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MEASUREMENT OF LUNG FUNCTION USING MAGNETOMETERS II. DATA ACQUS--ETC(U)  
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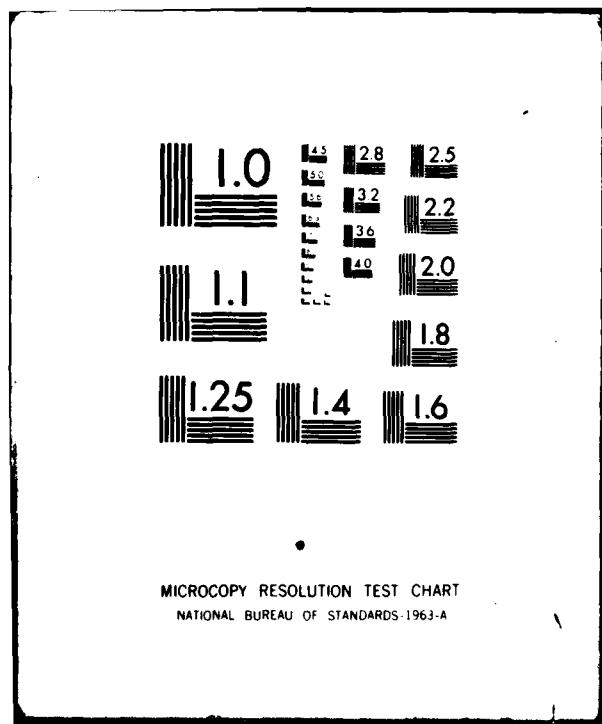
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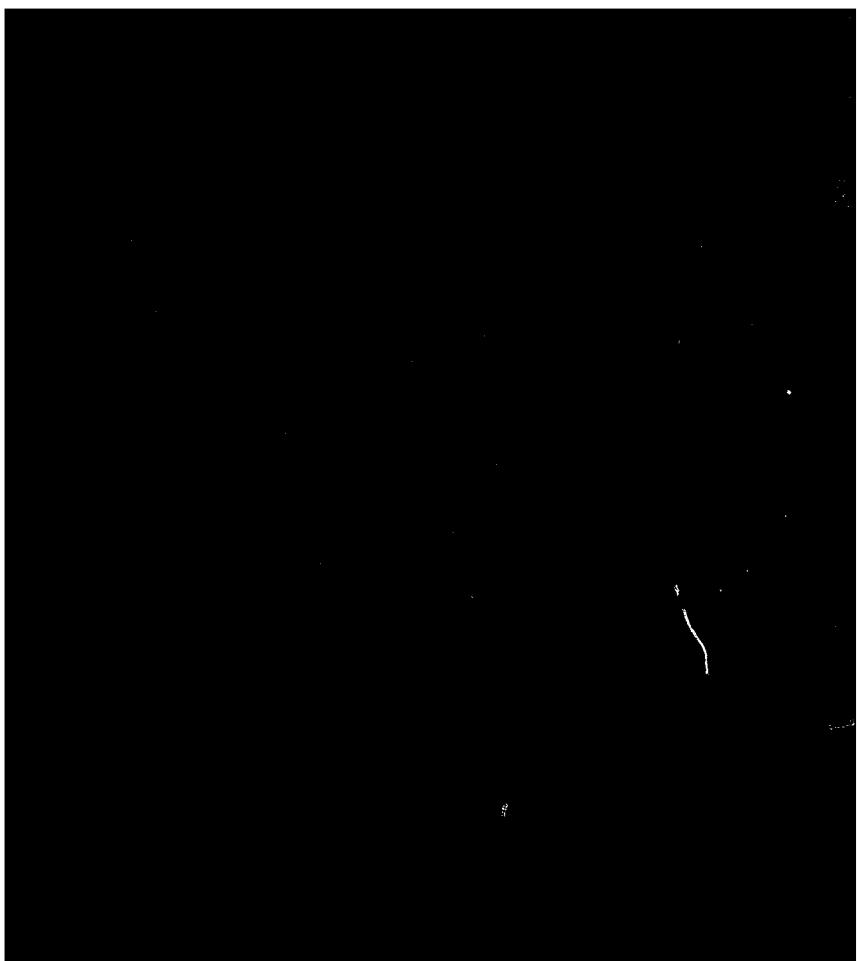
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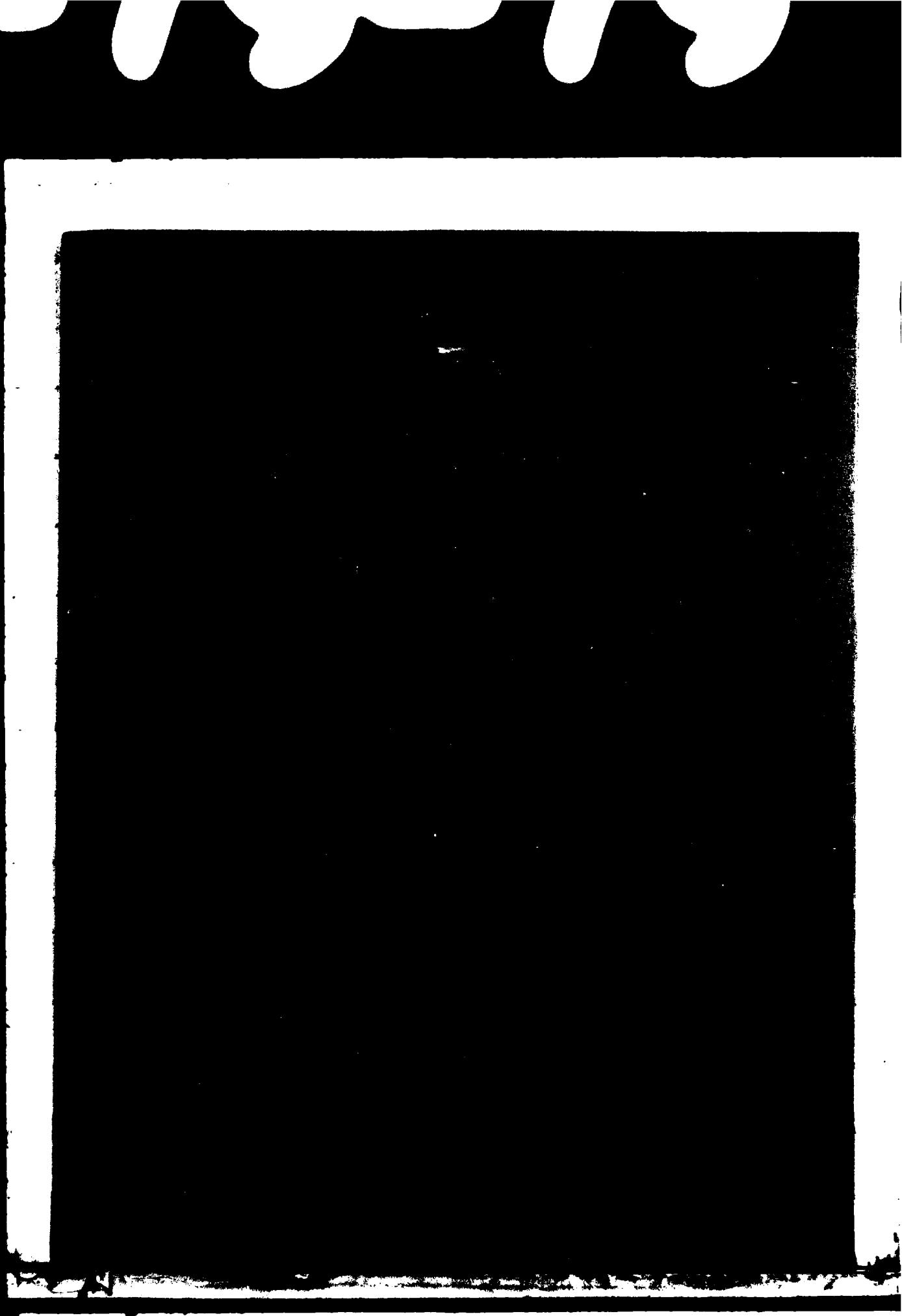
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TABLE OF CONTENTS

	<u>Page No.</u>
Introduction .....	1
PROGRAM ALLDAT .....	1
PROGRAM PLT .....	1
PROGRAM COMPARE .....	2
PROGRAMS M1 to M7 .....	2
PROGRAM CALC .....	2
References .....	4
Appendix 1. Step by Step guide to the Programs .....	5
Appendix 2. Program ALLDAT .....	23
Appendix 3. Program PLT .....	25
Appendix 4. Program COMPARE .....	29
Appendix 5. Program M5 .....	32
Appendix 6. Program CALC .....	36

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## MEASUREMENT OF LUNG FUNCTION USING MAGNETOMETERS.

### II. Data Acquisition and Analysis.

Donald L. Vawter, Ph.D.

The Hyperbaric Medicine and Physiology researchers who measure lung function using magnetometers currently use the program DATLOG to sample and store the magnetometer and spirometer output. To better visualize the chest and abdomen during the motion of respiration, we have developed a software package for plotting the sample data and for fitting a variety of models to the data. There are five basic programs discussed briefly in this report. The programs are interactive in nature and largely self-explanatory. The use of the programs on one particular data set is presented in Appendix 1, which should serve as a user's guide.

#### PROGRAM ALLDAT

This program prints the data stored on the specified input file. The input file should be in the form generated by DATLOG. The user has the option of printing out data at only a few points. This program is generally only useful for inspecting data for spurious points. The FORTRAN listing is contained in Appendix 2.

#### PROGRAM PLT

Program PLT has three functions:

- 1) Prepare a data file for plotting the data automatically, using program [1,100] PLOT. The spirometer output and the output from each magnetometer will be plotted. The user must input the name for the plotfile to be generated.
- 2) "DC Offset" the data. It may be useful in some situations to force the data set to be zero at either the start or the end of the data set. For example, because the change rather than absolute volume is important, one may wish to subtract the spirometer reading at the first data point from all values in the data set. This is especially useful if the first data point corresponds to end-expiratory values. The use of software to accomplish this function has an advantage over the previous method of offsetting the data electronically by use of a low-pass filter system. The advantage is that the "raw" data is not altered. Hence, if one discovers later that the initial point does not correspond to end expiration, one still has the original data set. The offset feature is also useful if there is drift present in the data. One can then offset the data by the average of the first and last data values. This, of course, works only if both points correspond to the same point in the respiratory cycle.

- 3) Search the data and determine the minimum and maximum values of the data for each channel. Thus, one can tell at a glance the excursions of the chest and abdomen and also the volume excursion for that data set. The FORTRAN listing of PLT is in Appendix 3.

#### PROGRAM COMPARE

Program COMPARE prepares a data set for plotting one channel data versus any other channel. For example, one can plot the change in anterior-posterior (A-P) chest diameter versus volume, or one can compare the change in A-P chest diameter versus the change in lateral chest diameter. The data set generated is compatible with the automatic plotting program [1,100] PLOT. The FORTRAN listing for COMPARE is found in Appendix 4.

#### PROGRAMS M1 to M7

These programs determine the constants for the seven models discussed below. The FORTRAN listing for Model 7 is found in Appendix 5. For the other models, the array "S" is altered according to the definitions in reference 1.

#### PROGRAM CALC

Program CALC generates data files for plotting the model curves on the VERSATEC plotter. The program also determines whether adding a constant to the predicted volume lowers the error. The program asks the user whether he wishes to use the offset. The offset should be used only when predictive results are desired and not for calibration curves. The FORTRAN listing is in Appendix 6.

The equations for Models 1 through 7 are given below.

$$\text{Model 1: } V = K_1 * (DC - DCO) - K_2 * (DA - DAO)$$

$$\text{Model 2: } V = K_1 * (APC - APCO) - K_2 * (APA - APAO)$$

$$\text{Model 3: } V = K_1 - K_2 * (APA - APAO)$$

$$\text{Model 4: } V = K_1 * (APC - APCO) - K_2$$

$$\text{Model 5: } V = K_1 * DC - K_2 * (DC/DA) - K_3$$

$$\text{Model 6: } V = K_1 * (DC - DCO) - K_2 * (DC/DA - DCO/DAO) - K_3$$

$$\text{Model 7: } V = K_1 * DC - K_2 * DA - K_3,$$

where  $V$  is volume,  $DC$  is the cross-sectional area of the chest,  $DA$  is the cross-sectional area of the abdomen,  $APC$  is the A-P diameter of the chest, and  $APA$  is the A-P diameter of the abdomen. The corresponding values at FRC (measured with callipers) are followed by "0".  $K_1$ ,  $K_2$ , and  $K_3$  are unknown constants that are determined by minimizing the squared error.

In the previous equations, although they are not anatomical models, we still assume the cross-sections of the abdomen and chest are elliptical when calculating areas.

REFERENCES

1. Vawter, D.L. Measurement of lung functions using magnetometers. I. Principles and mathematical modeling. Naval Medical Research Institute Bethesda, MD., 1979.
2. Konno, K., and J. Mead. Measurement of the separate volume changes of rib cage and abdomen during breathing. J. Appl. Physiol. 22:407-422, 1967. AD AO 60473
3. Robertson, C.H., M.E. Bradley, L.M. Fraser, and L.D. Homer. Computerized measurement of ventilation with four chest wall magnetometers. Naval Medical Research Institute, Bethesda, MD., 1978.

**Appendix 1: Step By Step Guide to the Programs**

\*\*\*\*\*  
EXAMPLE OF USING PROGRAM ALLDAT TO INSPECT DATA

\*\*\*\*\*  
RUN ALLDAT

FILE NAME? DK:PSRB.DAT#1  
PRINT EVERY ?TH POINT? 10  
EVERY 10TH POINT IS PRINTED

0.5824	0.2149	0.4782	-0.3183	0.7462
1.1353	0.4739	0.7131	-0.0307	0.8708
1.4856	0.5502	0.9084	0.2076	0.8653
1.3799	0.5329	0.9054	0.1524	0.7831
1.0560	0.3948	0.7513	-0.0481	0.6531
0.5427	0.3056	0.4279	-0.2806	0.5079
0.0448	0.0365	0.2478	-0.3968	0.4805
-0.2305	-0.0843	0.2066	-0.5508	0.3313
0.1748	0.0941	0.2997	-0.4259	0.5216
0.8534	0.3948	0.6079	-0.1411	0.6106
1.3953	0.5315	0.8810	0.1582	0.7243
1.4856	0.5861	0.9191	0.2570	0.7968
1.1353	0.4380	0.7864	0.0216	0.6763
0.6352	0.3085	0.4858	-0.2748	0.5134
0.1484	0.1027	0.2356	-0.3823	0.4395
-0.1799	-0.0814	0.2021	-0.4956	0.3751
-0.0235	-0.0095	0.2082	-0.4840	0.4381

TT2 -- STOP

> —

\*\*\*\*\*  
EXAMPLE USING PLT TO PREPARE DATA FOR PLOTTING  
\*\*\*\*\*

```
RUN PLT
INPUT FILENAME DK:PSRB.DAT#1
WRITE MODIFIED DATA TO FILE?NO
PTS 170 NO OF DATA POINTS FOR DC AVE 0,0
    0 0
OFFSET      0.000    0.000    0.000    0.000    0.000
PREPARE DATA FOR PLOT? YES
FILE NAME FOR PLOT DATA? TEST.PLO#1
PLOT EVERY ?TH DATA POINT 2
CHANNEL   J      MIN      J      MAX      DIFFERENCE
    1    155    -0.250    107    1.538    1.789
    2    156    -0.120    106    0.602    0.722
    3    159    0.190    104    0.927    0.737
    4    155    -0.562    108    0.266    0.828
    5    155    0.298     12    0.883    0.585
ANY MORE ? YES
INPUT FILENAME DK:PSRB.DAT#1
WRITE MODIFIED DATA TO FILE?YES
OUTPUT FILE NAME PSRB.MOD#1
PTS 170 NO OF DATA POINTS FOR DC AVE 1,0
    1 0
OFFSET      0.582    0.215    0.478    -0.318    0.746
TRUNCATE DATA? NO
PREPARE DATA FOR PLOT? YES
FILE NAME FOR PLOT DATA? TEST.PLO#2
PLOT EVERY ?TH DATA POINT 2
CHANNEL   J      MIN      J      MAX      DIFFERENCE
    1    155    -0.833    107    0.956    1.789
    2    156    -0.335    106    0.387    0.722
    3    159    -0.288    104    0.449    0.737
    4    155    -0.244    108    0.584    0.828
    5    155    -0.448     12    0.137    0.585
ANY MORE ? NO
TT2 -- STOP
>
```

\*\*\*\*\*  
PREPARING THE PLOTS FROM DATA SET GENERATED IN FLT  
\*\*\*\*\*

@[1,100]PLOT  
>RUN [110,110]PLOT.TSK

PROGRAM PLOT 09:05:13 08-AUG-79  
DATA FILE? [DEV.NAME.EXT;VER] TEST.PLO#1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 5  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM? -1.,2.  
X AXIS LABEL? <80 CHAR>  
SAMPLE POINT(TIME)  
Y AXIS LABEL? <80 CHAR>  
OUTPUT(L,CM)  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 2  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> TEST.PLO#1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
09:08:11 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] TEST.PLO#2  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 5  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM? -1.,2.  
X AXIS LABEL? <80 CHAR>  
SAMPLE POINT(TIME)  
Y AXIS LABEL? <80 CHAR>  
OUTPUT(L,CM)  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 2  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> TEST.PLO#2  
POSITION? (X,Y) .5,8.  
ANY MORE? YES  
NOTE? <80 CHAR> A = VOLUME; B = AP CHEST; C = LAT CHEST  
POSITION? (X,Y) .5,7.5  
ANY MORE? YES  
NOTE? <80 CHAR> D = AP ABDOMEN; E = LAT ABDOMEN  
POSITION? (X,Y) .5,7.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
09:10:59 08-AUG-79  
ANY MORE PLOTS? NO  
TT2 -- STOP END OF PROGRAM PLOT  
>\* WHAT IS YOUR TERMINAL NUMBER 'TTN' [S]: TT2  
>NFT @PLTT2  
>PIP PLTT2.CMD#\*,PLTT2A.CMD#\*,PLTT2B.CMD#\*/DE  
>@ <EOF> -8-  
>

\*\*\*\*\*  
FITTING VARIOUS MODELS TO DATA SET  
\*\*\*\*\*

RUN M1

FILE NAME DK:PSRB.DAT#1  
INITIAL VOLUME? 0  
APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
-0.24825090E+09  
V = A\*(AC-AC0) - B\*(AA - AAO)

A = 0.31541519E+02 B = -0.27743046E+02  
PRINT EVERY ?TH PT?10

POINT	MEASURED	CALC	ERR
1	582.4	559.3	-23.1
11	1135.3	1168.5	33.2
21	1485.6	1501.1	15.4
31	1379.9	1408.6	28.7
41	1056.0	1006.6	-49.4
51	542.7	534.7	-8.0
61	44.8	108.8	64.0
71	-230.5	-190.3	40.3
81	174.8	185.7	10.9
91	853.4	849.5	-3.8
101	1395.3	1371.7	-23.6
111	1485.6	1542.1	56.4
121	1135.3	1122.1	-13.2
131	635.2	573.8	-61.4
141	148.4	153.5	5.2
151	-179.9	-133.6	46.2
161	-23.5	-30.4	-7.0

ERROR SQ 0.2928E+06 ERRSQ/N 0.1723E+04 RMS 0.4150E+02  
CORRELATION COEFFICIENT 0.9978

ANY MORE ?N

TT2 -- STOP

>

RUN M2

FILE NAME DK:PSRB.DAT;1  
INITIAL VOLUME? 0  
APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
-0.36518832E+03  
V = A\*(D1C-D1C0) - B\*(D1A - D1A0)  
  
A = 0.24866968E+04 B = -0.14099380E+03  
PRINT EVERY ?TH FT?10

POINT	MEASURED	CALC	ERR
1	582.4	489.6	-92.7
11	1135.3	1174.2	38.8
21	1485.6	1397.4	-88.2
31	1379.9	1346.7	-33.2
41	1056.0	974.9	-81.1
51	542.7	720.4	177.6
61	44.8	34.9	-9.9
71	-230.5	-287.3	-56.8
81	174.8	173.9	-0.9
91	853.4	961.8	108.5
101	1395.3	1343.9	-51.4
111	1485.6	1493.8	8.2
121	1135.3	1092.1	-43.2
131	635.2	728.3	93.1
141	148.4	201.6	53.2
151	-179.9	-272.4	-92.5
161	-23.5	-91.8	-68.4

ERROR SQ 0.7859E+06 ERRSQ/N 0.4623E+04 RMS 0.6799E+02  
CORRELATION COEFFICIENT 0.9935

ANY MORE ?NO

TT2 -- STOP

>

RUN M3

FILE NAME DK:PSRB.DAT;1  
INITIAL VOLUME? 0  
APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
-0.19503306E+04  
V = A\*(1.) - B\*(D1A - D1A0)  
  
A = 0.10705438E+04 B = -0.22330249E+04  
PRINT EVERY ?TH PT?10

POINT	MEASURED	CALC	ERR
1	582.4	359.7	-222.7
11	1135.3	1002.1	-133.3
21	1485.6	1534.2	48.6
31	1379.9	1410.9	31.0
41	1056.0	963.1	-92.9
51	542.7	444.0	-98.7
61	44.8	184.5	139.6
71	-230.5	-159.4	71.1
81	174.8	119.6	-55.2
91	853.4	755.5	-97.8
101	1395.3	1423.9	28.6
111	1485.6	1644.5	158.9
121	1135.3	1118.9	-16.5
131	635.2	457.0	-178.2
141	148.4	216.9	68.5
151	-179.9	-36.2	143.7
161	-23.5	-10.2	13.3

ERROR SQ 0.2181E+07 ERRSQ/N 0.1283E+05 RMS 0.1133E+03  
CORRELATION COEFFICIENT 0.9815  
ANY MORE ?NO  
TT2 -- STOP  
>

RUN M4

FILE NAME DK:PSRB.DAT#1  
INITIAL VOLUME? 0  
APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 TAB = 30.5  
-0.14635099E+04  
V = A\*(D1C-D1C0) - B\*(1.)  
  
A = 0.26056196E+04 B = 0.51137753E+02  
PRINT EVERY ?TH PT?10

POINT	MEASURED	CALC	ERR
1	582.4	508.9	-73.4
11	1135.3	1183.7	48.4
21	1485.6	1382.4	-103.2
31	1379.9	1337.4	-42.5
41	1056.0	977.5	-78.5
51	542.7	745.1	202.4
61	44.8	44.1	-0.7
71	-230.5	-270.8	-40.3
81	174.8	194.0	19.2
91	853.4	977.5	124.2
101	1395.3	1333.7	-61.6
111	1485.6	1476.1	-9.5
121	1135.3	1090.0	-45.3
131	635.2	752.6	117.4
141	148.4	216.5	68.2
151	-179.9	-263.3	-83.4
161	-23.5	-75.9	-52.4

ERROR SQ 0.9401E+06 ERRSQ/N 0.5530E+04 RMS 0.7436E+02  
CORRELATION COEFFICIENT 0.9921

ANY MORE ?NO

TT2 -- STOP

>

RUN M5  
 INPUT DATA FILE NAME DK:PSRB.DAT;1  
 APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
 APC = 20.7 LC = 36.0 APAB = 20.7 TAB = 30.5  
 FRC VOL = ? 0  
 FRC VOLUME IN L = 0.000  
 0.61679439E+08 0.12292175E+06 0.10238236E+06 0.71447678E+08  
 0.12292175E+06 0.24504753E+03 0.20410135E+03 0.14035843E+06  
 0.10238236E+06 0.20410135E+03 0.17000000E+03 0.11683972E+06  
 0.13622161E+05 0.75260568E+06 0.74276812E+08 0.35471727E+09  
 V = HO\*AC - VA\*AC/AA - VC  
 HO 0.55248625E+02 VA 0.54526452E+04 VC 0.26039720E+05  
 PRINT EVERY ?TH PT?10

POINT	MEASURED	CALC	ERR
1	582.4	533.7	-48.7
11	1135.3	1154.7	19.3
21	1485.6	1471.8	-13.8
31	1379.9	1412.8	32.9
41	1056.0	1030.1	-25.9
51	542.7	573.9	31.1
61	44.8	60.3	15.5
71	-230.5	-202.3	28.3
81	174.8	169.5	-5.3
91	853.4	885.9	32.5
101	1395.3	1382.2	-13.1
111	1485.6	1527.5	41.9
121	1135.3	1138.5	3.1
131	635.2	622.9	-12.3
141	148.4	130.8	-17.5
151	-179.9	-174.8	5.1
161	-23.5	-63.1	-39.6

ERROR SQ 0.1035E+06 ERRSQ/N 0.6086E+03 RMS 0.2467E+02  
 CORRELATION COEFFICIENT 0.9991

ANY MORE ?NO

TT2 -- STOP

>

RUN M6  
 INPUT DATA FILE NAME DK:PSRB.DAT#1  
 APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
 APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
 FRC VOL = ? 0  
 FRC VOLUME IN L = 0.000  
 0.68712757E+05 0.60359670E+02 0.28849821E+04 0.30638805E+07  
 0.60359670E+02 0.74073050E-01 0.34456037E+01 0.24492416E+04  
 0.28849821E+04 0.34456037E+01 0.17000000E+03 0.11683972E+06  
 0.13622166E+05 0.75260603E+06 0.74276729E+08 0.19042154E+07  
 -0.38364E-01 -0.28492E-04 -0.13270E-02  
 V = HO\*(AC-AC0) - VA\*(AC/AA - AC0/AA0) - VC  
 HO 0.55248631E+02 VA 0.54526372E+04 VC 0.13978799E+03  
 PRINT EVERY ?TH PT?10

POINT	MEASURED	CALC	ERR
1	582.4	533.7	-48.7
11	1135.3	1154.7	19.3
21	1485.6	1471.8	-13.8
31	1379.9	1412.8	32.9
41	1056.0	1030.1	-25.9
51	542.7	573.9	31.1
61	44.8	60.3	15.5
71	-230.5	-202.3	28.3
81	174.8	169.5	-5.3
91	853.4	885.9	32.5
101	1395.3	1382.2	-13.1
111	1485.6	1527.5	41.9
121	1135.3	1138.5	3.1
131	635.2	622.9	-12.3
141	148.4	130.8	-17.5
151	-179.9	-174.8	5.1
161	-23.5	-63.1	-39.6

ERROR SQ 0.1035E+06 ERRSQ/N 0.6086E+03 RMS 0.2467E+02

NEW OFFSET AND VC 0.000 139.788

CORRELATION COEFFICIENT 0.9991

REPRINT DATA WITH NEW VC? N

ANY MORE ?N

TT2 -- STOP

>

RUN M7

INPUT DATA FILE NAME DK:PSRB.DAT#1  
APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
0.61679439E+08 0.51373341E+08 0.10238236E+06 0.71447639E+08  
0.51373341E+08 0.42790040E+08 0.85276428E+05 0.59477517E+08  
0.10238236E+06 0.85276428E+05 0.17000000E+03 0.11683972E+06  
0.23749693E+10 0.10533872E+12-0.31028363E+11 0.72372490E+14  
V = H0\*AC - VA\*AA - VC  
H0 0.44353719E+02 VA -0.13064743E+02 VC 0.32578312E+05  
PRINT EVERY ?TH PT?10

POINT	MEASURED	CALC	ERR
1	582.4	533.7	-48.7
11	1135.3	1154.7	19.4
21	1485.6	1472.3	-13.3
31	1379.9	1412.5	32.6
41	1056.0	1029.8	-26.2
51	542.7	574.2	31.5
61	44.8	60.1	15.2
71	-230.5	-201.9	28.6
81	174.8	169.6	-5.2
91	853.4	885.7	32.4
101	1395.3	1381.9	-13.4
111	1485.6	1527.7	42.0
121	1135.3	1138.1	2.8
131	635.2	623.3	-12.0
141	148.4	130.8	-17.5
151	-179.9	-175.1	4.8
161	-23.5	-63.2	-39.7

ERROR SQ 0.1034E+06 ERRSR/N 0.6080E+03 RMS 0.2466E+02  
CORRELATION COEFFICIENT 0.9991

ANY MORE ?NO

TT2 -- STOP

>

\*\*\*\*\*

PREPARING PLOTS FOR THE CURVE FITS

\*\*\*\*\*

RUN CALC

DO YOU NEED MODEL DESCRIPTION? YES

MODEL CALCULATIONS FOR ELIPTIC CYLINDERS

TYPE 1     $V = A*(AC-AC0) - B*(AAB-AAB0)$   
TYPE 2     $V = A*(D1C(DIAM)-D1C0) - B*(D1A(DIAM) - D1A0)$   
TYPE 3     $V = A - B*(AFAB(DIAM)- AFAB0)$   
TYPE 4     $V = A*(APC(DIAM)-APC0) - B$   
TYPE 5     $V = A*(AC) - B*(AC/AAB) - C$   
TYPE 6     $V = A*(AC-AC0) - B*(AC/AAB-AC0/AAB0) - C$   
TYPE 7     $V = A*AC - B*AAB - C$

INPUT DATA FILE NAME DK:PSRB.DAT#1  
MODEL TYPE? 1

COMPARISON FOR MODEL TYPE 1

PLOT COMPARISON ? YES  
FILE NAME? M1.PLO#1  
APC,LATC,APAB,LATAB =? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C =? 31.541519,-27.743046  
A 0.31541519E+02 B -0.27743046E+02 C 0.00000000E+00  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	559.3	-23.1
170	639.7	697.9	58.2

ERROR SQ 0.2928E+06    ERRSQ/N 0.1722E+04    RMS 0.4150E+02  
OFFSET ? NO

CORRELATION COEFFICIENT 0.9978 -16 -

REPRINT DATA WITH NEW C? NO

EVERY ?TH POINT PLOTTED? 2

ANY MORE ON THIS FILE? YES  
MODEL TYPE? 2

COMPARISON FOR MODEL TYPE 2

PLOT COMPARISON ? YES  
FILE NAME? M2.PLO#1  
NEW CHEST DIMENSIONS ?NO  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C = ? 2486.6968,-141.99380  
A 0.24866968E+04 B -0.14199380E+03 C 0.00000000E+00  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	489.3	-93.1
170	639.7	677.3	37.6

ERROR SQ 0.7859E+06 ERRSQ/N 0.4623E+04 RMS 0.6799E+02  
OFFSET ? NO  
CORRELATION COEFFICIENT 0.9935  
REPRINT DATA WITH NEW C? NO  
EVERY ?TH POINT PLOTTED? 2  
ANY MORE ON THIS FILE? YES  
MODEL TYPE? 3

COMPARISON FOR MODEL TYPE 3

PLOT COMPARISON ? YES  
FILE NAME? M3.PLO#1  
NEW CHEST DIMENSIONS ?NO  
FRC VOL = ? N\N\0  
FRC VOLUME IN L = 0.000  
A,B,C = ? 1070.5438,-2233.0249  
A 0.10705438E+04 B -0.22330249E+04 C 0.00000000E+00  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	359.7	-222.7
170	639.7	671.1	31.5

ERROR SQ 0.2181E+07 ERRSQ/N 0.1283E+05 RMS 0.1133E+03  
OFFSET ? NO  
CORRELATION COEFFICIENT 0.9815  
REPRINT DATA WITH NEW C? NO  
EVERY ?TH POINT PLOTTED? 2  
ANY MORE ON THIS FILE? YES  
MODEL TYPE? 4

COMPARISON FOR MODEL TYPE 4

PLOT COMPARISON ? Y  
FILE NAME? M4.PLO#1  
NEW CHEST DIMENSIONS ?N  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C = ? 2605.619651.137753  
TT2 -- EXITTING DUE TO ERROR 64

DO YOU NEED MODEL DESCRIPTION? NO  
INPUT DATA FILE NAME DK:PSRB.DAT:1  
MODEL TYPE? 4

COMPARISON FOR MODEL TYPE 4

PLOT COMPARISON ? YES  
FILE NAME? M4.PLO:1  
APC,LATC,APAB,LATAB = ? 20.7,36.,20.7,30.5  
APC = 20.7 LC = 36.0 APAB = 20.7 LAB = 30.5  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C = ? 2605.6196,51.137753  
A 0.26056196E+04 B 0.51137753E+02 C 0.00000000E+00  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	508.9	-73.4
170	639.7	685.1	45.5

ERROR SQ 0.9401E+06 ERRSQ/N 0.5530E+04 RMS 0.7436E+02  
OFFSET ? NO  
CORRELATION COEFFICIENT 0.9921  
REPRINT DATA WITH NEW C? NO  
EVERY ?TH POINT PLOTTED? 2  
ANY MORE ON THIS FILE? YES  
MODEL TYPE? 5

COMPARISON FOR MODEL TYPE 5

PLOT COMPARISON ? Y  
FILE NAME? M5.PLO:1  
NEW CHEST DIMENSIONS ?NO  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C = ? 55.248625,5452.6452,26039.72  
A 0.55248625E+02 B 0.54526452E+04 C 0.26039720E+05  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	533.7	-48.7
170	639.7	634.3	-5.4

ERROR SQ 0.1035E+06 ERRSQ/N 0.6086E+03 RMS 0.2467E+02  
OFFSET ? NO  
CORRELATION COEFFICIENT 0.9991  
REPRINT DATA WITH NEW C? NO  
EVERY ?TH POINT PLOTTED? 2  
ANY MORE ON THIS FILE? Y  
MODEL TYPE? 6

COMPARISON FOR MODEL TYPE 6

-18-

PLOT COMPARISON ? Y

FILE NAME? M6.PLO#1  
NEW CHEST DIMENSIONS ?N  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C =? 55.248631,5452.6372,139.78799  
A 0.55248631E+02 B 0.54526372E+04 C 0.13978799E+03  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	533.7	-48.7
170	639.7	634.3	-5.4

ERROR SQ 0.1035E+06 ERRSQ/N 0.6086E+03 RMS 0.2467E+02  
OFFSET ? NO  
CORRELATION COEFFICIENT 0.9991  
REPRINT DATA WITH NEW C? NO  
EVERY ?TH POINT PLOTTED? 2  
ANY MORE ON THIS FILE? YES  
MODEL TYPE? 7

COMPARISON FOR MODEL TYPE 7

PLOT COMPARISON ? YES  
FILE NAME? M7.PLO#1  
NEW CHEST DIMENSIONS ?NO  
FRC VOL = ? 0  
FRC VOLUME IN L = 0.000  
A,B,C =? 44.353719,-13.064743,32578.312  
A 0.44353719E+02 B -0.13064743E+02 C 0.32578312E+05  
PRINT EVERY ?TH PT?169

POINT	MEASURED	CALC	ERR
1	582.4	533.7	-48.7
170	639.7	634.6	-5.1

ERROR SQ 0.1034E+06 ERRSQ/N 0.6080E+03 RMS 0.2466E+02  
OFFSET ? NO  
CORRELATION COEFFICIENT 0.9991  
REPRINT DATA WITH NEW C? NO  
EVERY ?TH POINT PLOTTED? 2  
ANY MORE ON THIS FILE? NO  
ANY MORE ?NO  
TT2 -- STOP  
>

\*\*\*\*\*  
PLOTTING THE CURVE FITS  
\*\*\*\*\*

@C1,100]PLOT  
>RUN [110,110]PLOT.TSK

PROGRAM PLOT 10:01:41 08-AUG-79  
DATA FILE? [DEV.NAME.EXT;VER] M1.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
SAMPLE(TIME)  
Y AXIS LABEL? <80 CHAR>  
VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M1.PLO\$1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO

-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO

10:02:42 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] M2.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
SAMPLE(TIME)  
Y AXIS LABEL? <80 CHAR>  
VPO\OP\VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M2.PLO\$1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO

-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO

10:03:40 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] M3.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
SAMPLE(TIME)  
Y AXIS LABEL? <80 CHAR>  
VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M3.PLO\$1

POSITION? (X,Y) .5,8.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
10:04:30 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] M4.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
SAMPLE(TIME)  
Y AXIS LABEL? <80 CHAR>  
VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M4.PLO\$1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
10:05:24 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] M5.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
TIVIT\SAMPLE(TIME)  
Y AXIS LABEL? <80 CHAR>  
VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M5.PLO\$1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
10:06:20 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] M6.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
SAMPLE(TIME)  
Y AXIS LABEL? <80 CHAR>  
VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0  
ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M6.PLO\$1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
10:07:10 08-AUG-79  
ANY MORE PLOTS? YES  
DATA FILE? [DEV.NAME.EXT;VER] M7.PLO\$1  
NUMBER OF GRAPHS ON THIS SHEET? (MAX 10) 2  
X MINIMUM AND X MAXIMUM?  
Y MINIMUM AND Y MAXIMUM?  
X AXIS LABEL? <80 CHAR>  
SAMPLE(TIME) -21-  
Y AXIS LABEL? <80 CHAR>  
VOLUME  
NO. OF DECIMAL DIGITS FOR LABELING AXES? 0

ANY NOTES? <YES OR NO> YES  
NOTE? <80 CHAR> M7.PLO:1  
POSITION? (X,Y) .5,8.  
ANY MORE? NO  
-----CALCULATING VECTORS-----  
WANT GRID PATTERN ON THE GRAPH? <YES OR NO> NO  
10:07:58 08-AUG-79  
ANY MORE PLOTS? NO  
TT2 -- STOP END OF PROGRAM PLOT  
>\* WHAT IS YOUR TERMINAL NUMBER 'TTN' [S]: TT2  
>NFT @PLTT2  
>PIP PLTT2.CMD;\*,PLTT2A.CMD;\*,PLTT2B.CMD;\*/DE  
>@ <EOF>  
>

**Appendix 2: Program ALLDAT**

FORTRAN IV      V01C-03C      MON 20-AUG-79 08:57:27      PAGE 001  
CORE=19K, UIC=[160,1]      ALLDAT,ALLDAT/-SP=ALLDAT

```
*****  
C  
C  
C                    ALLDAT  
C  
C  
C                    *****  
C                    THIS PROGRAM PRINTS THE RAW DATA THAT HAS BEEN SAMPLED WITH  
C                    DATLOG. IT MAY BE USED TO GET A FEELING FOR  
C                    THE DATA BUT PRINTING EVERY PIECE OF DATA WASTES MUCH TIME.  
C                    YOU MAY ASK FOR ONLY REPRESENTATIVE POINTS TO BE PRINTED  
C                    *****  
0001     DIMENSION A(6),B(200),FILE(10)  
0002     30     FORMAT(5(3X,F9.4))  
0003     700    TYPE 29  
0004     29     FORMAT(' FILE NAME? ',$)  
0005     28     FORMAT(6A4)  
0006     ACCEPT 55,FILE  
0007     55     FORMAT(10A4)  
0008     CALL ASSIGN(3,FILE,0)  
0009     CALL FDBSET(3,'READONLY')  
0010     READ(3,ERR=700)DUM  
0011     REWIND 3  
0012     TYPE 705  
0013     705    FORMAT(' PRINT EVERY ?TH POINT? ',$)  
0014     ACCEPT 706,N  
0015     706    FORMAT(I3)  
0016     TYPE 707,N  
0017     707    FORMAT(' EVERY ',I3,'TH POINT IS PRINTED///')  
0018     IC = N-1  
0019     1     CONTINUE  
0020     READ (3,END=50) (A(I),I=1,6)  
0021     IC = IC + 1  
0022     IF(IC/N*N.NE.IC)GO TO 1  
0023     TYPE 30,(A(K),K=1,5)  
0024     GO TO 1  
0025     98    CONTINUE  
0026     31     FORMAT(2X,I3)  
0027     50     STOP  
0028     END
```

2

**Appendix 3: Program PLT**

**FORTRAN IV      V01C-03C**  
**CORE=19K, UIC=[160,1]**

MON 20-AUG-79 09:10:26

PAGE 001  
PLT,PLT/-SP=PLT

```

*****
C
C
C          PLT
C
C
C *****
C      THIS IS THE MAIN DATA REDUCTION PROGRAM FOR DATA FROM
C      DATLOG.  THE PROGRAM WILL TELL YOU MINIMUM AND
C      MAXIMUM VALUES FOR EACH CHANNEL, AND PREPARE THE DATA FOR
C      @E1,100] PLOT.  YOU MAY ALSO 'DC OFFSET' THE DATA
C      BY THE AVERAGE OF THE FIRST "N1" AND LAST "N2"
C      DATA POINTS.  IF YOU WANT THE BEGINING DO BE ZERO USE N1>0
C      AND N2=0.  IF YOU WANT THE LAST TO BE ZERO USE N1=0 AND N2>0
C      YOU MAY OF COURSE USE N1 = N2 = 0 AND YOU WILL GET NO
C      OFFSET.  THE DATA AFTER BEING OFFSET WILL BE WRITTEN TO A
C      NEW FILE IF YOU CHOOSE.  REMEMBER YOU MAY ONLY PLOT 100
C      DATA POINTS IN@E1,100]PLOT.
C *****
0001      DIMENSION SUM(50),JMIN(5),JMAX(5)
0002      DIMENSION X(6),XMIN(5),XMAX(5),Y(5,1250)
0003      DIMENSION FILE(10)
0004      DATA YB/1HY/
0005      GO TO 700
0006 751      CONTINUE
0007      TYPE 755
0008 755      FORMAT('  ANY MORE  ?  ',$,)
0009      ACCEPT 721,RRR
0010      IF(RRR.NE.YB)GO TO 752
0012 700      TYPE 701
0013 701      FORMAT('  INPUT FILENAME  ',$,)
0014      ACCEPT 702,FILE
0015 702      FORMAT(10A4)
0016      CALL ASSIGN(3,FILE,0)
0017      CALL FDBSET(3,'READONLY')
0018      READ(3,ERR=700)DUM
0019      REWIND 3
0020      TYPE 720
0021 720      FORMAT('  WRITE MODIFIED DATA TO FILE?$',)
0022      ACCEPT 721,R
0023 721      FORMAT(A1)
0024      IF(R.NE.YB) GO TO 725
0026 710      TYPE 711
0027 711      FORMAT('  OUTPUT FILE NAME  ',$,)
0028 712      ACCEPT 702,FILE
0029      CALL ASSIGN(4,FILE,0)
0030      CALL FDBSET(4,'NEW')
0031 725      IC = 0
0032 1      READ(3,END=50) (X(I),I=1,6)
0033      IC = IC + 1
0034      DO 2 J = 1,5
0035 2      Y(J,IC) = X(J)
0036      GO TO 1
0037 50      TYPE 51,IC

```

FORTRAN IV      V01C-03C      MON 20-AUG-79 09:10:26      PAGE 002  
CORE=19K, UIC=[160,1]      PLT,PLT/-SP=PLT

```
0038 51 FORMAT(' PTS ',I4,' NO OF DATA POINTS FOR DC AVE ',\$)
0039   ACCEPT 52, N1,N2
0040 52 FORMAT(I3,I3)
0041   TYPE 296,N1,N2
0042 296 FORMAT(3X,2I3)
0043   DO 4 J = 1,5
0044   SUM(J) = 0
0045   IF(N1.LE.0) GO TO 6
0047   DO 5 K = 1,N1
0048   SUM(J) = SUM(J) + Y(J,K)
0049 5  CONTINUE
0050 6  IF(N2.LE.0) GO TO 8
0052   DO 7 K = 1,N2
0053   SUM(J) = SUM(J) + Y(J,IC-K+1)
0054 7  CONTINUE
0055 8  CONTINUE
0056   IF(N1+N2.NE.0)SUM(J) = SUM(J)/(N1+N2)
0058   DO 10 K = 1,IC
0059 10  Y(J,K) = Y(J,K) - SUM(J)
0060 4  CONTINUE
0061   TYPE 58,(SUM(J),J=1,5)
0062 58  FORMAT(' OFFSETS ',5(2X,F8.3))
0063   IF(R.NE.YB)GO TO 731
0065   NSTA = 1
0066   NSTO = IC
0067   TYPE 1300
0068 1300 FORMAT(' TRUNCATE DATA? ',\$)
0069   ACCEPT 721,R4
0070   IF(R4.EQ.YB) TYPE 1310
0072   IF(R4.EQ.YB) ACCEPT 1305,NSTA,NSTO
0074 1310 FORMAT(' 1ST AND LAST POINTS ? ',\$)
0075 1305 FORMAT(2I4)
0076   DO 730 K= NSTA,NSTO
0077   WRITE(4)(Y(J,K),J=1,5),DUM
0078 730 CONTINUE
0079 731 CONTINUE
0080   TYPE 740
0081 740 FORMAT(' PREPARE DATA FOR PLOT? ',\$)
0082   ACCEPT 721,RR
0083   IF(RR.NE.YB)GO TO 750
0085   TYPE 760
0086 760 FORMAT(' FILE NAME FOR PLOT DATA? ',\$)
0087   ACCEPT 702,FILE
0088   CALL ASSIGN(1,FILE,0)
0089   CALL FDBSET(1,'NEW')
0090   TYPE 60
0091 60  FORMAT(' PLOT EVERY ?TH DATA POINT ',\$)
0092 77  FORMAT(2X,F8.0,' ','F9.4')
0093 72  FORMAT(I3,' ','I1,' ')
0094   ACCEPT 61,N3
0095 61  FORMAT(I2)
0096   NC= IC/N3
0097   IF(NC>N3.NE.IC) NC=NC + 1
0099   DO 70 I = 1,5
```

FORTRAN IV        U01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 09:10:26

PAGE 003  
PLT,PLT/-SP=PLT

```
0100      WRITE(1,72) NC,I
0101      DO 75 K = 1,IC,N3
0102      A=K
0103      WRITE(1,77) A,Y(I,K)
0104 75      CONTINUE
0105 70      CONTINUE
0106 750     CONTINUE
0107      DO 90 J=1,5
0108      XMIN(J) = Y(J,1)
0109      XMAX(J)=Y(J,1)
0110      JMIN(J) = 1
0111      JMAX(J) = 1
0112      DO 90 K = 1,IC
0113      IF(XMIN(J).GT.Y(J,K)) JMIN(J) = K
0115      IF(XMIN(J).GT.Y(J,K))XMIN(J)= Y(J,K)
0117      IF(XMAX(J).LT.Y(J,K))JMAX(J) = K
0119      IF(XMAX(J).LT.Y(J,K))XMAX(J)=Y(J,K)
0121 90      CONTINUE
0122      TYPE 800
0123 800     FORMAT(4X,' CHANNEL   J      MIN      J      MAX
1DIFFERENCE ')
0124      DO 89 K = 1,5
0125 89      TYPE 95,K,JMIN(K),XMIN(K),JMAX(K),XMAX(K),XMAX(K)-XMIN(K)
0126      CALL CLOSE(3)
0127      IF(RR.EQ.YB)CALL CLOSE(1)
0129 95      FORMAT(7X,I3,4X,I4,3X,F8.3,3X,I4,3X,F8.3,5X,F8.3)
0130      IF(R.EQ.YB)CALL CLOSE(4)
0132      GO TO 751
0133 752     STOP
0134      END
```

**Appendix 4: Program COMPARE**

FORTRAN IV        V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 09:06:33

PAGE 001  
COMPARE,COMPARE/-SP=COMPARE

```
C*****  
C  
C      COMPARE  
C  
C*****  
C  
C      THIS PROGRAM COMPARES THE OUTPUT OF ANY TWO CHANNELS OF  
C      DATA IN A FORMAT CONSISTENT WITH THE OUTPUT OF DATLOG  
C  
C*****  
0001      DIMENSION B(6)  
0002      DIMENSION X(6,999)  
0003      DIMENSION FILE(10)  
0004      DATA Y/1HY/  
0005 100  FORMAT(10A4)  
0006 110  FORMAT(I3,',',I1,',')  
0007 120  FORMAT(2X,F8.4,',',F8.4)  
0008 135  CONTINUE  
0009      NN = 0  
0010 1     TYPE 101  
0011 101  FORMAT(//' INPUT FILE? ',\$)  
0012      ACCEPT 100,FILE  
0013      CALL ASSIGN(3,FILE,0)  
0014      CALL FDBSET(3,'READONLY')  
0015      READ(3,ERR=1)DUM  
0016      REWIND 3  
0017      TYPE 102  
0018 102  FORMAT(' OUTPUT FILE? ',\$)  
0019      ACCEPT 100,FILE  
0020      CALL ASSIGN(4,FILE,0)  
0021      CALL FDBSET(4,'NEW')  
0022      TYPE 103  
0023 103  FORMAT(' CHANNEL ? = X? ',\$)  
0024      ACCEPT 104,N1  
0025 104  FORMAT(I1)  
0026      TYPE 105  
0027 105  FORMAT(' CHANNEL ? = Y? ',\$)  
0028      ACCEPT 104,N2  
0029      IC = 0  
0030      READ(3)(B(I),I=1,6)  
0031      XMIN = B(N1)  
0032      XMAX = XMIN  
0033      YMIN = B(N2)  
0034      YMAX = YMIN  
0035      REWIND 3  
0036 25    READ(3,END=50)(X(I,IC+1),I=1,6)  
0037      IF(X(N1,IC+1).LT.XMIN) XMIN = X(N1,IC+1)  
0038      IF(X(N1,IC+1).GT.XMAX) XMAX = X(N1,IC+1)  
0039      IF(X(N2,IC+1).LT.YMIN) YMIN = X(N2,IC+1)  
0040      IF(X(N2,IC+1).GT.YMAX) YMAX = X(N2,IC+1)  
0041      IC = IC + 1
```

FORTRAN IV      V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 09:06:33

PAGE 002  
COMPARE,COMPARE/-SP=COMPARE

```
0046      GO TO 25
0047  50      WRITE(4,110)IC,NN
0048      TYPE 150,XMIN,XMAX
0049      TYPE 151, YMIN,YMAX
0050  150     FORMAT(' XMIN ',F8.4,' XMAX ',F8.4)
0051  151     FORMAT(' YMIN ',F8.4,' YMAX ',F8.4)
0052      DO 30I =1,IC
0053  30      WRITE(4,120)X(N1,I),X(N2,I)
0054      CALL CLOSE(3)
0055      CALL CLOSE(4)
0056      TYPE 130
0057  130     FORMAT(' ANY MORE? ',*)
0058      ACCEPT 131,YB
0059      IF(YB.EQ.Y) GO TO 135
0061  131     FORMAT(A1)
0062      STOP
0063      END
```

FORTRAN IV      STORAGE MAP

NAME	OFFSET	ATTRIBUTES
B	000006	REAL*4    ARRAY (6)
X	000036	REAL*4    ARRAY (6,999) VECTORED
FILE	056706	REAL*4    ARRAY (10)
Y	056756	REAL*4    VARIABLE
NN	063222	INTEGER*2 VARIABLE
ASSIGN	000000	REAL*4    PROCEDURE
FDBSET	000000	REAL*4    PROCEDURE
DUM	063224	REAL*4    VARIABLE
N1	063230	INTEGER*2 VARIABLE
N2	063232	INTEGER*2 VARIABLE
IC	063234	INTEGER*2 VARIABLE
I	063236	INTEGER*2 VARIABLE
XMIN	063240	REAL*4    VARIABLE
XMAX	063244	REAL*4    VARIABLE
YMIN	063250	REAL*4    VARIABLE
YMAX	063254	REAL*4    VARIABLE
CLOSE	000000	REAL*4    PROCEDURE
YB	063260	REAL*4    VARIABLE

>

**Appendix 5: Program M5**

FORTRAN IV V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 08:51:23

PAGE 001  
M5,M5/-SP=M5

```
*****  
C  
C  
C      M5 CURVE FIT FOR MODEL 5 3 PARAMETER MODEL  
C  
C*****  
0001    DOUBLE PRECISION DC,DA,V,APC,XLC,APAB,XLAB,VFRC  
0002    DOUBLE PRECISION PI,D1C,D2C,D1A,D2A,H0,VA,VC,SER,SX  
1,SX2,SY,SY2,SXY,VM,D2D,VV,ER,CC  
0003    DIMENSION FILE(10)  
0004    DOUBLE PRECISION S(12),XIC,DETC,XN1,XN2,XN3  
0005    DOUBLE PRECISION AO  
0006    DATA YY/1HY/  
0007    NDIC = 0  
0008 900    TYPE 600  
0009 600    FORMAT(' INPUT DATA FILE NAME ', $)  
0010    ACCEPT 601,FILE  
0011 601    FORMAT(10A4)  
0012    CALL ASSIGN(3,FILE,0)  
0013    CALL FDBSET(3,'READONLY')  
0014    READ(3,ERR=900) DUM  
0015    REWIND 3  
0016    IF(NDIC.EQ.0.) GO TO 2002  
0018    TYPE 432  
0019    ACCEPT 401,YB  
0020    IF(YB.NE.YY) GO TO 433  
0022 432    FORMAT(' NEW CHEST DIMENSIONS ? ', $)  
0023 2002    TYPE 602  
0024 602    FORMAT(' APC,LATC,APAB,LATAB =? ', $)  
0025    ACCEPT 603,APC,XLC,APAB,XLAB  
0026    TYPE 619,APC,XLC,APAB,XLAB  
0027 619    FORMAT(' APC =',F6.1,', LC =',F6.1,', APAB =',F6.1,', LAB ='  
1,F6.1)  
0028    NDIC = 1  
0029 603    FORMAT(4FB.0)  
0030 433    TYPE 500  
0031 500    FORMAT(' FRC VOL = ? ', $)  
0032    ACCEPT 501 ,VFRC  
0033 501    FORMAT(F8.3)  
0034    TYPE 502 ,VFRC  
0035 502    FORMAT(' FRC VOLUME IN L = ',FB.3)  
0036    IC=1  
0037    DO 56 I = 1,12  
0038 56    S(I) = 0  
0039    AO= APC*XLC  
0040    PI=3.1415926  
0041 60    READ(3,END=50) (VVV,D1CC,D2CC,D1AC,D2AC,DUM)  
0042    V = VVV  
0043    D1C = D1CC  
0044    D2C = D2CC  
0045    D1A=D1AC  
0046    D2A=D2AC  
0047    D1C=D1C + APC
```

FORTRAN IV V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 08:51:23

PAGE 002  
M5,M5/-SP=M5

```
0048      D2C= D2C + XLC
0049      D1A = D1A + APAB
0050      D2A = D2A + XLAB
0051      DC = PI*D1C*D2C/4.
0052      DA = PI*D1A*D2A/4.
0053 678   FORMAT(2X,F8.3)
0054      V =( V +VFRC)*1000.
0055      S(1) = S(1) + DC*DC
0056      S(2) = S(2) + DC/DA*DC
0057      S(3) = S(3) + DC
0058      S(4) = S(4)+ V*DC
0059      S(6) = S(6) + DC*DC/DA/DA
0060      S(7) = S(7) + DC/DA
0061      S(8) = S(8) + DC*V/DA
0062      S(11) = S(11) + 1
0063      S(12) = S(12) + V
0064      IC = IC + 1
0065      GO TO 60
0066 50    S(5) = S(2)
0067      S(9) = S(3)
0068      S(10) = S(7)
0069      TYPE 99,(S(I),I=1,12)
0070      DETC = S(1)*(S(6)*S(11) - S(7)*S(10))
0071      DETC = DETC + S(9)*(S(2)*S(7)-S(3)*S(6))
0072      DETC = DETC -S(5)*(S(2)*S(11)-S(3)*S(10))
0073      XN1 = S(4)*(S(6)*S(11)-S(7)*S(10))
0074      XN1 = XN1 + S(12)*(S(2)*S(7)-S(3)*S(6))
0075      XN1 = XN1 - S(8)*(S(2)*S(11)-S(3)*S(10))
0076      XN2 = S(1)*(S(7)*S(12)-S(8)*S(11))
0077      XN2 = XN2 + S(9)*(S(3)*S(8)-S(4)*S(7))
0078      XN2 = XN2 - S(5)*(S(3)*S(12)-S(4)*S(11))
0079      XN3 = S(1)*(S(8)*S(10)-S(6)*S(12))
0080      XN3 = XN3 + S(9)*(S(4)*S(6)-S(2)*S(8))
0081      XN3 = XN3 - S(5)*(S(4)*S(10)-S(2)*S(12))
0082      IC = IC -1
0083      TYPE 99,DETC,XN1,XN2,XN3
0084 99    FORMAT(2X,4E15.8)
0085      HO = XN1/DETC
0086      VA = XN2/DETC
0087      VC= XN3/DETC
0088      TYPE 71
0089 71    FORMAT(' V = HO*AC - VA*AC/AA - VC ')
0090      TYPE 70,HO,VA,VC
0091 70    FORMAT(' HO ',E15.8,' VA ',E15.8,' VC ',E15.8)
0092      TYPE 1000
0093 1000  FORMAT(' PRINT EVERY ?TH PT?',$)
0094      ACCEPT 1001,NPO
0095 1001  FORMAT(I3)
0096      IC = 1
0097      SER = 0
0098      SX = 0
0099      SX2 = 0
0100      SY = 0
0101      SY2 = 0
```

FORTRAN IV      V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 08:51:23

PAGE 003  
M5,M5/-SP=M5

```
0102      SXY = 0
0103      REWIND 3
0104      TYPE 490
0105 490  FORMAT(//',POINT',5X,'MEASURED',5X,'CALC',8X,'ERR')
0106 424  READ(3,END=430)(VVV,D1CC,D2CC,D1AC,D2AC,DUM)
0107      D1C = D1CC
0108      D2C = D2CC
0109      D1A = D1AC
0110      D2A = D2AC
0111      VM = VVV
0112      D1C=D1C+APC
0113      D2C=D2C+XLC
0114      D2A=D2A+XLAB
0115      D1A=D1A+APAB
0116      DC = PI*D1C*D2C/4.
0117      DA= PI*D1A*D2A/4.
0118      VV = HO*(DC) - VA*(DC/DA)-VC
0119      VM = 1000.* (VM + VFRC)
0120      ER = VV - VM
0121      SX = SX + VM
0122      SX2 = SX2 + VM*VM
0123      SY = SY + VV
0124      SY2 = SY2 + VV*VV
0125      SXY = SXY + VM*VV
0126      NN =IC + NPO-1
0127      SER = SER + ER*ER
0128      IF(NN/NPO*NPO.NE.NN)GO TO 1003
0129      TYPE 425, IC,VM,VV,ER
0130
0131 425  FORMAT(3X,I4,5X,F8.1,5X,F8.1,5X,F8.1)
0132 1003 IC = IC + 1
0133      GO TO 424
0134 430  TYPE 427,SER,SER/(IC-1),(SER/(IC-1))**.5
0135      IC = IC - 1
0136      SXY = SXY - SX*SY/IC
0137      SXY = SXY/(IC-1)
0138      SX = SX2 - SX*SX/IC
0139      SX = SX/(IC-1)
0140      SX = SX**.5
0141      SY = SY2 - SY*SY/IC
0142      SY = SY/(IC-1)
0143      SY = SY**.5
0144      CC = SXY/SX/SY
0145      TYPE 1100,CC
0146 1100  FORMAT(' CORRELATION COEFFICIENT ',F8.4)
0147 427  FORMAT(//', ERROR SQ ',E12.4,3X,'ERRSQ/N ',E12.4,', RMS ',
1E12.4)
0148 400  FORMAT(' ANY MORE ?',$)
0149      TYPE 400
0150      CALL CLOSE(3)
0151 401  FORMAT(A1)
0152      ACCEPT 401,YB
0153      IF(YB.EQ.YY)GO TO 900
0155      STOP
0156      END
```

**Appendix 6: Program CALC**

FORTRAN IV V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 09:15:28

PAGE 001

CALC,CALC/-SP=CALC

```
*****  
C  
C  
C PROGRAM CALC  
C  
C PREPARES MODEL FITS FOR VERSATEC PLOTTING  
C  
C*****  
0001 DOUBLE PRECISION DC,DA,UV,H0,HQ,VA,VC  
0002 DOUBLE PRECISION VM,APC,XLC,APAB,XLAB,UFRC,PI,CONS,SER,SX  
0003 DOUBLE PRECISION SX2,SY,SY2,SXY,DC0,DAO,D1C0,D1A0,D2C0,D2A0  
0004 DOUBLE PRECISION D1C,D2C,D1A,D2A,D2D,ER,CC  
0005 DIMENSION UV(999),VM(999)  
0006 DIMENSION FILE(10)  
0007 DOUBLE PRECISION S(12),XIC,DETC,XN1,XN2,XN3  
0008 DOUBLE PRECISION AO  
0009 DATA YY/1HY/  
0010 TYPE 4000  
0011 4000 FORMAT(' DO YOU NEED MODEL DESCRIPTION? ', $)  
0012 ACCEPT 401,Y  
0013 IF(Y.NE.YY) GO TO 4005  
0015 TYPE 4010  
0016 4010 FORMAT(////' MODEL CALCULATIONS FOR ELIFTIC CYLINDERS'  
1////)  
0017 TYPE 4006  
0018 4006 FORMAT(' TYPE 1 V = A*(AC-AC0) - B*(AAB-AAB0) //'  
1' TYPE 2 V = A*(D1C(DIAM)-D1C0) - B*(D1A(DIAM) - D1A0)//'  
2' TYPE 3 V = A - B*(APAB(DIAM) - APAB0)//'  
3' TYPE 4 V = A*(APC(DIAM)-APC0) - B//'  
4' TYPE 5 V = A*(AC) - B*(AC/AAB) - C//'  
5' TYPE 6 V = A*(AC-AC0) - B*(AC/AAB-AC0/AAB0) - C//'  
6' TYPE 7 V = A*AC - B*AAB - C///)  
0019 4005 CONTINUE  
0020 NDIC = 0  
0021 900 TYPE 600  
0022 600 FORMAT(' INPUT DATA FILE NAME ', $)  
0023 ACCEPT 601,FILE  
0024 601 FORMAT(10A4)  
0025 CALL ASSIGN(3,FILE,0)  
0026 CALL FDBSET(3,'READONLY')  
0027 READ(3,ERR=900)DUM  
0028 4999 REWIND 3  
0029 TYPE 6000  
0030 6000 FORMAT(' MODEL TYPE? ', $)  
0031 ACCEPT 1001,MTY  
0032 TYPE 6001, MTY  
0033 6001 FORMAT(//' COMPARISON FOR MODEL TYPE',I3//)  
0034 TYPE 9876  
0035 9876 FORMAT(' PLOT COMPARISON ? ', $)  
0036 ACCEPT 401,YYYY  
0037 IF(YYYY.NE.YY)GO TO 9875  
0039 TYPE 9874  
0040 9874 FORMAT(' FILE NAME? ', $)
```

**FORTRAN IV      V01C-03C**  
**CORE=19K, UIC=[160,1]**

MON 20-AUG-79 09:15:28

B PAGE 002  
CALC,CALC/-SP=CALC

```

0041      ACCEPT 601,FILE
0042      CALL ASSIGN(4,FILE,0)
0043      CALL FDBSET(4,'NEW')
0044 9875    CONTINUE
0045      IF(NDIC.EQ.0. ) GO TO 2002
0047      TYPE 432
0048      ACCEPT 401,YB
0049      IF(YB.NE.YY) GO TO 433
0051 432    FORMAT(' NEW CHEST DIMENSIONS ? ',\$)
0052 2002    TYPE 602
0053 602    FORMAT(' APC,LATC,APAB,LATAB =? ',\$)
0054      ACCEPT 603,APC,XLC,APAB,XLAB
0055      TYPE 619,APC,XLC,APAB,XLAB
0056 619    FORMAT(' APC =',F6.1,' LC =',F6.1,' APAB =',F6.1,' LAB ='
1,F6.1)
0057      NDIC = 1
0058 603    FORMAT(4FB.0)
0059 433    TYPE 500
0060 500    FORMAT(' FRC VOL = ? ',\$)
0061      ACCEPT 501 ,VFRC
0062 501    FORMAT(F8.3)
0063      TYPE 502 ,VFRC
0064 502    FORMAT(' FRC VOLUME IN L = ',F8.3)
0065      IC=1
0066      DO 56 I = 1,12
0067 56      S(I) = 0
0068      AO= APC*XLC
0069      PI=3.1415926
0070      GO TO 1234
0071 678    FORMAT(2X,F8.3)
0072 1300   FORMAT(3(2X,E12.5))
0073 1234   CONTINUE
0074      TYPE 1235
0075 1235   FORMAT(' A,B,C =? ',\$)
0076      ACCEPT 1236,HO,VA,VC
0077 1236   FORMAT(3F12.0)
0078      CONS = 0
0079 999    TYPE 70,HO,VA,VC
0080 70      FORMAT(' A ',E15.8,' B ',E15.8,' C ',E15.8)
0081 76      FORMAT(F8.0)
0082      TYPE 1000
0083 1000   FORMAT(' PRINT EVERY 7TH PT?',\$)
0084      ACCEPT 1001,NPO
0085 1001   FORMAT(I3)
0086      IC = 1
0087      SER = 0
0088      SX = 0
0089      SX2 = 0
0090      SY = 0
0091      SY2 = 0
0092      SXY = 0
0093      DCO = PI*APC*XLC/4.
0094      DAO = PI*APAB*XLAB/4.
0095      D1CO = APC

```

FORTRAN IV        V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 09:15:28

PAGE 003

CALC,CALC/-SP=CALC

```
0096      D1AO = APAB
0097      D2CO = XLC
0098      D2AO = XLAB
0099      REWIND 3
0100      TYPE 490
0101 490  FORMAT(//',POINT',5X,'MEASURED',5X,'CALC',8X,'ERR')
0102 424  READ(3,END=430)(VVM,DD1,DD2,DD3,DD4,DUM)
0103      D1C= DD1
0104      D2C=DD2
0105      D1A=DD3
0106      D2A=DD4
0107      VM(IC) = VVM
0108      D1C=D1C+APC
0109      D2C=D2C+XLC
0110      D2A=D2A+XLAB
0111      D1A=D1A+APAB
0112      DC = PI*D1C*D2C/4.
0113      DA= PI*D1A*D2A/4.
0114      IF(MTY.EQ.1) UV(IC) = HO*(DC - DC0) - VA*(DA-DAO)+ CONS
0116      IF(MTY.EQ.2) UV(IC) = HO*(D1C-D1C0) - VA*(D1A-D1AO)+ CONS
0118      IF(MTY.EQ.3) UV(IC) = HO - VA*(D1A-D1AO)
0120      IF(MTY.EQ.4) UV(IC) = HO*(D1C-D1C0) - VA
0122      IF(MTY.EQ.5) UV(IC) = HO*DC - VA*DC/DA - VC
0124      IF(MTY.EQ.6) UV(IC) = HO*(DC-DC0) -VA*(DC/DA-DAO/DAO) - VC
0126      IF(MTY.EQ.7) UV(IC) = HO*DC - VA*DA - VC
0128      VM(IC) = 1000.* (VM(IC) + VFRC)
0129      ER = UV(IC) - VM(IC)
0130      SX = SX + VM(IC)
0131      SX2 = SX2 + VM(IC)*VM(IC)
0132      SY = SY + UV(IC)
0133      SY2 = SY2 + UV(IC)*UV(IC)
0134      SXY = SXY + VM(IC)*UV(IC)
0135      NN = IC + NPO-1
0136      SER = SER + ER*ER
0137      IF(NN/NPO*NPO.NE.NN)GO TO 1003
0139      TYPE 425, IC,VM(IC),UV(IC),ER
0140 425  FORMAT(3X,I4,5X,F8.1,5X,F8.1,5X,F8.1)
0141 1003  IC = IC + 1
0142      GO TO 424
0143 430  TYPE 427,SER,SER/(IC-1),(SER/(IC-1))**.5
0144      IC = IC - 1
0145      CONS = (SX-SY)/IC
0146      TYPE 9000
0147 9000  FORMAT(' OFFSET ? ',\$)
0148      ACCEPT 401,HY
0149      IF(HY.NE.YY) GO TO 9001
0151      IF(MTY.EQ.3) HO = HO + CONS
0153      IF(MTY.EQ.4) VA = VA -CONS
0155      IF(MTY.EQ.5.OR.MTY.EQ.6.OR.MTY.EQ.7) VC = VC-CONS
0157      TYPE 77,CONS
0158 77   FORMAT(' NEW OFFSET ',F12.3,3X,F12.3)
0159 9001  SXY = SXY - SX*SY/IC
0160      SXY = SXY/(IC-1)
0161      SX = SX2 - SX*SX/IC
```

FORTRAN IV      V01C-03C  
CORE=19K, UIC=[160,1]

MON 20-AUG-79 09:15:28

PAGE 004

CALC,CALC/-SP=CALC

```
0162      SX = SX/(IC-1)
0163      SX = SX**.5
0164      SY = SY2 - SY*SY/IC
0165      SY = SY/(IC-1)
0166      SY = SY**.5
0167      CC = SXY/SX/SY
0168      TYPE 1100,CC
0169      TYPE 1200
0170 1200 FORMAT(' REPRINT DATA WITH NEW CT ',\$)
0171      ACCEPT 401,YB
0172      IF(YB.EQ.YY) GO TO 999
0174 1100 FORMAT(' CORRELATION COEFFICIENT ',F8.4)
0175 427  FORMAT('// ERROR SQ ',E12.4,3X,'ERRSQ/N ',E12.4,' RMS
1E12.4)
0176 400  FORMAT(' ANY MORE ? ',\$)
0177      IF(YYYY.NE.YY) GO TO 8755
0179      I00 = 0
0180      TYPE 8760
0181 8760 FORMAT(' EVERY ?TH POINT PLOTTED? ',\$)
0182      ACCEPT 1001 ,NP
0183      NTDT = IC/NP+ 1
0184      IF((NTOT-1)*NP.EQ.IC)NTOT = NTOT-1
0186      WRITE(4,8765)NTOT,I00
0187      I00 = 4
0188 8765 FORMAT(I3,',',I1,',')
0189      DO 8764 I = 1,IC,NP
0190      XIC = I
0191      WRITE(4,8763)XIC,UV(I)
0192 8764 CONTINUE
0193 8763 FORMAT(2X,F8.0,',',F9.4)
0194      WRITE(4,8765)NTOT,I00
0195      DO 8762 I =1,IC,NP
0196      XIC = I
0197 8762 WRITE(4,8763)XIC,VM(I)
0198      CALL CLOSE(4)
0199 8755 TYPE 5000
0200 5000 FORMAT(' ANY MORE ON THIS FILE? ',\$)
0201      ACCEPT 401,Y
0202      IF(Y.EQ.YY)GO TO 4999
0204      CALL CLOSE(3)
0205      TYPE 400
0206 401  FORMAT(A1)
0207      ACCEPT 401,YB
0208      IF(YB.EQ.YY)GO TO 900
0210      STOP
0211      END
```