916090
40.1858585859	3.024411
40.9515151515	3.134521
41.7171717172	3.246543
42.4828282829	3.360487
43.2484848485	3.476365
44.0141414142	3.594187
44.7797979798	3.713964
45.5454545455	3.835707
46.3111111111	3.959425
47.0767676768	4.085128
47.8424242424	4.212738
48.6080808081	4.342181
49.3737373738	4.473467
50.1393939394	4.606587
50.9050505051	4.741505
51.6707070707	4.878200
52.4363636364	5.016679
53.2020202020	5.156950
53.9676767677	5.299020
54.7333333334	5.442754
55.4989898990	5.588017
56.2646464647	5.734864
57.0303030303	5.883348
57.7959595960	6.033479
58.5616161616	6.185266
59.3272727273	6.338719
60.0929292930	6.493847
60.8585858586	6.650660
61.6242424243	6.809159
62.3898989899	6.969342
63.1555555556	7.131216
63.9212121212	7.294787
64.6868686869	7.460063
65.4525252526	7.627052
66.2181818182	7.795762
66.9838383839	7.966200
67.7494949495	8.138374
68.5151515152	8.312250

69.2808080808	8.487788
70.0464646465	8.664987
70.8121212122	8.843855
71.5777777778	9.024399
72.3434343435	9.206627
73.1090909091	9.390547
73.8747474748	9.576167
74.6404040404	9.763495
75.4060606061	9.952497
76.1717171718	10.143127
76.9373737374	10.335380
77.7030303031	10.529252
78.4686868687	10.724676
79.2343434344	10.921590
80.0000000000	11.120000

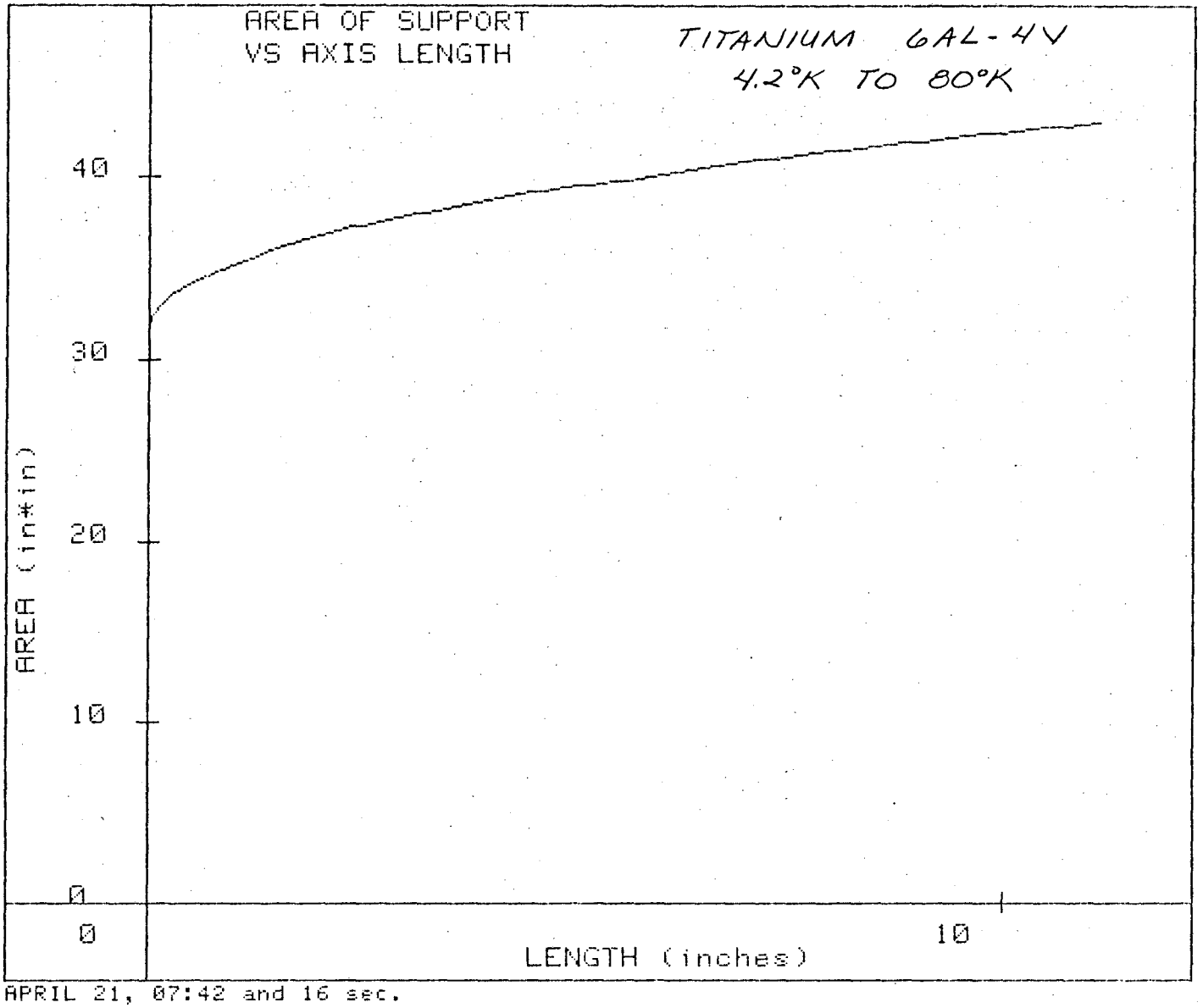


APRIL 21, 07:41 and 18 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	STRESS lb/in*in
0.000000	79584.8027
.014920	79205.2955
.032366	78831.4257
.052252	78464.2047
.074542	78096.9836
.099258	77729.7626
.126425	77362.5416
.156064	76995.3206
.188200	76628.0996
.222852	76278.8754
.260022	76002.9634
.299561	75727.0514
.341092	75451.1394
.384384	75175.2274
.429452	74899.3154
.476308	74623.4034
.524966	74347.4914
.575423	74115.5849
.627676	73886.0717
.681735	73656.5586

.737655	73427.0455
.795586	73197.5324
.855636	72968.0192
.917816	72738.5061
.982156	72477.1320
1.048692	72201.2200
1.117445	71925.3080
1.188434	71649.3960
1.261675	71373.4840
1.337152	71097.5720
1.414740	70821.6600
1.494334	70566.0705
1.575923	70336.5573
1.659506	70107.0442
1.745094	69877.5311
1.832703	69648.0179
1.922344	69418.5048
2.014032	69188.9917
2.107735	68967.5690
2.203212	68783.9585
2.300262	68600.3480
2.398895	68416.7375
2.499118	68233.1270
2.600940	68049.5165
2.704370	67865.9060
2.809417	67682.2955
2.916090	67498.3825
3.024411	67314.4411
3.134521	67130.4998
3.246543	66946.5585
3.360487	66762.6171
3.476365	66578.6758
3.594187	66394.7345
3.713964	66211.0134
3.835707	66027.4029
3.959425	65843.7924
4.085128	65660.1819
4.212738	65476.5714
4.342181	65292.9609
4.473467	65109.3504
4.606587	64944.1884
4.741505	64806.2324
4.878200	64668.2764
5.016679	64530.3204
5.156950	64392.3644
5.299020	64254.4084
5.442754	64116.4524
5.588017	63971.4013
5.734864	63787.7908
5.883348	63604.1803
6.033479	63420.5698
6.185266	63236.9593
6.338719	63053.3488
6.493847	62869.7383
6.650660	62686.1278
6.809159	62543.3172
6.969342	62405.3612
7.131216	62267.4052
7.294787	62129.4492
7.460063	61991.4932
7.627052	61853.5372
7.795762	61715.5812
7.966200	61577.7852
8.138374	61440.0774
8.312250	61302.3695

8.487788	61164.6616
8.664987	61026.9537
8.843855	60889.2458
9.024399	60751.5380
9.206627	60613.7350
9.390547	60475.7790
9.576167	60337.8230
9.763495	60199.8670
9.952497	60061.9110
10.143127	59923.9550
10.335380	59785.9990
10.529252	59654.2533
10.724676	59562.4480
10.921590	59470.6428
11.120000	59378.8375



APRIL 21, 07:42 and 16 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	AREA OF SUPPORT in*in
0.00000	32.041293
.01492	32.194817
.03237	32.347506
.05225	32.498896
.07454	32.651709
.09926	32.805967
.12642	32.961689
.15606	33.118896
.18820	33.277610
.22285	33.429963
.26002	33.551323
.29956	33.673568
.34109	33.796706
.38438	33.920749
.42945	34.045705
.47631	34.171585
.52497	34.298400
.57542	34.405719
.62768	34.512594
.68173	34.620135

.73766	34.728348
.79559	34.837240
.85564	34.946817
.91782	35.057085
.98216	35.183511
1.04869	35.317963
1.11745	35.453446
1.18843	35.589972
1.26168	35.727554
1.33715	35.866204
1.41474	36.005934
1.49433	36.136347
1.57592	36.254262
1.65951	36.372950
1.74509	36.492417
1.83270	36.612671
1.92234	36.733721
2.01403	36.855574
2.10774	36.973900
2.20321	37.072597
2.30026	37.171823
2.39889	37.271581
2.49912	37.371877
2.60094	37.472713
2.70437	37.574095
2.80942	37.676027
2.91609	37.778683
3.02441	37.881916
3.13452	37.985715
3.24654	38.090083
3.36049	38.195028
3.47637	38.300551
3.59419	38.406660
3.71396	38.513230
3.83571	38.620329
3.95943	38.728024
4.08513	38.836323
4.21274	38.945228
4.34218	39.054746
4.47347	39.164882
4.60659	39.264483
4.74151	39.348067
4.87820	39.432008
5.01668	39.516308
5.15695	39.600969
5.29902	39.685993
5.44275	39.771383
5.58802	39.861562
5.73486	39.976302
5.88335	40.091704
6.03348	40.207775
6.18527	40.324520
6.33872	40.441944
6.49385	40.560054
6.65066	40.678857
6.80916	40.771742
6.96934	40.861874
7.13122	40.952405
7.29479	41.043338
7.46006	41.134676
7.62705	41.226422
7.79576	41.318577
7.96620	41.411038
8.13837	41.503854
8.31225	41.597087

8.48779	41.690740
8.66499	41.784815
8.84386	41.879317
9.02440	41.974246
9.20663	42.069673
9.39055	42.165641
9.57617	42.262048
9.76349	42.358898
9.95250	42.456192
10.14313	42.553934
10.33538	42.652127
10.52925	42.746323
10.72468	42.812209
10.92159	42.878299
11.12000	42.944593

INPUT PARAMETERS AND RESULTS:
APRIL 21, 07:44 and 05 sec.

THIS OUTPUT IS FOR TITANIUM 6AL-4V

THE TEMPERATURE RANGE IS BETWEEN 82 deg K AND 290 deg K

THE FORCE EXERTED ON THE SUPPORT IS 2550000 LBS

THE LENGTH OF THE SUPPORT IS 2.908 INCHES

THE YIELD STRESS FACTOR IS .333333

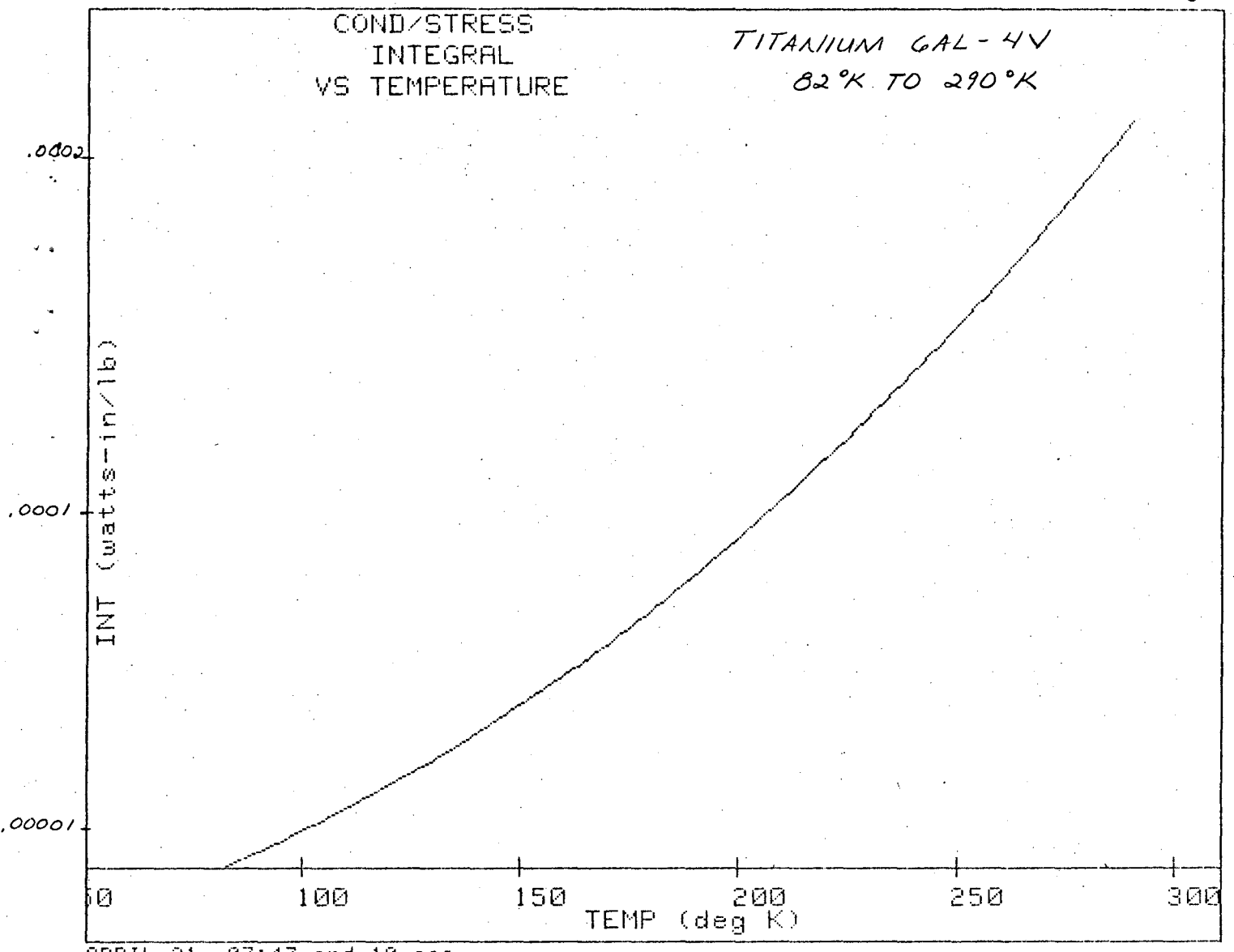
THE NUMBER OF YIELD STRESS INPUT POINTS IS 25

THE NUMBER OF THERMAL CONDUCTIVITY INPUT POINTS IS 21

THE TEMPERATURE INCREMENT IS 2.10101010101

THE FINAL INTEGRAL FROM 82 TO 290 deg K IS 2.07966022482E-04

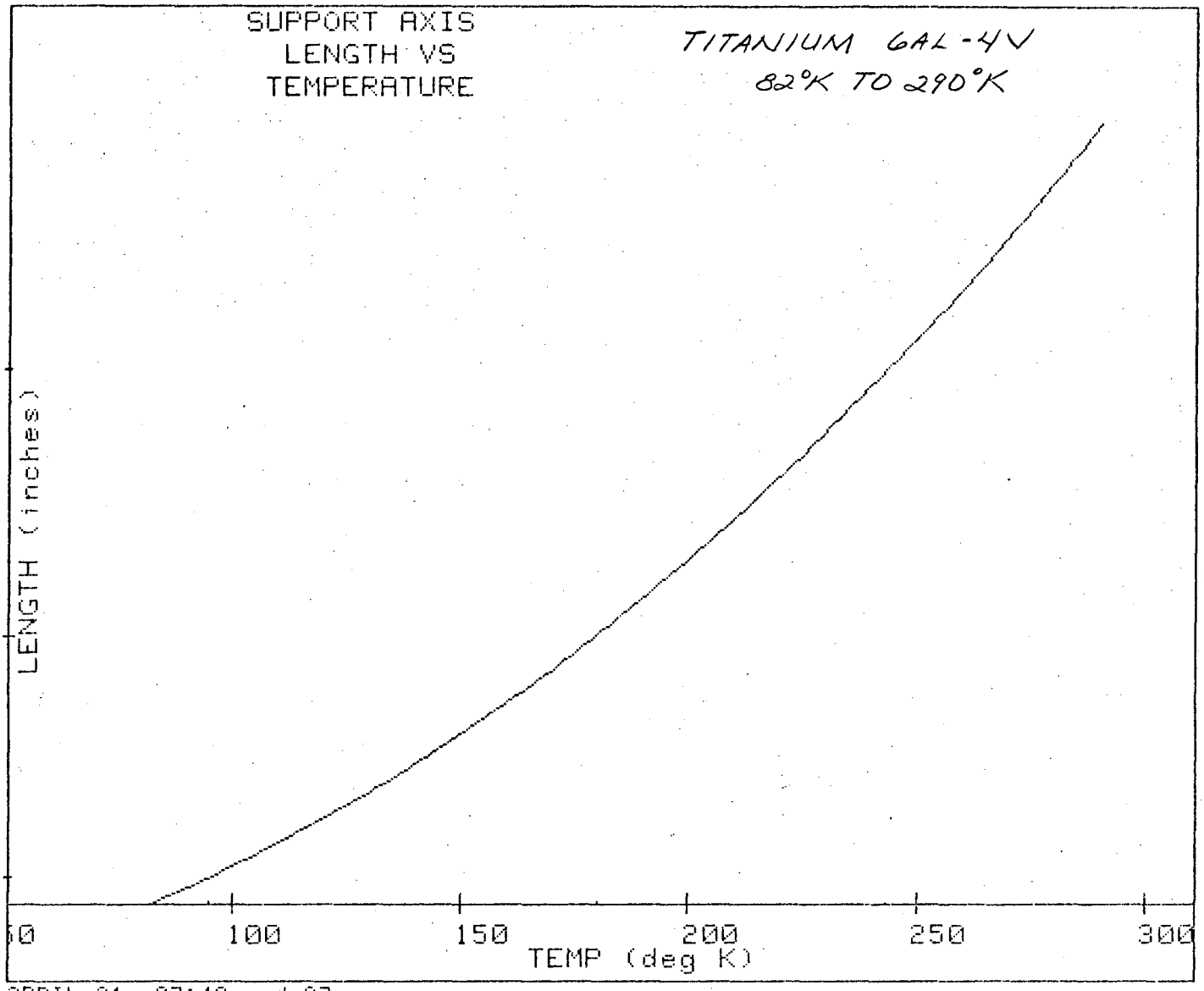
THE HEAT LOAD ON THE SUPPORT IS 547.09135589 watts



APRIL 21, 07:47 and 10 sec.
CALCULATED DATA:

TEMPERATURE deg K	INTEGRAL watts-in/lb
82.0000000000	0.0000000000
84.1010101010	.0000010857
86.2020202020	.0000021953
88.3030303030	.0000033298
90.4040404040	.0000044867
92.5050505051	.0000056630
94.6060606061	.0000068583
96.7070707071	.0000080726
98.8080808081	.0000093062
100.9090909090	.0000105592
103.0101010100	.0000118318
105.1111111110	.0000131241
107.2121212120	.0000144365
109.3131313130	.0000157689
111.4141414140	.0000171217
113.5151515150	.0000184950
115.6161616160	.0000198889
117.7171717170	.0000213030
119.8181818180	.0000227359
121.9191919190	.0000241874

124.0202020200	.0000256576
126.1212121210	.0000271465
128.2222222220	.0000286545
130.3232323230	.0000301816
132.4242424240	.0000317280
134.5252525250	.0000332939
136.6262626260	.0000348794
138.7272727270	.0000364847
140.8282828280	.0000381100
142.9292929290	.0000397555
145.0303030300	.0000414213
147.1313131310	.0000431074
149.2323232320	.0000448141
151.3333333330	.0000465414
153.4343434340	.0000482897
155.5353535350	.0000500592
157.6363636360	.0000518499
159.7373737370	.0000536623
161.8383838380	.0000554963
163.9393939390	.0000573524
166.0404040400	.0000592308
168.1414141410	.0000611315
170.2424242420	.0000630550
172.3434343430	.0000650011
174.4444444440	.0000669686
176.5454545460	.0000689563
178.6464646470	.0000709641
180.7474747480	.0000729923
182.8484848480	.0000750409
184.9494949490	.0000771100
187.0505050510	.0000791999
189.1515151520	.0000813104
191.2525252530	.0000834419
193.3535353540	.0000855944
195.4545454550	.0000877679
197.5555555560	.0000899627
199.6565656570	.0000921788
201.7575757580	.0000944155
203.8585858590	.0000966719
205.9595959600	.0000989480
208.0606060610	.0001012439
210.1616161620	.0001035599
212.2626262630	.0001058958
214.3636363640	.0001082520
216.4646464650	.0001106284
218.5656565660	.0001130252
220.6666666670	.0001154426
222.7676767680	.0001178805
224.8686868690	.0001203393
226.9696969700	.0001228188
229.0707070710	.0001253195
231.1717171720	.0001278417
233.2727272730	.0001303855
235.3737373740	.0001329512
237.4747474750	.0001355388
239.5757575760	.0001381484
241.6767676770	.0001407802
243.7777777780	.0001434343
245.8787878790	.0001461108
247.9797979800	.0001488099
250.0808080810	.0001515316
252.1818181820	.0001542762
254.2828282830	.0001570437
256.3838383840	.0001598347
258.4848484850	.0001626501



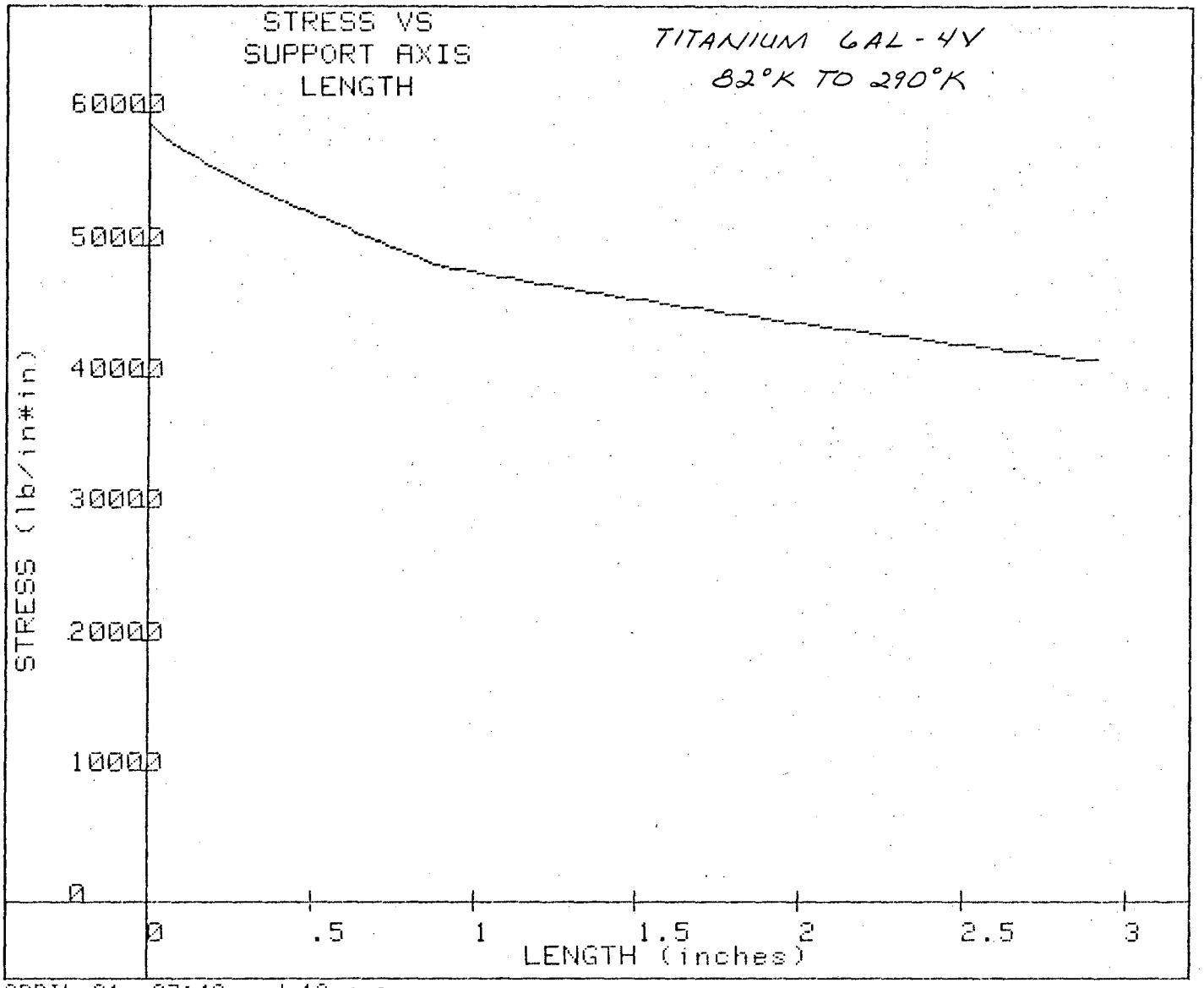
APRIL 21, 07:48 and 07 sec.
CALCULATED DATA:

TEMPERATURE deg K	SUPPORT AXIS LENGTH inches
82.0000000000	0.000000
84.1010101010	.015182
86.2020202020	.030697
88.3030303030	.046560
90.4040404040	.062738
92.5050505051	.079186
94.6060606061	.095899
96.7070707071	.112879
98.8080808081	.130129
100.9090909090	.147649
103.0101010100	.165444
105.1111111110	.183515
107.2121212120	.201866
109.3131313130	.220498
111.4141414140	.239413
113.5151515150	.258616
115.6161616160	.278108
117.7171717170	.297881
119.8181818180	.317918
121.9191919190	.338214

260.5858585860	.0001654905
262.6868686870	.0001683559
264.7878787880	.0001712466
266.8888888890	.0001741627
268.9898989900	.0001771044
271.0909090910	.0001800717
273.1919191920	.0001830649
275.2929292930	.0001860842
277.3939393940	.0001891295
279.4949494950	.0001922013
281.5959595960	.0001952994
283.6969696970	.0001984244
285.7979797980	.0002015768
287.8989898990	.0002047573
290.0000000000	.0002079660

124.0202020200	.358771
126.1212121210	.379591
128.2222222220	.400677
130.3232323230	.422031
132.4242424240	.443654
134.5252525250	.465550
136.6262626260	.487720
138.7272727270	.510168
140.8282828280	.532894
142.9292929290	.555903
145.0303030300	.579196
147.1313131310	.602773
149.2323232320	.626638
151.3333333330	.650792
153.4343434340	.675238
155.5353535350	.699980
157.6363636360	.725020
159.7373737370	.750362
161.8383838380	.776008
163.9393939390	.801962
166.0404040400	.828227
168.1414141410	.854806
170.2424242420	.881701
172.3434343430	.908914
174.4444444440	.936426
176.5454545460	.964219
178.6464646470	.992295
180.7474747480	1.020655
182.8484848480	1.049301
184.9494949490	1.078234
187.0505050510	1.107456
189.1515151520	1.136968
191.2525252530	1.166773
193.3535353540	1.196871
195.4545454550	1.227264
197.5555555560	1.257953
199.6565656570	1.288941
201.7575757580	1.320217
203.8585858590	1.351768
205.9595959600	1.383595
208.0606060610	1.415699
210.1616161620	1.448083
212.2626262630	1.480747
214.3636363640	1.513693
216.4646464650	1.546923
218.5656565660	1.580438
220.6666666670	1.614240
222.7676767680	1.648330
224.8686868690	1.682710
226.9696969700	1.717382
229.0707070710	1.752349
231.1717171720	1.787617
233.2727272730	1.823188
235.3737373740	1.859064
237.4747474750	1.895246
239.5757575760	1.931736
241.6767676770	1.968537
243.7777777780	2.005649
245.8787878790	2.043075
247.9797979800	2.080816
250.0808080810	2.118875
252.1818181820	2.157252
254.2828282830	2.195951
256.3838383840	2.234978
258.4848484850	2.274345

260.5858585860	2.314062
262.6868686870	2.354130
264.7878787880	2.394551
266.8888888890	2.435327
268.9898989900	2.476460
271.0909090910	2.517953
273.1919191920	2.559807
275.2929292930	2.602025
277.3939393940	2.644609
279.4949494950	2.687560
281.5959595960	2.730882
283.6969696970	2.774579
285.7979797980	2.818660
287.8989898990	2.863133
290.0000000000	2.908000

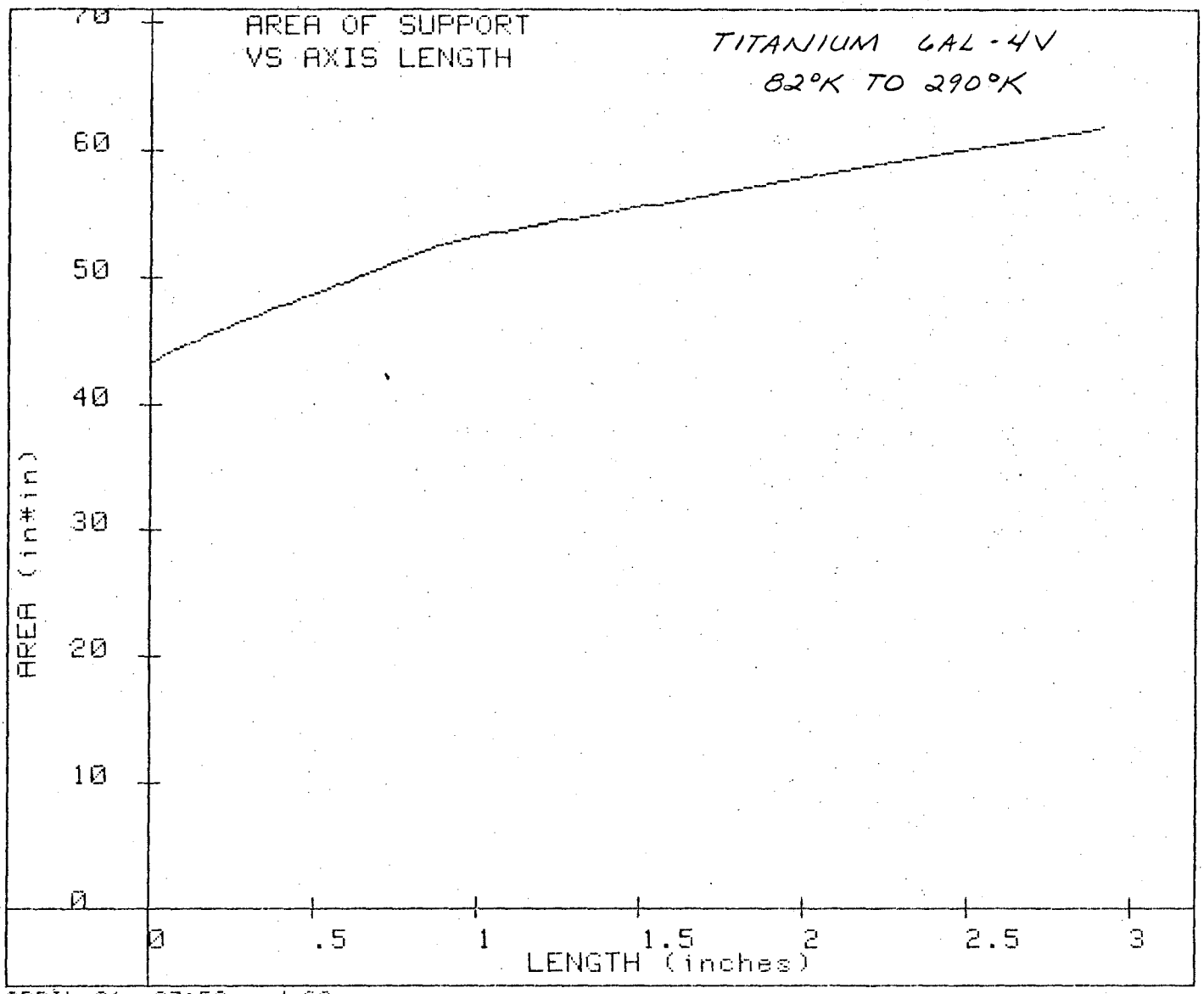


APRIL 21, 07:49 and 12 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	STRESS lb/in*in
0.000000	59139.0296
.015182	58830.6947
.030697	58452.8156
.046560	58074.9365
.062738	57797.8008
.079186	57545.6092
.095899	57293.4176
.112879	57041.2260
.130129	56789.0345
.147649	56536.8429
.165444	56284.6513
.183515	56032.4597
.201866	55780.2682
.220498	55528.0766
.239413	55275.8850
.258616	55023.6934
.278108	54771.5019
.297881	54534.0882
.317918	54307.1975
.338214	54080.3068

.358771	53853.4161
.379591	53626.5253
.400677	53399.6346
.422031	53172.7439
.443654	52945.8532
.465550	52718.9625
.487720	52492.0718
.510168	52265.1811
.532894	52038.2903
.555903	51811.3996
.579196	51575.3860
.602773	51323.2852
.626638	51071.1844
.650792	50819.0837
.675238	50566.9829
.699980	50314.8821
.725020	50062.7813
.750362	49810.6805
.776008	49558.5797
.801962	49306.4789
.828227	49054.3781
.854806	48802.2773
.881701	48550.1765
.908914	48315.6804
.936426	48189.6300
.964219	48063.5796
.992295	47937.5292
1.020655	47811.4788
1.049301	47685.4284
1.078234	47559.3780
1.107456	47433.3276
1.136968	47307.2772
1.166773	47181.2268
1.196871	47055.1764
1.227264	46929.1260
1.257953	46803.0756
1.288941	46677.0252
1.320217	46550.9332
1.351768	46424.8374
1.383595	46298.7416
1.415699	46172.6458
1.448083	46046.5500
1.480747	45920.4542
1.513693	45794.3585
1.546923	45668.2627
1.580438	45542.1669
1.614240	45416.0711
1.648330	45289.9753
1.682710	45163.8795
1.717382	45037.7837
1.752349	44911.7197
1.787617	44785.6693
1.823188	44659.6189
1.859064	44533.5685
1.895246	44407.5181
1.931736	44281.4677
1.968537	44155.4173
2.005649	44029.3670
2.043075	43903.3166
2.080816	43777.2662
2.118875	43651.2158
2.157252	43525.1654
2.195951	43399.1150
2.234978	43273.0646
2.274345	43147.0142

2.314062	43020.9638
2.354130	42894.9134
2.394551	42768.8630
2.435327	42642.8126
2.476460	42516.7622
2.517953	42390.7118
2.559807	42264.6614
2.602025	42138.6110
2.644609	42012.5606
2.687560	41886.5102
2.730882	41760.4598
2.774579	41634.7385
2.818660	41509.9755
2.863133	41385.2126
2.908000	41260.4496



APRIL 21, 07:50 and 08 sec.
CALCULATED DATA:

SUPPORT AXIS LENGTH inches	AREA OF SUPPORT in*in
0.00000	43.118733
.01518	43.344720
.03070	43.624930
.04656	43.908787
.06274	44.119326
.07919	44.312677
.09590	44.507731
.11288	44.704509
.13013	44.903035
.14765	45.103332
.16544	45.305424
.18352	45.509335
.20187	45.715090
.22050	45.922714
.23941	46.132233
.25862	46.343672
.27811	46.557058
.29788	46.759744
.31792	46.955102
.33821	47.152099

.35877	47.350757
.37959	47.551095
.40068	47.753136
.42203	47.956901
.44365	48.162412
.46555	48.369692
.48772	48.578765
.51017	48.789652
.53289	49.002378
.55590	49.216968
.57920	49.442189
.60277	49.685050
.62664	49.930309
.65079	50.178000
.67524	50.428162
.69998	50.680830
.72502	50.936043
.75036	51.193840
.77601	51.454259
.80196	51.717341
.82823	51.983128
.85481	52.251660
.88170	52.522981
.90891	52.777897
.93643	52.915949
.96422	53.054725
.99229	53.194231
1.02065	53.334472
1.04930	53.475455
1.07823	53.617186
1.10746	53.759669
1.13697	53.902912
1.16677	54.046920
1.19687	54.191700
1.22726	54.337257
1.25795	54.483599
1.28894	54.630731
1.32022	54.778709
1.35177	54.927494
1.38359	55.077091
1.41570	55.227504
1.44808	55.378742
1.48075	55.530810
1.51369	55.683715
1.54692	55.837465
1.58044	55.992066
1.61424	56.147525
1.64833	56.303851
1.68271	56.461049
1.71738	56.619127
1.75235	56.778053
1.78762	56.937856
1.82319	57.098562
1.85906	57.260177
1.89525	57.422709
1.93174	57.586167
1.96854	57.750558
2.00565	57.915891
2.04307	58.082172
2.08082	58.249412
2.11887	58.417617
2.15725	58.586796
2.19595	58.756959
2.23498	58.928112
2.27435	59.100266

2.31406	59.273428
2.35413	59.447608
2.39455	59.622815
2.43533	59.799057
2.47646	59.976345
2.51795	60.154687
2.55981	60.334093
2.60202	60.514572
2.64461	60.696134
2.68756	60.878789
2.73088	61.062546
2.77458	61.246932
2.81866	61.431017
2.86313	61.616211
2.90800	61.802526

```
10    INPUT "DOES THE COMPUTER HAVE A REAL TIME CLOCK?",Rtime$
20    INPUT "INPUT THE MAXIMUM TEMPERATURE IN deg K",Tmax
30    INPUT "INPUT THE MINIMUM TEMPERATURE IN deg K",Tmin
40    INPUT "INPUT THE YIELD STRESS FACTOR 'K'",K
50    DIM X1(20),Y1(20),Z1(20),Z2(20),Xx(101),Yy(101),Yy1(101),Yy2(101),Int(100)
,Thermo(20),Dx(100),Ax(100),Yx(100)
60    DIM X(101),Y(101)
61    PRINT "DO YOU WANT A HARDCOPY OF THE INPUT PARAMETERS AND RESULTS?"
62    INPUT Answer$
63    IF (Answer$="YES") OR (Answer$="Y") THEN GOTO 66
64    An=0
65    GOTO 70
66    An=1
70    F=2.55E6
80    L=11.12
90    A=0
100   READ N1
110   FOR I=1 TO N1
120   READ Z1(I)
130   NEXT I
140   FOR I=1 TO N1
150   READ Y1(I)
160   NEXT I
170   READ N2
180   FOR I=1 TO N2
190   READ Z2(I)
200   NEXT I
210   FOR I=1 TO N2
220   READ Thermo(I)
230   NEXT I
240   Xn=(Tmax-Tmin)/99
250   FOR I=1 TO 100
260   Xx(I)=Tmin+(I-1)*Xn
270   FOR J=1 TO N1-1
280   IF (Z1(J)<Xx(I)) AND (Xx(I)<=Z1(J+1)) THEN GOTO 300
290   GOTO 310
300   Yy1(I)=Y1(J)+(Y1(J+1)-Y1(J))/(Z1(J+1)-Z1(J))*(Xx(I)-Z1(J))
310   NEXT J
320   NEXT I
330   FOR I=1 TO 100
340   FOR J=1 TO N2-1
350   IF (Z2(J)<Xx(I)) AND (Xx(I)<=Z2(J+1)) THEN GOTO 370
360   GOTO 380
370   Yy2(I)=Thermo(J)+(Thermo(J+1)-Thermo(J))/(Z2(J+1)-Z2(J))*(Xx(I)-Z2(J))
380   NEXT J
390   NEXT I
400   FOR I=1 TO 100
410   Yy(I)=Yy2(I)/Yy1(I)
420   Yx(I)=Yy1(I)*K
430   NEXT I
440   Int(1)=0
450   FOR I=2 TO 100
460   Int(I)=Int(I-1)+(Yy(I)+Yy(I-1))*Xn/2
470   NEXT I
480   FOR I=1 TO 100
490   Dx(I)=L*Int(I)/Int(100)
500   Ax(I)=F/Yx(I)
510   NEXT I
511   IF An=1 THEN PRINTER IS 0
512   IF An=0 THEN PRINTER IS 16
520   GOTO 750
530   PRINT "INPUT DATA:"
540   PRINT ""
550   PRINT "TEMPERATURE      YIELD STRESS"
560   PRINT "   deg K            lb/in*in"
```

```
570   PRINT ""
580   FOR I=1 TO N1
590   PRINT USING 600;Z1(I),Y1(I)
600   IMAGE XXDDD.DDXXXXXXXX,DDDDDDDD.DDD
610   NEXT I
630   GOTO 3190
640   PRINT "INPUT DATA:"
650   PRINT ""
660   PRINT "TEMPERATURE       THERMAL COND"
670   PRINT "   deg K         watts-in/deg K"
680   PRINT ""
690   FOR I=1 TO N2
700   PRINT USING 710;Z2(I),Thermo(I)
710   IMAGE XXDDD.DDXXXXXXXX,DDD.DDDDDDDD
720   NEXT I
740   GOTO 3190
750   PRINT "INPUT PARAMETERS AND RESULTS:"
760   IF (Rtime$="YES") OR (Rtime$="Y") THEN GOSUB Rtime
770   PRINT ""
771   PRINT "THIS OUTPUT IS FOR 304 LN STAINLESS STEEL"
772   PRINT ""
780   PRINT "THE TEMPERATURE RANGE IS BETWEEN";Tmin;"deg K AND";Tmax;"deg K"
790   PRINT ""
800   PRINT "THE FORCE EXERTED ON THE SUPPORT IS";F;"LBS"
810   PRINT ""
820   PRINT "THE LENGTH OF THE SUPPORT IS";L;"INCHES"
830   PRINT ""
840   PRINT "THE YIELD STRESS FACTOR IS";K
850   PRINT ""
860   PRINT "THE NUMBER OF YIELD STRESS INPUT POINTS IS";N1
870   PRINT ""
880   PRINT "THE NUMBER OF THERMAL CONDUCTIVITY INPUT POINTS IS";N2
890   PRINT ""
900   PRINT "THE TEMPERATURE INCREMENT IS";Xn
910   GOTO 1460
920   PRINT "CALCULATED DATA:"
930   PRINT ""
940   PRINT "  TEMPERATURE      THERMAL COND / YIELD STRESS"
950   PRINT "     deg K              watts-in/lb deg K"
960   PRINT ""
970   FOR I=1 TO 100
980   PRINT USING 990;Xx(I),Yy(I)
990   IMAGE DDD.DDDDDDDDDDXXXXXXXXXX,DD.DDDDDDDDDDXXXXXXXXXXXXX
1000  NEXT I
1020  GOTO 3190
1030  PRINT "CALCULATED DATA:"
1040  PRINT ""
1050  PRINT "  TEMPERATURE          INTEGRAL"
1060  PRINT "     deg K            watts-in/lb"
1070  PRINT ""
1080  FOR I=1 TO 100
1090  PRINT USING 1100;Xx(I),Int(I)
1100  IMAGE DDD.DDDDDDDDDDXXXXX,DDD.DDDDDDDDDD
1110  NEXT I
1130  GOTO 3190
1140  PRINT "CALCULATED DATA:"
1150  PRINT ""
1160  PRINT "  TEMPERATURE      SUPPORT AXIS LENGTH"
1170  PRINT "     deg K                 inches"
1180  PRINT ""
1190  FOR I=1 TO 100
1200  PRINT USING 1210;Xx(I),Dx(I)
1210  IMAGE DDD.DDDDDDDDDDXXXXXXXX,DDDD.DDDDDD
1220  NEXT I
1240  GOTO 3190
1250  PRINT "CALCULATED DATA:"
```

```
1260  PRINT ""
1270  PRINT "SUPPORT AXIS LENGTH          STRESS"
1280  PRINT "      inches                 lb/in*in"
1290  PRINT ""
1300  FOR I=1 TO 100
1310  PRINT USING 1320;Dx(I),Yx(I)
1320  IMAGE XXXDDD.DDDDDDXXXXXXXXXXXXX,DDDDDD.DDDD
1330  NEXT I
1350  GOTO 3190
1360  PRINT "CALCULATED DATA:"
1370  PRINT ""
1380  PRINT "SUPPORT AXIS LENGTH         AREA OF SUPPORT"
1390  PRINT "      inches                      in*in"
1400  PRINT ""
1410  FOR I=1 TO 100
1420  PRINT USING 1430;Dx(I),Ax(I)
1430  IMAGE XXXDDD.DDDDDXXXXXXXXXXXXXXXXX,DDDD.DDDDDD
1440  NEXT I
1450  GOTO 3190
1460  PRINT ""
1470  PRINT "THE FINAL INTEGRAL FROM";Tmin;"TO";Tmax;"deg K IS";Int(100)
1480  PRINT ""
1490  Q=F*Int(100)/(L*K)
1500  PRINT "THE HEAT LOAD ON THE SUPPORT IS";Q;"watts"
1501  PRINTER IS 16
1510  WAIT 3000
1520  Nplot=1 ! DEFAULT VALUE FOR THE NUMBER OF PLOTS.
1530  N=N1
1540  MAT X=Z1
1550  MAT Y=Y1
1560  Titlea$="YIELD STRESS VS"
1570  Titleb$="  TEMPERATURE"
1580  Xlabel$="TEMP (deg K)"
1590  Ylabel$="STRESS (lb/in*in)"
1591  A=1
1600  GOSUB Graphics
1610  N=N2
1620  MAT X=Z2
1630  MAT Y=Thermo
1640  Titlea$=" THERMAL COND"
1650  Titleb$="VS TEMPERATURE"
1660  Xlabel$="TEMP (deg K)"
1670  Ylabel$="COND (Watts-in/K)"
1671  A=2
1680  GOSUB Graphics
1690  N=100
1700  MAT X=Xx
1710  MAT Y=Yy
1720  Titlea$="THERMAL COND /"
1730  Titleb$="YIELD STRESS"
1740  Titlec$="VS TEMPERATURE"
1750  Ylabel$="COND/STRESS"
1760  Xlabel$="TEMP (deg K)"
1761  A=3
1770  GOSUB Graphics
1780  N=100
1790  MAT X=Xx
1800  MAT Y=Int
1810  Titlea$=" COND/STRESS"
1820  Titleb$="   INTEGRAL"
1830  Titlec$="VS TEMPERATURE"
1840  Xlabel$="TEMP (deg K)"
1850  Ylabel$="INT (watts-in/lb)"
1851  A=4
1860  GOSUB Graphics
```

```
1870  N=100
1880  MAT X=Xx
1890  MAT Y=Dx
1900  Titlea$="SUPPORT AXIS"
1910  Titleb$="  LENGTH VS"
1920  Titlec$=" TEMPERATURE"
1930  Xlabel$="TEMP (deg K)"
1940  Ylabel$="LENGTH (inches)"
1941  A=5
1950  GOSUB Graphics
1960  N=100
1970  MAT X=Dx
1980  MAT Y=Yx
1990  Titlea$=" STRESS VS"
2000  Titleb$="SUPPORT AXIS"
2010  Titlec$="   LENGTH"
2020  Xlabel$="LENGTH (inches)"
2030  Ylabel$="STRESS (lb/in*in)"
2031  A=6
2040  GOSUB Graphics
2050  N=100
2060  MAT X=Dx
2070  MAT Y=Ax
2080  Titlea$="AREA OF SUPPORT"
2090  Titleb$="VS AXIS LENGTH"
2100  Titlec$=""
2110  Xlabel$="LENGTH (inches)"
2120  Ylabel$="AREA (in*in)"
2121  A=7
2130  GOSUB Graphics
2140  STOP
2150  END
2160 Graphics:  Code$="Graphics"
2170  Ymax=Y(1)
2180  Ymin=Y(1)
2190  Imax=1
2200  Imin=1
2210  FOR I=1 TO N
2220  IF Y(I)>Ymax THEN Imax=I
2230  IF Y(I)>Ymax THEN Ymax=Y(I)
2240  IF Y(I)<Ymin THEN Imin=I
2250  IF Y(I)<Ymin THEN Ymin=Y(I)
2260  NEXT I
2270  IF Nplot=1 THEN GOTO 2340
2280  FOR I=1 TO N
2290  IF Y1(I)>Ymax THEN Imax=I
2300  IF Y1(I)>Ymax THEN Ymax=Y1(I)
2310  IF Y1(I)<Ymin THEN Imin=I
2320  IF Y1(I)<Ymin THEN Ymin=Y1(I)
2330  NEXT I
2340  Xmin=X(1)
2350  Xmax=X(N)
2360  IF Ymin>0 THEN Ymin=0
2370  Ysize=Ymax-Ymin
2380  Xsize=ABS(Xmax-Xmin)
2390  FOR I=-20 TO 20
2400  Xscale=Xsize*10^I
2410  Yscale=Ysize*10^I
2420  IF (Xscale>1) AND (Xscale<=10) THEN Ixscale=I
2430  IF (Yscale>1) AND (Yscale<=10) THEN Iyscale=I
2440  NEXT I
2450  Xscale=Xsize*10^Ixscale
2460  Yscale=Ysize*10^Iyscale
2470  IF (Xscale>=1) AND (Xscale<2) THEN Xscale=.2*10^(-Ixscale)
2480  IF (Yscale>=1) AND (Yscale<2) THEN Yscale=.2*10^(-Iyscale)
```

```
2490  IF (Xscale>=2) AND (Xscale<5) THEN Xscale=.5*10^(-Ixscale)
2500  IF (Yscale>=2) AND (Yscale<5) THEN Yscale=.5*10^(-Iyscale)
2510  IF (Xscale>=5) AND (Xscale<10) THEN Xscale=1*10^(-Ixscale)
2520  IF (Yscale>=5) AND (Yscale<10) THEN Yscale=1*10^(-Iyscale)
2530  GRAPHICS
2540  GCLEAR
2550  LOCATE 0,123,0,100
2560  FRAME
2570  SCALE Xmin-.15*Xsize,Xmax+.1*Xsize,Ymin-.1*Ysize,Ymax+.15*Ysize
2580  AXES Xscale,Yscale,0,0
2590  MOVE X(1),Y(1)
2600  FOR I=1 TO N
2610  DRAW X(I),Y(I)
2620  NEXT I
2630  IF Nplot=1 THEN GOTO 2700
2640  LINE TYPE 8
2650  MOVE X(1),Y1(I)
2660  FOR I=1 TO N
2670  DRAW X(I),Y1(I)
2680  NEXT I
2690  LINE TYPE 1
2700  FOR I=0 TO 12
2710  MOVE (I-.1)*Xscale,-.05*Ysize
2720  LABEL I*Xscale
2730  NEXT I
2740  FOR I=-10 TO 10
2750  MOVE -.1*Xsize,I*Yscale
2760  LABEL I*Yscale
2770  NEXT I
2780  MOVE Xmin+.1*Xsize,Ymax+.12*Ysize
2790  LABEL Titles$
2800  LABEL Titleb$
2810  LABEL Titlec$
2820  MOVE Xmin+.4*Xsize,-.08*Ysize
2830  LABEL Xlabel$
2840  MOVE Xmin-.12*Xsize,Ymin+.3*Ysize
2850  LDIR PI/2
2860  LABEL Ylabel$
2870  LDIR 0
2880  IF Nplot=1 THEN GOTO 2990
2890  MOVE Xmin+.4*Xsize,Ymin+.1*Ysize
2900  LABEL C1$
2910  MOVE Xmin+.65*Xsize,Ymin+.1*Ysize
2920  DRAW Xmax,Ymin+.1*Ysize
2930  MOVE Xmin+.4*Xsize,Ymin+.05*Ysize
2940  LABEL C2$
2950  LINE TYPE 8
2960  MOVE Xmin+.65*Xsize,Ymin+.05*Ysize
2970  DRAW Xmax,Ymin+.05*Ysize
2980  LINE TYPE 1
2990  WAIT 5000
3000  PRINT PAGE
3010  PRINT "DO YOU WANT A HARD COPY OF THIS GRAPH?"
3020  INPUT Answer$
3030  IF (Answer$="YES") OR (Answer$="Y") THEN GOSUB Dump
3040  GCLEAR
3050  Answer$="NO"
3060  EXIT GRAPHICS
3070  RETURN
3080 Dump: PRINTER IS 0
3090  PRINT PAGE
3100  DUMP GRAPHICS
3110  IF (Rtime$="YES") OR (Rtime$="Y") THEN GOSUB Rtime
3120  IF A=1 THEN GOTO 530
3130  IF A=2 THEN GOTO 640
```

```
3140  IF A=3 THEN GOTO 920
3150  IF A=4 THEN GOTO 1030
3160  IF A=5 THEN GOTO 1140
3170  IF A=6 THEN GOTO 1250
3180  IF A=7 THEN GOTO 1360
3190  PRINTER IS 16
3200  RETURN
3210 Rtime:  ! SUBROUTINE TO PRINT THE CURRENT REAL TIME.
3220  OUTPUT 9;"R" !REQUESTS THE REAL TIME FROM THE CLOCK.
3230  ENTER 9;T$ !ASSIGNS THE OUTPUT OF THE CLOCK TO T$.
3240  IF T$[1;2]="01" THEN Month$="JANUARY"
3250  IF T$[1;2]="02" THEN Month$="FEBRUARY"
3260  IF T$[1;2]="03" THEN Month$="MARCH"
3270  IF T$[1;2]="04" THEN Month$="APRIL"
3280  IF T$[1;2]="05" THEN Month$="MAY"
3290  IF T$[1;2]="06" THEN Month$="JUNE"
3300  IF T$[1;2]="07" THEN Month$="JULY"
3310  IF T$[1;2]="08" THEN Month$="AUGUST"
3320  IF T$[1;2]="09" THEN Month$="SEPTEMBER"
3330  IF T$[1;2]="10" THEN Month$="OCTOBER"
3340  IF T$[1;2]="11" THEN Month$="NOVEMBER"
3350  IF T$[1;2]="12" THEN Month$="DECEMBER"
3360  PRINT Month$;" ";T$[4;2];",";" ";T$[7;5];" and ";T$[13];" sec."
3370  RETURN
3380  DATA 3
3390  DATA 0,77,300
3400  DATA 112E3,90E3,42E3
3410  DATA 18
3420  DATA 0,10,20,30,40,50,60,70,80,90,100,120,140,160,180,200,250,300
3430  DATA 0,.0196,.0495,.0838,.1194,.1473,.1727,.193,.2108,.2286,.2413,.2616,.2
794,.3048,.3124,.3302,.3556,.381
```

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