ISSN 0389-4010
UDC 519.24

TECHNICAL REPORT OF NATIONAL AEROSPACE LABORATORY

TR-737T

Computer Programs for Estimation of the Flutter and Divergence Boundaries from Random Responses at a Subcritical Range

Yasukatsu ANDO and Yuji MATSUZAKI

September, 1982

NATIONAL AEROSPACE LABORATORY

CHŌFU, TOKYO, JAPAN

CONTENTS

Computer Programs for Estimation of the Flutter and Divergence Boundaries from Random Responses at a Subcritical Range*

Yasukatsu ANDO and Yuji MATSUZAKI **

Summary

This report describes a set of computer programs for NAL's method of estimation of the vibration characteristics and boundaries for flutter and divergence of an aeroelastic system subjected to stationary random noises. The programs listed here are those for the calculations of the auto-coariance function of a time series and Jury's stability parameters of the characteristic equations of fourth and eighth orders, and those for the estimation of the stability boundary, frequency and damping ratio of the system.

概　要

定常な不規則擾乱による気流の乱れで励振された空力弾性系の応答から振動特性およびフラッタまたはダイバージェンス限界値を推定する航技研の方法による一連の計算プログラムを記載する。記載したプログラムは時系列の自己共分散関数の計算，4次あるいは8次の特性方程式の係数，安定限界値および振動数と減衰率の推定に関するものである。

1. INTRODUCTION

A new efficient technique for estimating the stability boundary and vibration characteristics of an aeroelastic system has recently been developed in the National Aerospace Laboratory[1, 2]. The NAL method for the estimation consists of the following procedures. A time series of the response of the aeroelastic system to the gaussian random noise input is represented by an AR-MA process[1—3]. The order and coefficients of the process are estimated by Akaike's AIC minimum procedure[4]. Stability of the system is evaluated with the aid of Jury's stability criteria[5], in which the AR coefficients estimated are used. The stability boundary is estimated by fitting a straight line or a parabolic curve to the stability parameters which are plotted against the dynamic pressure. An equivalent system with viscous damping is introduced in order to evaluate the frequencies and damping ratios from the AR coefficients.

* Received July 6, 1982

** First Airframe Division

Refs. 1 and 2 give the details of the theoretical background of the analysis on which the program is based. Some information on the data analysis is also given in Ref. 3, especially, regarding the selection of values of the parameters used in the programs.

2. COMPUTER PROGRAMS

The set of the programs for the estimation (NAL ESBACS) includes six subprograms which are named CK, AKAIKE, JURY-CE4, JURY-CE8, JURY-CE4-EB and FRED. Except for the program AKAIKE the program listings will be given in the present report.

2.1) Program CK

This program calculates the mean, variance, standard deviation and autocovariance function of a sampled data.

2.2) Program AKAIKE

This program is basically the same as a combination of the two sub-programs CANARM and AUTARM of Ref. 4. Using the autocovariance of the sampled data, this computes the order and coefficients of the AR-MA model. A number of modifications have been made in the two subprograms so that this program can be fitted directly to the objective of this set of the programs.

The essential modification introduced in to the AKAIKE program is the calculation of the AR and MA coefficients of a specific pair of orders of the ARMA process, instead of just evaluating those of the order at which AIC is minimum. Such a calculation is required for the three mode analysis mentioned in Refs. 1 and 2a. When the calculation is made for the MB-th order of the AR part, insert a statement between the 138th and 139th cards of the program CANARM of Ref. 4, like

```
138 C   Dependence accepted when
        MIN-DIC is NEGATIVE
        IF (M1.EQ.MB+1) GO TO
        6999
139     IF (X3(M1).GT.0.0)
        GO TO 110
```

2.3) Program JURY-CE4

This program computes Jury's stability parameters for the 4th order characteristic equation from the coefficients of the AR part. This program provides a preliminary information about the selection of the parameters of JURY-CE4-EB.

2.4) Program JURY-CE4-EB

This program computes Jury's stability parameters for the 4th order characteristic equation and estimates the flutter or divergence boundary.

2.5) Program JURY-CE8

This program computes Jury's stability parameters for the 8th order characteristic equation from the coefficients of the AR part.

2.6) Program FRED

This program computes the frequencies and damping ratios of an equivalent system of J-DOF with viscous damping from the coefficients of the AR part.

3. PROGRAM LISTS

Program listing for CK

```
      C      KOUGIKEN NO HOUHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
      C      SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
      C      ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
      C      CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL,S
      C      METHOD.
      C      NAL ESBACS - 1 - 0001
      C      ****************************************************************
      C      PROGRAM AUTOCOVARIANCE FUNCTION CK.
      C      PROGRAM CK CALCULATES MEAN, VARIANCE, STANDARD DEVIATION AND
      C      AUTOCOVARIANCE FUNCTION.
      C      KO     : DATA NO. FOR THE FIRST SET OF DATA,
      C      KAISU : DATA NO. FOR THE LAST SET OF DATA.
      C      IBSTOP : MAXIMUM NO. OF DATA BLOCKS IN MAGNETIC TAPE WHICH ARE
      C               TRANSFERED TO FILE.
      C      N      : NUMBER OF DATA POINTS
      C      LAGHO : MAXIMUM LAG OF COVARIANCE
      C      YBAR   : MEAN
      C      VAR    : VARIANCE
      C      STD    : STANDARD DEVIATION
      C      C(K):AUTOCOVARIANCE SEQUENCE OF Y(I) COMPUTATION.
      C
             INTEGER*2  IDATA(260)
             DIMENSION Y( 8250)
             DIMENSION C(501)
      CC
      CC     INITIAL DATA
             KO=1
             KAISU=11
             IBSTOP=33
             N= 8192
             LAGHO=200
             IEND=11
             IOUT=51
             IEND=IEND+KAISU-KO
      CC
             DO 50 IN=11,IEND
      CC     INITIAL CONDITION INPUT AND PRINT OUT
             IB=1
      CC
             READ(IN,1,END=40,ERR=40)(IDATA(I),I=1,257)
             CALL NOVALB(IDATA)
             WRITE(6,220) IDATA(257)
             WRITE(6,240)(IDATA(I),I=101,105)
             WRITE(6,250) IDATA(106)
             WRITE(6,260)(IDATA(I),I=107,114)
             WRITE(6,270) IDATA(15),IDATA(16),IDATA(17),IDATA(18),IDATA(19)
             WRITE(6,280) IDATA(37)
             WRITE(6,3) IB
             WRITE(6,2)(IDATA(I),I=1,260)
      CC
             DO  30 J=1,IBSTOP-1
             IB=IB+1
      CC
             READ(IN,1,END=40,ERR=40)(IDATA(I),I=1,255)
             IQ=0
             DO 20 K=6,255
             IQ=IQ+1
          20 IDATA(IQ)=IDATA(K)-10000
```

```
      DO 10 K=1,250
      JK=250*(IB-2)+K
      Y(JK)=IDATA(K)*1.0
   10 CONTINUE
      IF(J.GE. 3) GO TO 120
      WRITE(6,3) IB
      WRITE(6,2)(IDATA(I),I=1,250)
  120 CONTINUE
   30 CONTINUE
   40 CONTINUE
CC
CC    C(K):AUTOCOVARIANCE SEQUENCE OF Y(I) COMPUTATION , PUNCH OUT
      AN=1.0/N
      YBAR=0.
      DO 101 I=1,N
      YBAR=YBAR+Y(I)
  101 CONTINUE
      YBAR=YBAR*AN
      RMM1=N-1
      VAR=0.0
      DO 105 I=1,N
      Y(I)=Y(I)-YBAR
      VAR=VAR+(Y(I)**2)
  105 CONTINUE
      VAR=VAR/RMM1
      STD=SQRT(VAR)
      WRITE(6,55) YBAR,VAR,STD
      KL=LAGHO+1
      DO 110 K=1,KL
      C(K)=0.
      J=K-1
      JJ=N-J
      DO 121 I=1,JJ
      C(K)=C(K)+Y(I)*Y(I+J)
  121 CONTINUE
      C(K)=C(K)*AN
  110 CONTINUE
      WRITE(6,150) N,LAGHO
      WRITE(6,60)
      WRITE(6,130)(C(K),K=1,KL)
CC
      WRITE(IOUT)    N,LAGHO,(C(K),K=1,KL)
      ENDFILE  IOUT
      IOUT=IOUT+1
   50 CONTINUE
      STOP
CC
    1 FORMAT(200A2,57A2)
    2 FORMAT(1H ,5X,20I6)
    3 FORMAT(1H ,///,' BLK=',I5)
   55 FORMAT(1H0,'YBAR=',E15.8,5X,'VAR=',E15.8,5X,'STD=',E15.8//)
   60 FORMAT(1H0,4HC(K)//)
  130 FORMAT(1H0,5E15.7)
  150 FORMAT(1H0,2HN=,I5,5X,6HLAGHO=,I5)
  220 FORMAT(1H0,'TIME SERIES ANALYSIS',/,1H ,'FILE NO.=',I2)
C230  FORMAT(1H ,'MACH=',F10.3,/,1H ,'BPF=',I2,'-',I4,'(HZ)')
  240 FORMAT(1H ,' EXP. NAME IS ',5A2,'.')
  250 FORMAT(1H ,' EXP.NO.=',I6)
```

```
  260 FORMAT(1H ,' OPERATOR NAME IS ',8A2,'.')
  270 FORMAT(1H ,' Y:M:D:H:M =',I2,':',I2,':',I2,':',I2,':',I2)
  280 FORMAT(1H ,' SAMPLING TIME =',I6,'*0.0001')
      END

      SUBROUTINE NOVALB(ID)
      INTEGER*2  ID(260)
      CALL AECONV(ID      ,1,ID(101),1,10,IE)
      IF(IE.NE.0) WRITE(6,100) IE
      ID(106)=ID(6)
      CALL AECONV(ID(7),1,ID(107),1,16,IE)
      IF(IE.NE.0) WRITE(6,100) IE
      ID(257)=ID(257)+1
      RETURN
  100 FORMAT(1H ,' ***,AECONV-ERR CODE ',I7)
      END
```

Input example for program CK

```
// EXPAND USDK,RNO=51,FILE='C01.M8001',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=52,FILE='C01.M8002',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=53,FILE='C01.M8003',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=54,FILE='C01.M8004',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=55,FILE='C01.M8005',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=56,FILE='C01.M8006',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=57,FILE='C01.M8007',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=58,FILE='C01.M8008',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=59,FILE='C01.M8009',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=60,FILE='C01.M8010',DISP=NEW,RECFM=VBS

// EXPAND USDK,RNO=61,FILE='C01.M8011',DISP=NEW,RECFM=VBS

// EXPAND MTR,RNO=11,FSEQ=02,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=12,FSEQ=03,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=13,FSEQ=04,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=14,FSEQ=05,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=15,FSEQ=06,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=16,FSEQ=07,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=17,FSEQ=08,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=18,FSEQ=09,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=19,FSEQ=10,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=20,FSEQ=11,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0

// EXPAND MTR,RNO=21,FSEQ=12,BSIZE=514,RSIZE=514,RECFM=F,VOL=C01MT0
```

```
Output for program CK
TIME SERIES ANALYSIS
FILE NO.= 2
 EXP. NAME IS SDIVER
 EXP.NO.=      1
 OPERATOR NAME IS E
 Y:M:D:H:M =82: 1:14:10:36
 SAMPLING TIME =     10*0.0001


BLK=     1
      21316 18774 17746  8224  8224      1 17696  8224  8224  8224  8224  8224  8224  8224    82     1    14    10    36     1
         82     1    14    10    29      0     0  1028     1     1     0     1     1     0     0     0    10     0     0     0
          0     0     0     0     0      0     0     0 21316 18774 17746  8224  8224     1 17696  8224  8224  8224  8224  8224
       8224  8224    82     1    14     10    36     1    82     1    14    10    29     0     0  1028     1     1     0     1
          1     0     0     0    10      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
      -7484-13851-14887 16448 16448      1-15040 16448 16448 16448 16448 16448 16448 16448     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
          0     0     0     0     0      0     0     0     0     0     0     0     0     0     0     0     1     2     0     0     0


BLK=     2
        -14    14    42    68    93   116   138   159   178   195   212   227   241   254   266   277   286   295   301   306
        312   316   319   322   323   322   323   324   324   324   324   325   326   328   331   334   340   345   350   357
        364   371   379   387   394   401   407   413   417   419   420   419   415   409   401   391   378   362   345   324
        301   276   248   219   187   154   119    84    47    11   -23   -61   -95  -129  -161  -191  -219  -245  -267  -288
       -307  -324  -337  -348  -357  -363  -367  -368  -369  -368  -365  -361  -355  -347  -340  -331  -323  -315  -305  -296
       -287  -281  -274  -269  -264  -260  -257  -255  -254  -254  -254  -255  -256  -255  -254  -252  -250  -245  -240  -231
       -219  -206  -191  -174  -155  -134  -112   -88   -62   -35    -8    18    44    71    97   122   146   170   191   211
        230   247   264   279   290   301   311   318   326   333   336   339   341   340   340   338   335   331   324   317
        309   298   288   275   263   248   232   214   196   178   158   134   112    88    61    34     6   -23   -53   -84
       -116  -147  -179  -210  -240  -268  -296  -320  -344  -364  -381  -396  -408  -416  -421  -421  -420  -414  -405  -394
       -378  -359  -338  -315  -289  -261  -231  -198  -167  -134   -99   -66   -34    -3    28    57    84   105   128   147
        162   173   182   189   190   189   183   175   163   148   131   112    89    64    39    12   -15   -43   -71  -100
       -127  -154  -180  -204  -227  -248  -266  -284  -296  -308


BLK=     3
       -316  -323  -326  -327  -326  -322  -316  -306  -296  -283  -269  -254  -237  -218  -200  -179  -158  -138  -116   -94
        -73   -51   -28    -7    14    34    55    76    95   116   137   157   177   197   219   242   265   289   314   341
        368   397   428   460   493   529   565   602   640   678   718   757   797   834   873   908   942   974  1004  1031
       1054  1074  1088  1099  1104  1106  1103  1094  1080  1060  1036  1006   972   932   888   838   785   728   668   605
        540   471   403   334   265   197   130    65     4   -56  -112  -163  -210  -251  -287  -317  -342  -360  -372  -378
       -376  -370  -357  -340  -317  -290  -259  -224  -186  -147  -105   -63   -21    21    63   102   140   176   207   236
        260   281   298   309   316   318   314   306   295   278   257   232   202   169   134    96    54    12   -33   -78
       -125  -172  -219  -267  -311  -356  -398  -440  -480  -516  -548  -577  -603  -626  -642  -655  -666  -669  -668  -662
       -652  -638  -619  -597  -572  -541  -509  -474  -437  -399  -359  -319  -278  -238  -198  -160  -123   -89   -56   -25
          0    21    37    47    52    53    49    38    24     5   -15   -39   -66   -94  -122  -152  -183  -215  -249  -284
       -320  -358  -397  -438  -479  -522  -566  -609  -654  -696  -738  -777  -815  -850  -881  -907  -929  -946  -958  -964
       -964  -957  -946  -928  -903  -875  -840  -800  -755  -704  -650  -594  -533  -470  -406  -340  -275  -209  -143   -79
        -16    43    99   152   201   243   281   313   340   360

YBAR= 0.21257324E+01      VAR= 0.16652244E+06      STD= 0.40807153E+03


N= 8192      LAGHO=   200
```

C(K)

0.1665021E+06	0.1660025E+06	0.1645139E+06	0.1620431E+06	0.1586197E+06
0.1542686E+06	0.1490338E+06	0.1429528E+06	0.1360837E+06	0.1284859E+06
0.1202214E+06	0.1113614E+06	0.1019821E+06	0.9215475E+05	0.8196581E+05
0.7149131E+05	0.6082581E+05	0.5004212E+05	0.3923747E+05	0.2848216E+05
0.1783083E+05	0.7384602E+04	-0.2779025E+04	-0.1258939E+05	-0.2198728E+05
-0.3090762E+05	-0.3927509E+05	-0.4706778E+05	-0.5422934E+05	-0.6070909E+05
-0.6649331E+05	-0.7154306E+05	-0.7583550E+05	-0.7935719E+05	-0.8209569E+05
-0.8405306E+05	-0.8523000E+05	-0.8564225E+05	-0.8530350E+05	-0.8423562E+05
-0.8246475E+05	-0.8002187E+05	-0.7694962E+05	-0.7328200E+05	-0.6906794E+05
-0.6435750E+05	-0.5920853E+05	-0.5367062E+05	-0.4779847E+05	-0.4165991E+05
-0.3531494E+05	-0.2881254E+05	-0.2221621E+05	-0.1559312E+05	-0.9002184E+04
-0.2505771E+04	0.3842984E+04	0.9992895E+04	0.1588988E+05	0.2148495E+05
0.2673279E+05	0.3159218E+05	0.3601644E+05	0.3998041E+05	0.4346531E+05
0.4644116E+05	0.4888981E+05	0.5079353E+05	0.5214637E+05	0.5294353E+05
0.5318412E+05	0.5287600E+05	0.5202856E+05	0.5065366E+05	0.4877591E+05
0.4641362E+05	0.4359484E+05	0.4035062E+05	0.3671803E+05	0.3272342E+05
0.2840348E+05	0.2380428E+05	0.1896919E+05	0.1394246E+05	0.8766062E+04
0.3486238E+04	-0.1853633E+04	-0.7209121E+04	-0.1253398E+05	-0.1778509E+05
-0.2292034E+05	-0.2789898E+05	-0.3267329E+05	-0.3720919E+05	-0.4148466E+05
-0.4546769E+05	-0.4913284E+05	-0.5244722E+05	-0.5539037E+05	-0.5794562E+05
-0.6009534E+05	-0.6183031E+05	-0.6314466E+05	-0.6403409E+05	-0.6449819E+05
-0.6454031E+05	-0.6416962E+05	-0.6339600E+05	-0.6223437E+05	-0.6070266E+05
-0.5881797E+05	-0.5660609E+05	-0.5410316E+05	-0.5131478E+05	-0.4827950E+05
-0.4503128E+05	-0.4160197E+05	-0.3802931E+05	-0.3433931E+05	-0.3056403E+05
-0.2674283E+05	-0.2291128E+05	-0.1910365E+05	-0.1535287E+05	-0.1169184E+05
-0.8151711E+04	-0.4761496E+04	-0.1548968E+04	0.1460653E+04	0.4246488E+04
0.6785668E+04	0.9060008E+04	0.1105363E+05	0.1275350E+05	0.1415006E+05
0.1523574E+05	0.1600637E+05	0.1646055E+05	0.1659994E+05	0.1642920E+05
0.1595527E+05	0.1518870E+05	0.1414134E+05	0.1282813E+05	0.1126748E+05
0.9477934E+04	0.7480824E+04	0.5300070E+04	0.2957830E+04	0.4812393E+03
-0.2103482E+04	-0.4768426E+04	-0.7485464E+04	-0.1022733E+05	-0.1296496E+05
-0.1567057E+05	-0.1831664E+05	-0.2087705E+05	-0.2332600E+05	-0.2563935E+05

```
-0.2779432E+05 -0.2976973E+05 -0.3154250E+05 -0.3308991E+05 -0.3441806E+05
-0.3550409E+05 -0.3633534E+05 -0.3690369E+05 -0.3720441E+05 -0.3723453E+05
-0.3699259E+05 -0.3648078E+05 -0.3570566E+05 -0.3467725E+05 -0.3339725E+05
-0.3187594E+05 -0.3012676E+05 -0.2816723E+05 -0.2601457E+05 -0.2368718E+05
-0.2120486E+05 -0.1858864E+05 -0.1586084E+05 -0.1304404E+05 -0.1016196E+05
-0.7239039E+04 -0.4298824E+04 -0.1366257E+04  0.1538302E+04  0.4391410E+04
 0.7170004E+04  0.9851836E+04  0.1241776E+05  0.1484798E+05  0.1712477E+05
 0.1923166E+05  0.2115436E+05  0.2287991E+05  0.2439743E+05  0.2569791E+05
 0.2677450E+05
```

Program listing for JURY-CE4

```
      C      KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
      C      SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
      C      ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
      C      CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL,S
      C      METHOD.
      C      NAL ESBACS - 2 - 0003
      C      *****************************************************************
      C      PROGRAM JURY-CE4 COMPUTES JURY'S STABILITY PARAMETERS FOR
      C      CHARACTERISTIC EQUATION OF 4TH ORDER.
      C      THE PROGRAM INPUTS COEFFICIENTS OF AR PART.
      C      KO    : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
      C      KAISU : DATA NO. FOR THE LAST SET OF DATA.
      C      QQ(KO): DYNAMIC PRESSURE.
      C      BO,...,B3 : AR COEFFICIENTS B(0),...,B(3).
      C      *
      C      * STABILITY PARAMETERS *
      C      *
      C      G+1 AND G-1 : G(1) AND G(-1)
      C      D5 : DET(X3-Y3) , D6 : 2(B4-B0)-(B1-B3) , D7 : (B1-B3)-2(B0-B4)
      C
             REAL*8    B4(21),B3(21),B2(21),B1(21),B0(21)
             DIMENSION D1(21),D2(21),D5(21),D6(21),D7(21),QQ(42)
      CC
             READ(5,556) KO,KAISU
             WRITE(6,100)
         555 CONTINUE
             READ(5,500) QQ(KO)
             B4(KO)=1.0
             READ(5,510)      B3(KO),B2(KO),B1(KO),B0(KO)
             D1(KO)=B4(KO)+B3(KO)+B2(KO)+B1(KO)+B0(KO)
             D2(KO)=B4(KO)+B2(KO)+B0(KO)-B3(KO)-B1(KO)
             D5(KO)=(B0(KO)**3)+(B4(KO)**3)+(2.0*B2(KO)*B4(KO)*B0(KO)
            1   +B1(KO)*B3(KO)*B4(KO)+B0(KO)*B1(KO)*B3(KO))
            2   -(B4(KO)**2+B3(KO)**2+B0(KO)*B4(KO)+B0(KO)*B2(KO))
            3   *B0(KO)-(B2(KO)*B4(KO)+B1(KO)**2)*B4(KO)
             D6(KO)=2.0*(B4(KO)-B0(KO))-(B1(KO)-B3(KO))
             D7(KO)=(B1(KO)-B3(KO))-2.0*(B0(KO)-B4(KO))
      CC
      CC     PRINTS OUT :
             WRITE(6,181) KO,QQ(KO),B4(KO),B3(KO),B2(KO),B1(KO),B0(KO)
             WRITE(6,182) KO,QQ(KO),D1(KO),D2(KO),D5(KO),D6(KO),D7(KO)
      CC     PRINTS END
             IF(KO.EQ.KAISU) GO TO 558
             KO=KO+1
             GO TO 555
         558 CONTINUE
             STOP
         100 FORMAT(1H0,10X,'TABLE OF AR COEF. AND STABILITY PARAMETERS',//)
         181 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'  B4=',E13.5,2X,'  B3=',
            * E13.5,2X,'  B2=',E13.5,2X,'  B1=',E13.5,2X,'  B0=',E13.5,/)
         182 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,' G+1=',E13.5,2X,' G-1=',
            * E13.5,2X,'  D5=',E13.5,2X,'  D6=',E13.5,2X,'  D7=',E13.5,//)
         500 FORMAT(F10.0)
         510 FORMAT(4D20.10)
         556 FORMAT(2I5)
             END
```

Input example for program JURY-CE4

```
    1    7
0.697
  -0.3870621811D+01  0.5719954687D+01  -0.3822636170D+01  0.9752230984D+00
0.724
  -0.3870751267D+01  0.5715480661D+01  -0.3813428771D+01  0.9704536878D+00
0.772
  -0.3876385509D+01  0.5730587338D+01  -0.3827188110D+01  0.9747041524D+00
0.802
  -0.3869157356D+01  0.5711384821D+01  -0.3809756352D+01  0.9694635446D+00
0.823
  -0.3877836368D+01  0.5734186824D+01  -0.3829655712D+01  0.9751856517D+00
0.836
  -0.3873212193D+01  0.5722079326D+01  -0.3818873227D+01  0.9720295563D+00
0.847
  -0.3886669923D+01  0.5758122654D+01  -0.3851425664D+01  0.9818472339D+00
```

Output for program JURY-CE4

TABLE OF AR COEF. AND STABILITY PARAMETERS

```
NO.= 1  Q= 0.6970   B4=  0.10000D+01   B3= -0.38706D+01   B2= 0.57200D+01   B1= -0.38226D+01   B0= 0.97522D+00
NO.= 1  Q= 0.6970   G+1= 0.19198E-02   G-1=  0.15388E+02   D5= 0.42651E-06   D6=  0.15682E-02   D7= 0.97539E-01

NO.= 2  Q= 0.7240   B4=  0.10000D+01   B3= -0.38708D+01   B2= 0.57155D+01   B1= -0.38134D+01   B0= 0.97045D+00
NO.= 2  Q= 0.7240   G+1= 0.17543E-02   G-1=  0.15370E+02   D5= 0.54967E-06   D6=  0.17701E-02   D7= 0.11642E+00

NO.= 3  Q= 0.7720   B4=  0.10000D+01   B3= -0.38764D+01   B2= 0.57306D+01   B1= -0.38272D+01   B0= 0.97470D+00
NO.= 3  Q= 0.7720   G+1= 0.17179E-02   G-1=  0.15409E+02   D5= 0.42440E-06   D6=  0.13943E-02   D7= 0.99789E-01

NO.= 4  Q= 0.8020   B4=  0.10000D+01   B3= -0.38692D+01   B2= 0.57114D+01   B1= -0.38098D+01   B0= 0.96946D+00
NO.= 4  Q= 0.8020   G+1= 0.19347E-02   G-1=  0.15360E+02   D5= 0.52175E-06   D6=  0.16719E-02   D7= 0.12047E+00

NO.= 5  Q= 0.8230   B4=  0.10000D+01   B3= -0.38778D+01   B2= 0.57342D+01   B1= -0.38297D+01   B0= 0.97519D+00
NO.= 5  Q= 0.8230   G+1= 0.18804E-02   G-1=  0.15417E+02   D5= 0.24329E-06   D6=  0.14480E-02   D7= 0.97809E-01

NO.= 6  Q= 0.8360   B4=  0.10000D+01   B3= -0.38732D+01   B2= 0.57221D+01   B1= -0.38189D+01   B0= 0.97203D+00
NO.= 6  Q= 0.8360   G+1= 0.20235E-02   G-1=  0.15386E+02   D5= 0.27846E-06   D6=  0.16019E-02   D7= 0.11028E+00

NO.= 7  Q= 0.8470   B4=  0.10000D+01   B3= -0.38867D+01   B2= 0.57581D+01   B1= -0.38514D+01   B0= 0.98185D+00
NO.= 7  Q= 0.8470   G+1= 0.18743E-02   G-1=  0.15478E+02   D5= 0.89669E-07   D6=  0.10613E-02   D7= 0.71550E-01
```

Program listing for JURY-CE4-EB

```
      C      KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
      C      SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
      C      ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
      C      CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL,S
      C      METHOD.
      C      NAL ESBACS - 2 - 0004
      C      ****************************************************************
      C      PROGRAM JURY-CE4-FB COMPUTES JURY'S STABILITY PARAMETERS FOR
      C      CHARACTERISTIC EQUATION OF 4TH ORDER, AND ESTIMATE BOUNDARY.
      C      THE PROGRAM INPUTS THE EXPERIMENTAL AND PROCESS CONDITION, AND
      C      THE ORDER AND COEFFICIENTS OF AR PART.
      C      BOUNDARY IS ESTIMATED FITTING A STRAIGHT LINE AND A PARABOLIC
      C      CURVE TO STABILITY PARAMETERS BY THE LEAST SQUARES METHOD.
      C      PARAMETERS ARE PLOTTED AND THE CRITICAL POINT IS GIVEN ON THE
      C      ABSCISSA.
      C      KO    : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
      C      KAISU : DATA NO. FOR THE LAST SET OF DATA.
      C      QQ(KO): DYNAMIC PRESSURE.
      C      B0,...,B3 : AR COEFFICIENTS B(0),...,B(3).
      C      *
      C      * STABILITY PARAMETERS *
      C      *
      C      G+1 AND G-1 : G(1) AND G(-1)
      C      F+I AND F-I : DET(XI+YI) AND DET(XI-YI)  FOR I=1,3
      C      F+2 : (B1-B3)-2(B0-B4)
      C
             REAL*8 SPMD(12),SBM( 3, 3),W
      C      MM OF X(MM,3) AND XXX(3,MM) AT DIMENSION IS SET TO A NUMERICAL
      C      VALUE WHICH IS CALCULATED FROM KAISU-KO+1 .
             DIMENSION X( 7,3),XX(3,3),XXX(3, 7),B(3)
             DIMENSION FLMA(21),FLMAS(21)
             DIMENSION SX( 3, 3),SY( 3, 3),SHI( 3, 3)
             REAL*8    B4(12),B3(12),B2(12),B1(12),B0(12)
             DIMENSION A4(12),A3(12),A2(12),A1(12),A0(12)
             DIMENSION CC(13),PD(12)
             DIMENSION D1(21),D1S1(21),JD11(20),SDD11(20),QD1S1(20)
             DIMENSION        D1S2(21),JD12(20),SDD12(20),QD1S2(20)
             DIMENSION D2(21),D2S1(21),JD21(20),SDD21(20),QD2S1(20)
             DIMENSION        D2S2(21),JD22(20),SDD22(20),QD2S2(20)
             DIMENSION D5(21),D5S1(21),JD51(20),SDD51(20),QD5S1(20)
             DIMENSION        D5S2(21),JD52(20),SDD52(20),QD5S2(20)
             DIMENSION D6(21),D6S1(21),JD61(20),SDD61(20),QD6S1(20)
             DIMENSION        D6S2(21),JD62(20),SDD62(20),QD6S2(20)
             DIMENSION D7(21),D7S1(21),JD71(20),SDD71(20),QD7S1(20)
             DIMENSION        D7S2(21),JD72(20),SDD72(20),QD7S2(20)
             DIMENSION E5(21),E5S1(21),JE51(20),SDE51(20),QE5S1(20)
             DIMENSION        E5S2(21),JE52(20),SDE52(20),QE5S2(20)
             DIMENSION E6(21),E6S1(21),JE61(20),SDE61(20),QE6S1(20)
             DIMENSION        E6S2(21),JE62(20),SDE62(20),QE6S2(20)
             DIMENSION E7(21),E7S1(21),JE71(20),SDE71(20),QE7S1(20)
             DIMENSION        E7S2(21),JE72(20),SDE72(20),QE7S2(20)
             DIMENSION QQ(42),WORK1(42),WORK2(42)
      CC
             READ(5,556) KO,KAISU
             WRITE(6,100)
             M=4
             MIND=KAISU
      CC
```

```
  555 CONTINUE
      READ(5,500) QQ(KO)
      B4(KO)=1.0
      READ(5,510)      B3(KO),B2(KO),B1(KO),B0(KO)
CC
      D1(KO)=B4(KO)+B3(KO)+B2(KO)+B1(KO)+B0(KO)
      D2(KO)=B4(KO)+B2(KO)+B0(KO)-B3(KO)-B1(KO)
      D7(KO)=(B1(KO)-B3(KO))-2.0*(B0(KO)-B4(KO))
            W=(B0(KO)**3)+(B4(KO)**3)+(2.0*B2(KO)*B4(KO)*B0(KO)
     1   +B1(KO)*B3(KO)*B4(KO)+B0(KO)*B1(KO)*B3(KO))
     2   -(B4(KO)**2+B3(KO)**2+B0(KO)*B4(KO)+B0(KO)*B2(KO))
     3   *B0(KO)-(B2(KO)*B4(KO)+B1(KO)**2)*B4(KO)
      E7(KO)= W
CC
      CC(1)=B0(KO)
      CC(2)=B1(KO)
      CC(3)=B2(KO)
      CC(4)=B3(KO)
      CC(5)=B4(KO)
      M0=M-1
      M1=M+1
      DO 95 I=1,M
   95 PD(I)=0.0
      CALL SAJT(M,M1,M0,CC,PD,SPMD,SBM,SX,SY,SHI)
      D5(KO)=PD(1)
      D6(KO)=PD(2)
      E5(KO)=PD(3)
      E6(KO)=PD(4)
CC
CC    PRINTS OUT :
      WRITE(6,181) KO,QQ(KO),B4(KO),B3(KO),B2(KO),B1(KO),B0(KO)
      WRITE(6,182) KO,QQ(KO),D1(KO),D2(KO),D5(KO),D6(KO),D7(KO)
      WRITE(6,682) KO,QQ(KO),D1(KO),D2(KO),E5(KO),E6(KO),E7(KO)
CC    PRINTS END
      IF(KO.EQ.KAISU) GO TO 558
      KO=KO+1
      GO TO 555
  558 CONTINUE
      WRITE(6,688)
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JD11(KO)=0
      SDD11(KO)=0.0
      QD1S1(KO)=0.0
      JD12(KO)=0
      SDD12(KO)=0.0
      QD1S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 130
      WRITE(6,122)
  123 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 124 I=1,KSU
      FLMA(I)=D1(I)
      FLMAS(I)=0.0
  124 CONTINUE
```

```
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 125
      GO TO 127
  125 JD11(KO)=1
      SDD11(KO)=SD
      DO 126 I=1,KSU1
      D1S1(I)=FLMAS(I)
  126 CONTINUE
      QD1S1(KO)=QQ(KSU1)
  127 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 128
      GO TO 121
  128 JD12(KO)=1
      SDD12(KO)=SD
      DO 129 I=1,KSU1
      D1S2(I)=FLMAS(I)
  129 CONTINUE
      QD1S2(KO)=QQ(KSU1)
  121 CONTINUE
      IF(JISU.EQ.2) GO TO 130
      JISU=JISU+1
      GO TO 123
  130 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JD21(KO)=0
      SDD21(KO)=0.0
      QD2S1(KO)=0.0
      JD22(KO)=0
      SDD22(KO)=0.0
      QD2S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 140
      WRITE(6,132)
  133 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 134 I=1,KSU
      FLMA(I)=D2(I)
      FLMAS(I)=0.0
  134 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 135
      GO TO 137
  135 JD21(KO)=1
      SDD21(KO)=SD
      DO 136 I=1,KSU1
      D2S1(I)=FLMAS(I)
  136 CONTINUE
      QD2S1(KO)=QQ(KSU1)
  137 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 138
      GO TO 131
  138 JD22(KO)=1
      SDD22(KO)=SD
```

```
      DO 139 I=1,KSU1
      D2S2(I)=FLMAS(I)
  139 CONTINUE
      QD2S2(KO)=QQ(KSU1)
  131 CONTINUE
      IF(JISU.EQ.2) GO TO 140
      JISU=JISU+1
      GO TO 133
  140 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JD51(KO)=0
      SDD51(KO)=0.0
      QD5S1(KO)=0.0
      JD52(KO)=0
      SDD52(KO)=0.0
      QD5S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 150
      WRITE(6,142)
  143 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 144 I=1,KSU
      FLMA(I)=D5(I)
      FLMAS(I)=0.0
  144 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 145
      GO TO 147
  145 JD51(KO)=1
      SDD51(KO)=SD
      DO 146 I=1,KSU1
      D5S1(I)=FLMAS(I)
  146 CONTINUE
      QD5S1(KO)=QQ(KSU1)
  147 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 148
      GO TO 141
  148 JD52(KO)=1
      SDD52(KO)=SD
      DO 149 I=1,KSU1
      D5S2(I)=FLMAS(I)
  149 CONTINUE
      QD5S2(KO)=QQ(KSU1)
  141 CONTINUE
      IF(JISU.EQ.2) GO TO 150
      JISU=JISU+1
      GO TO 143
  150 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JD61(KO)=0
      SDD61(KO)=0.0
      QD6S1(KO)=0.0
```

```
      JD62(KO)=0
      SDD62(KO)=0.0
      QD6S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 160
      WRITE(6,152)
  153 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 154 I=1,KSU
      FLMA(I)=D6(I)
      FLMAS(I)=0.0
  154 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 155
      GO TO 157
  155 JD61(KO)=1
      SDD61(KO)=SD
      DO 156 I=1,KSU1
      D6S1(I)=FLMAS(I)
  156 CONTINUE
      QD6S1(KO)=QQ(KSU1)
  157 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 158
      GO TO 151
  158 JD62(KO)=1
      SDD62(KO)=SD
      DO 159 I=1,KSU1
      D6S2(I)=FLMAS(I)
  159 CONTINUE
      QD6S2(KO)=QQ(KSU1)
  151 CONTINUE
      IF(JISU.EQ.2) GO TO 160
      JISU=JISU+1
      GO TO 153
  160 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JD71(KO)=0
      SDD71(KO)=0.0
      QD7S1(KO)=0.0
      JD72(KO)=0
      SDD72(KO)=0.0
      QD7S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 170
      WRITE(6,162)
  163 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 164 I=1,KSU
      FLMA(I)=D7(I)
      FLMAS(I)=0.0
  164 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
```

```
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 165
      GO TO 167
  165 JD71(KO)=1
      SDD71(KO)=SD
      DO 166 I=1,KSU1
      D7S1(I)=FLMAS(I)
  166 CONTINUE
      QD7S1(KO)=QQ(KSU1)
  167 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 168
      GO TO 161
  168 JD72(KO)=1
      SDD72(KO)=SD
      DO 169 I=1,KSU1
      D7S2(I)=FLMAS(I)
  169 CONTINUE
      QD7S2(KO)=QQ(KSU1)
  161 CONTINUE
      IF(JISU.EQ.2) GO TO 170
      JISU=JISU+1
      GO TO 163
  170 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JE51(KO)=0
      SDE51(KO)=0.0
      QE5S1(KO)=0.0
      JE52(KO)=0
      SDE52(KO)=0.0
      QE5S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 450
      WRITE(6,442)
  443 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 444 I=1,KSU
      FLMA(I)=E5(I)
      FLMAS(I)=0.0
  444 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 445
      GO TO 447
  445 JE51(KO)=1
      SDE51(KO)=SD
      DO 446 I=1,KSU1
      E5S1(I)=FLMAS(I)
  446 CONTINUE
      QE5S1(KO)=QQ(KSU1)
  447 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 448
      GO TO 441
  448 JE52(KO)=1
      SDE52(KO)=SD
      DO 449 I=1,KSU1
      E5S2(I)=FLMAS(I)
```

```
  449 CONTINUE
      QE5S2(KO)=QQ(KSU1)
  441 CONTINUE
      IF(JISU.EQ.2) GO TO 450
      JISU=JISU+1
      GO TO 443
  450 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JE61(KO)=0
      SDE61(KO)=0.0
      QE6S1(KO)=0.0
      JE62(KO)=0
      SDE62(KO)=0.0
      QE6S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 460
      WRITE(6,452)
  453 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 454 I=1,KSU
      FLMA(I)=E6(I)
      FLMAS(I)=0.0
  454 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 455
      GO TO 457
  455 JE61(KO)=1
      SDE61(KO)=SD
      DO 456 I=1,KSU1
      E6S1(I)=FLMAS(I)
  456 CONTINUE
      QE6S1(KO)=QQ(KSU1)
  457 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 458
      GO TO 451
  458 JE62(KO)=1
      SDE62(KO)=SD
      DO 459 I=1,KSU1
      E6S2(I)=FLMAS(I)
  459 CONTINUE
      QE6S2(KO)=QQ(KSU1)
  451 CONTINUE
      IF(JISU.EQ.2) GO TO 460
      JISU=JISU+1
      GO TO 453
  460 CONTINUE
CC
CC    LEAST SQUARES ESTIMATES :
      JISU=1
      JE71(KO)=0
      SDE71(KO)=0.0
      QE7S1(KO)=0.0
      JE72(KO)=0
      SDE72(KO)=0.0
```

```
      QE7S2(KO)=0.0
      IF(KO.LT.MIND) GO TO 470
      WRITE(6,462)
  463 CONTINUE
      KSU=KO
      KSU1=KSU+1
      IJIS=JISU+1
      DO 464 I=1,KSU
      FLMA(I)=E7(I)
      FLMAS(I)=0.0
  464 CONTINUE
      FLMAS(KSU1)=0.0
      CALL FLSE(KSU,KSU1,JISU,IJIS,QQ,FLMA,FLMAS,X,XX,XXX,B,SD)
      IF(SD.GT.0.0.AND.JISU.EQ.1) GO TO 465
      GO TO 467
  465 JE71(KO)=1
      SDE71(KO)=SD
      DO 466 I=1,KSU1
      E7S1(I)=FLMAS(I)
  466 CONTINUE
      QE7S1(KO)=QQ(KSU1)
  467 CONTINUE
      IF(SD.GT.0.0.AND.JISU.EQ.2) GO TO 468
      GO TO 461
  468 JE72(KO)=1
      SDE72(KO)=SD
      DO 469 I=1,KSU1
      E7S2(I)=FLMAS(I)
  469 CONTINUE
      QE7S2(KO)=QQ(KSU1)
  461 CONTINUE
      IF(JISU.EQ.2) GO TO 470
      JISU=JISU+1
      GO TO 463
  470 CONTINUE
CC
C     PRINT OUT
C     WRITE(6,183) KO,QQ(KO),QD1S1(KO),SDD11(KO),QD1S2(KO),SDD12(KO)
C     WRITE(6,184) KO,QQ(KO),QD2S1(KO),SDD21(KO),QD2S2(KO),SDD22(KO)
C     WRITE(6,185) KO,QQ(KO),QD5S1(KO),SDD51(KO),QD5S2(KO),SDD52(KO)
C     WRITE(6,186) KO,QQ(KO),QD6S1(KO),SDD61(KO),QD6S2(KO),SDD62(KO)
C     WRITE(6,187) KO,QQ(KO),QD7S1(KO),SDD71(KO),QD7S2(KO),SDD72(KO)
C     WRITE(6,188) KO,QQ(KO),QE5S1(KO),SDE51(KO),QE5S2(KO),SDE52(KO)
C     WRITE(6,189) KO,QQ(KO),QE6S1(KO),SDE61(KO),QE6S2(KO),SDE62(KO)
C     WRITE(6,190) KO,QQ(KO),QE7S1(KO),SDE71(KO),QE7S2(KO),SDE72(KO)
C        GO TO 4320
CC
CC    PLOTS OF CHARACTERISTIC COEFFICIENT VS DYNAMIC PRESSURE :
      L=KO
      LN=1
      DO 195 I=1,KO
      B3(I)=B3(I)*(-1.0)
      B1(I)=B1(I)*(-1.0)
      A4(I)=SNGL(B4(I))
      A3(I)=SNGL(B3(I))
      A2(I)=SNGL(B2(I))
      A1(I)=SNGL(B1(I))
      A0(I)=SNGL(B0(I))
```

```
000398     195 CONTINUE
000399         CALL PLOT(LN,L,QQ,A3,0.5,1.0,3.80,3.90,
          *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
          * DYNAMIC PRESSURE                 ,
          *28H B3     VS Q(KG/CM2)            )
000400         CALL PLOT(LN,L,QQ,A2,0.5,1.0,5.60,5.80,
          *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
          * DYNAMIC PRESSURE                 ,
          *28H B2     VS Q(KG/CM2)            )
000401         CALL PLOT(LN,L,QQ,A1,0.5,1.0,3.80,3.86,
          *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
          * DYNAMIC PRESSURE                 ,
          *28H B1     VS Q(KG/CM2)            )
000402         CALL PLOT(LN,L,QQ,A0,0.5,1.0,0.95,1.00,
          *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
          * DYNAMIC PRESSURE                 ,
          *28H B0     VS Q(KG/CM2)            )
        CC
        CC
        CC     PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
000403         L=2*(K0+1)
000404         LN=2
000405         IF(QD1S1(K0).EQ.0.0.AND.QD1S2(K0).EQ.0.0) GO TO 254
000406         IF(QD1S1(K0).EQ.0.0) GO TO 253
000407         DO 252 I=1,K0
000408         WORK1(I)=D1(I)
000409         IK=I+(K0+1)
000410         WORK1(IK)= D1S1(I)
000411         QQ(IK)=QQ(I)
000412     252 CONTINUE
000413         WORK1(K0+1)=0.0
000414         WORK1(L)=0.0
000415         QQ(K0+1)=QD1S1(K0)
000416         QQ(L)=QQ(K0+1)
000417         CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,0.5E-02,
          *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
          * DYNAMIC PRESSURE (O:I,*:F)   ,
          *28H G+11   VS Q(KG/CM2)            )
000418     253 CONTINUE
000419         IF(QD1S2(K0).EQ.0.0) GO TO 254
000420         DO 255 I=1,K0
000421         WORK2(I)=D1(I)
000422         IK=I+(K0+1)
000423         WORK2(IK)=D1S2(I)
000424         QQ(IK)=QQ(I)
000425     255 CONTINUE
000426         WORK2(K0+1)=0.0
000427         WORK2(L)=0.0
000428         QQ(K0+1)=QD1S2(K0)
000429         QQ(L)=QQ(K0+1)
000430         CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,0.5E-02,
          *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
          * DYNAMIC PRESSURE (O:I,*:F)   ,
          *28H G+12     VS Q(KG/CM2)          )
000431     254 CONTINUE
        CC     PLOTS END
        CC
        CC     PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
```

```
      L=2*(KO+1)
      LN=2
      IF(QD2S1(KO).EQ.0.0.AND.QD2S2(KO).EQ.0.0) GO TO 264
      IF(QD2S1(KO).EQ.0.0) GO TO 263
      DO 262 I=1,KO
      WORK1(I)=D2(I)
      IK=I+(KO+1)
      WORK1(IK)= D2S1(I)
      QQ(IK)=QQ(I)
  262 CONTINUE
      WORK1(KO+1)=0.0
      WORK1(L)=0.0
      QQ(KO+1)=QD2S1(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,0.2E+02,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H G-11  VS Q(KG/CM2)        )
  263 CONTINUE
      IF(QD2S2(KO).EQ.0.0) GO TO 264
      DO 265 I=1,KO
      WORK2(I)=D2(I)
      IK=I+(KO+1)
      WORK2(IK)=D2S2(I)
      QQ(IK)=QQ(I)
  265 CONTINUE
      WORK2(KO+1)=0.0
      WORK2(L)=0.0
      QQ(KO+1)=QD2S2(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,0.2E+02,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H G-12    VS Q(KG/CM2)        )
  264 CONTINUE
CC    PLOTS END
CC
CC    PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
      L=2*(KO+1)
      LN=2
      IF(QD5S1(KO).EQ.0.0.AND.QD5S2(KO).EQ.0.0) GO TO 274
      IF(QD5S1(KO).EQ.0.0) GO TO 273
      DO 272 I=1,KO
      WORK1(I)=D5(I)
      IK=I+(KO+1)
      WORK1(IK)= D5S1(I)
      QQ(IK)=QQ(I)
  272 CONTINUE
      WORK1(KO+1)=0.0
      WORK1(L)=0.0
      QQ(KO+1)=QD5S1(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,0.2E-01,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H F+31  VS Q(KG/CM2)        )
  273 CONTINUE
      IF(QD5S2(KO).EQ.0.0) GO TO 274
```

```
      DO 275 I=1,KO
      WORK2(I)=D5(I)
      IK=I+(KO+1)
      WORK2(IK)=D5S2(I)
      QQ(IK)=QQ(I)
  275 CONTINUE
      WORK2(KO+1)=0.0
      WORK2(L)=0.0
      QQ(KO+1)=QD5S2(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,0.2E-01,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H F+32     VS Q(KG/CM2)        )
  274 CONTINUE
CC    PLOTS END
CC
CC    PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
      L=2*(KO+1)
      LN=2
      IF(QD6S1(KO).EQ.0.0.AND.QD6S2(KO).EQ.0.0) GO TO 284
      IF(QD6S1(KO).EQ.0.0) GO TO 283
      DO 282 I=1,KO
      WORK1(I)=D6(I)
      IK=I+(KO+1)
      WORK1(IK)= D6S1(I)
      QQ(IK)=QQ(I)
  282 CONTINUE
      WORK1(KO+1)=0.0
      WORK1(L)=0.0
      QQ(KO+1)=QD6S1(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,0.2E+01,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H F+11   VS Q(KG/CM2)        )
  283 CONTINUE
      IF(QD6S2(KO).EQ.0.0) GO TO 284
      DO 285 I=1,KO
      WORK2(I)=D6(I)
      IK=I+(KO+1)
      WORK2(IK)=D6S2(I)
      QQ(IK)=QQ(I)
  285 CONTINUE
      WORK2(KO+1)=0.0
      WORK2(L)=0.0
      QQ(KO+1)=QD6S2(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,0.2E+01,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H F+12     VS Q(KG/CM2)       )
  284 CONTINUE
CC    PLOTS END
CC
CC    PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
      L=2*(KO+1)
      LN=2
```

```
      IF(QD7S1(KO).EQ.0.0.AND.QD7S2(KO).EQ.0.0) GO TO 294
      IF(QD7S1(KO).EQ.0.0) GO TO 293
      DO 292 I=1,KO
      WORK1(I)=D7(I)
      IK=I+(KO+1)
      WORK1(IK)= D7S1(I)
      QQ(IK)=QQ(I)
  292 CONTINUE
      WORK1(KO+1)=0.0
      WORK1(L)=0.0
      QQ(KO+1)=QD7S1(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,0.15E+00,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)   ,
     *28H F+11  VS Q(KG/CM2)          )
  293 CONTINUE
      IF(QD7S2(KO).EQ.0.0) GO TO 294
      DO 295 I=1,KO
      WORK2(I)=D7(I)
      IK=I+(KO+1)
      WORK2(IK)=D7S2(I)
      QQ(IK)=QQ(I)
  295 CONTINUE
      WORK2(KO+1)=0.0
      WORK2(L)=0.0
      QQ(KO+1)=QD7S2(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,0.15E+00,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)   ,
     *28H F+12     VS Q(KG/CM2)       )
  294 CONTINUE
CC    PLOTS END
CC
CC    PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
      L=2*(KO+1)
      LN=2
      IF(QE5S1(KO).EQ.0.0.AND.QE5S2(KO).EQ.0.0) GO TO 774
      IF(QE5S1(KO).EQ.0.0) GO TO 773
      DO 772 I=1,KO
      WORK1(I)=E5(I)
      IK=I+(KO+1)
      WORK1(IK)= E5S1(I)
      QQ(IK)=QQ(I)
  772 CONTINUE
      WORK1(KO+1)=0.0
      WORK1(L)=0.0
      QQ(KO+1)=QE5S1(KO)
      QQ(L)=QQ(KO+1)
      CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,1.00E-06,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)   ,
     *28H F-31  VS Q(KG/CM2)          )
  773 CONTINUE
      IF(QE5S2(KO).EQ.0.0) GO TO 774
      DO 775 I=1,KO
      WORK2(I)=E5(I)
```

```
          IK=I+(K0+1)
          WORK2(IK)=E5S2(I)
          QQ(IK)=QQ(I)
      775 CONTINUE
          WORK2(K0+1)=0.0
          WORK2(L)=0.0
          QQ(K0+1)=QE5S2(K0)
          QQ(L)=QQ(K0+1)
          CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,1.00E-06,
         *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
         * DYNAMIC PRESSURE (O:I,*:F)  ,
         *28H F-32     VS Q(KG/CM2)        )
      774 CONTINUE
CC        PLOTS END
CC
CC        PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
          L=2*(K0+1)
          LN=2
          IF(QE6S1(K0).EQ.0.0.AND.QE6S2(K0).EQ.0.0) GO TO 784
          IF(QE6S1(K0).EQ.0.0) GO TO 783
          DO 782 I=1,K0
          WORK1(I)=E6(I)
          IK=I+(K0+1)
          WORK1(IK)= E6S1(I)
          QQ(IK)=QQ(I)
      782 CONTINUE
          WORK1(K0+1)=0.0
          WORK1(L)=0.0
          QQ(K0+1)=QE6S1(K0)
          QQ(L)=QQ(K0+1)
          CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,0.4E-01,
         *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
         * DYNAMIC PRESSURE (O:I,*:F)  ,
         *28H F-11   VS Q(KG/CM2)        )
      783 CONTINUE
          IF(QE6S2(K0).EQ.0.0) GO TO 784
          DO 785 I=1,K0
          WORK2(I)=E6(I)
          IK=I+(K0+1)
          WORK2(IK)=E6S2(I)
          QQ(IK)=QQ(I)
      785 CONTINUE
          WORK2(K0+1)=0.0
          WORK2(L)=0.0
          QQ(K0+1)=QE6S2(K0)
          QQ(L)=QQ(K0+1)
          CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,0.4E-01,
         *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
         * DYNAMIC PRESSURE (O:I,*:F)  ,
         *28H F-12     VS Q(KG/CM2)        )
      784 CONTINUE
CC        PLOTS END
CC
CC        PLOTS OF STABILITY MARGIN VS DYNAMIC PRESSURE :
          L=2*(K0+1)
          LN=2
          IF(QE7S1(K0).EQ.0.0.AND.QE7S2(K0).EQ.0.0) GO TO 794
          IF(QE7S1(K0).EQ.0.0) GO TO 793
```

```
      DO 792 I=1,K0
      WORK1(I)=E7(I)
      IK=I+(K0+1)
      WORK1(IK)= E7S1(I)
      QQ(IK)=QQ(I)
  792 CONTINUE
      WORK1(K0+1)=0.0
      WORK1(L)=0.0
      QQ(K0+1)=QE7S1(K0)
      QQ(L)=QQ(K0+1)
      CALL PLOT(LN,L,QQ,WORK1,0.5,1.0,0.0,1.00E-06,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H F-31  VS Q(KG/CM2)        )
  793 CONTINUE
      IF(QE7S2(K0).EQ.0.0) GO TO 794
      DO 795 I=1,K0
      WORK2(I)=E7(I)
      IK=I+(K0+1)
      WORK2(IK)=E7S2(I)
      QQ(IK)=QQ(I)
  795 CONTINUE
      WORK2(K0+1)=0.0
      WORK2(L)=0.0
      QQ(K0+1)=QE7S2(K0)
      QQ(L)=QQ(K0+1)
      CALL PLOT(LN,L,QQ,WORK2,0.5,1.0,0.0,1.00E-06,
     *92H  PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL
     * DYNAMIC PRESSURE (O:I,*:F)  ,
     *28H F-32    VS Q(KG/CM2)       )
  794 CONTINUE
CC    PLOTS END
 4320    CONTINUE
      STOP
  100 FORMAT(1H0,10X,'TABLE OF AR COEF. AND STABILITY PARAMETERS',//)
  181 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'  B4=',E13.5,2X,'  B3=',
     * E13.5,2X,'  B2=',E13.5,2X,'  B1=',E13.5,2X,'  B0=',E13.5,/)
  182 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,' G+1=',E13.5,2X,' G-1=',
     * E13.5,2X,' F+3=',E13.5,2X,' F+1=',E13.5,2X,' F+2=',E13.5,/)
  682 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,' G+1=',E13.5,2X,' G-1=',
     * E13.5,2X,' F-3=',E13.5,2X,' F-1=',E13.5,2X,' F-3=',E13.5,//)
C 183 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'G+11=',E13.5,2X,'SD11=',
C    * E13.5,2X,'G+12=',E13.5,2X,'SD12=',E13.5,/)
C 184 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'G-11=',E13.5,2X,'SD11=',
C    * E13.5,2X,'G-12=',E13.5,2X,'SD12=',E13.5,/)
C 185 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'F+31=',E13.5,2X,'SD31=',
C    * E13.5,2X,'F+32=',E13.5,2X,'SD32=',E13.5,/)
C 186 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'F+11=',E13.5,2X,'SD11=',
C    * E13.5,2X,'F+12=',E13.5,2X,'SD12=',E13.5,/)
C 187 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'F+11=',E13.5,2X,'SD11=',
C    * E13.5,2X,'F+12=',E13.5,2X,'SD12=',E13.5,/)
C 188 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'F-31=',E13.5,2X,'SD31=',
C    * E13.5,2X,'F-32=',E13.5,2X,'SD32=',E13.5,/)
C 189 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'F-11=',E13.5,2X,'SD11=',
C    * E13.5,2X,'F-12=',E13.5,2X,'SD12=',E13.5,/)
C 190 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'F-31=',E13.5,2X,'SD31=',
C    * E13.5,2X,'F-32=',E13.5,2X,'SD32=',E13.5,/)
 122  FORMAT(1H ,'***** G(+1) *****')

 132  FORMAT(1H ,'***** G(-1) *****')
 142  FORMAT(1H ,'***** F+3 *****')
 152  FORMAT(1H ,'***** F+1 *****')
 162  FORMAT(1H ,'***** F+2  *****')
 442  FORMAT(1H ,'***** F-3 *****')
 452  FORMAT(1H ,'***** F-1 *****')
 462  FORMAT(1H ,'***** F-3 *****')
  500 FORMAT(F10.0)
  510 FORMAT(4D20.10)
  556 FORMAT(2I5)
  688 FORMAT(1H ,'FITTING OF STRAIGHT LINE AND PARABOLIC CURVE TO STABIL
     *ITY PARAMETERS',//)
      END
```

```
      SUBROUTINE FLSE(KSU,KSU1,JISU,IJIS,Q,FLMA,FLMAS,X,XX,XXX,B,SD)
C     LEAST SQUARES ESTIMATES
C     INPUT:
C      KSU :KSU=KAISU
C      KSU1:KSU1=KAISU1=KAISU+1
C      JISU:JISU=1,OR 2
C      IJIS:IJIS=2(JISU=1),OR 3(JISU=2)
C      Q(KSU1):DYNAMIC PRESSURE
C     OUT PUT:
C     A1*Q+A0
C     A2*Q**2+A1*Q+A0
C
      DIMENSION X(KSU,   3),XX(   3,   3),XXX(   3,KSU),B(   3)
      DIMENSION Q(KSU1),FLMA(KSU1),FLMAS(KSU1)
      DO 10 I=1,KSU
      X(I,1)=Q(I)**2
      X(I,   2)=Q(I)
      X(I,3)=1.0
   10 CONTINUE
      DO 30 I=1,3
      DO 30 J=1,3
      W=0.0
      DO 20 K=1,KSU
      W=W+X(K,I)*X(K,J)
   20 CONTINUE
      XX(I,J)=W
   30 CONTINUE
      IF(JISU.EQ.1) GO TO 2
C     THIS PROGRAM USES A STANDARD SUBROUTINE MINVS(XX,IJIS,IJIS,1.0E-5,
C     ILL) TO OBTAIN INVERSE MATRIX XX(IJIS,IJIS) OF ORIGINAL MATRIX
C     XX(IJIS,IJIS) .
      CALL MINVS(XX,IJIS,IJIS,1.0E-5,ILL)
      IF(ILL.EQ.0) GO TO 1
      WRITE(6,130)
  130 FORMAT(1H ,'INVERS OF XX NOT OBTAINED : (ILL IS NOT EQUAL TO ZERO)
     *',/)
      STOP
    2 DETR=1.0/(XX(2,2)*XX(3,3)-XX(2,3)*XX(3,2))
      P1=XX(3,3)*DETR
      P2=-XX(2,3)*DETR
      P3=-XX(3,2)*DETR
      P4=XX(2,2)*DETR
      XX(2,2)=P1
      XX(2,3)=P2
      XX(3,2)=P3
      XX(3,3)=P4
      XX(1,1)=0.0
      XX(1,2)=0.0
      XX(1,3)=0.0
      XX(2,1)=0.0
      XX(3,1)=0.0
    1 CONTINUE
      DO 50 I=1,3
      DO 50 J=1,KSU
      W=0.0
      DO 40 K=1,3
      W=W+XX(I,K)*X(J,K)
   40 CONTINUE
```

```
          XXX(I,J)=W
   50 CONTINUE
      DO 70 I=1,3
      W=0.0
      DO 60 J=1,KSU
      W=W+XXX(I,J)*FLMA(J)
   60 CONTINUE
      B(I)=W
   70 CONTINUE
      IF(JISU.EQ.1) GO TO 4
      IF(JISU.EQ.2) GO TO 5
    3 CONTINUE
      DO 90 I=1,KSU
      W=0.0
      DO 80 J=1,3
      W=W+X(I,J)*B(J)
   80 CONTINUE
      FLMAS(I)=W
   90 CONTINUE
      W=0.0
      W1=0.0
      DO 100 I=1,KSU
      W=W+(FLMAS(I)-FLMA(I))**2
  100 CONTINUE
C         WRITE(6,523) W
      W1=(FLMA(1)**2)*FLOAT(KSU)
      SD=SQRT(W/W1)*100.0
      GO TO 9
    4 CONTINUE
      Q(KSU1)=-B(3)/B(2)
      B(1)=0.0
      GO TO 3
    5 CONTINUE
      Q(KSU1)=0.0
      IF(B(1).GT.0.0) GO TO 6
      GO TO 7
    6 F=(B(1)*(-B(2)/(2.0*B(1)))**2)+B(2)*(-B(2)/(2.0*B(1)))+B(3)
      IF(F.GT.0.0) GO TO 8
    7 P1=B(2)**2-4.0*B(1)*B(3)
      IF(P1.LE.0.0) GO TO 8
      P1=SQRT(P1)
      Q1=(-B(2)-P1)/(2.0*B(1))
      Q2=(-B(2)+P1)/(2.0*B(1))
      Q(KSU1)=Q1
CC    WRITE(6,110) Q1,Q2
      GO TO 3
    9 CONTINUE
C     PRINT OUT
CC    WRITE(6,525) JISU,SD,(B(I),I=1,    3)
      FLMA(KSU1)=0.0
      FLMAS(KSU1)=0.0
      WRITE(6,527)
      DO 530 I=1,KSU
      WRITE(6,540) I,Q(I),FLMA(I)
  530 CONTINUE
      WRITE(6,545) Q(KSU1)
      IF(IJIS.EQ.2) WRITE(6,524) (B(I),I=2,3)
      IF(IJIS.EQ.3) WRITE(6,525) (B(I),I=1,3)
```

```
      RETURN
    8 CONTINUE
      WRITE(6,120)
      RETURN
C 110 FORMAT(1H ,'Q1(KG/CM2)=',E13.5,2X,'Q2(KG/CM2)=',E13.5,/)
  120 FORMAT(1H ,'FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABI
     *LITY',/)
C 523    FORMAT(1H ,'(FS-F)**2=',E13.5,/)
  524 FORMAT(1H ,'COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE,',2
     *(2X,E15.7),/)
  525 FORMAT(1H ,'COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CUR
     *VE,',3(2X,E15.7),/)
C 525 FORMAT(1H ,I1,2X,'ORDER',2X,'STANDARD DEVIATION=',E13.5,/(1H ,'COE
C    AFFICIENTS B2,B1,B0=',    3(E13.5,2X)))
  527 FORMAT(1H0,3X,'I',5X,'Q(KG/CM2)',10X,'VALUES OF PARAMETER',/)
  540 FORMAT(1H ,2X,I2,2(2X,E15.7))
  545 FORMAT(1H ,70X,'PREDICTED Q FOR INSTABILITY = ',E15.7,/)
      END
```

```
      SUBROUTINE PLOT(LN,N,X,Y,XMIN,XMAX,YMIN,YMAX,TITL,AXIS)
      CHARACTER   BLANK,ASTER,PLUS,XY,XY2
      DIMENSION X(200),Y(200),TITL(23),XY(51,101),XA(11),AXIS(7)
      DIMENSION XY2(51,101)
      DATA BLANK,ASTER,PLUS/1H ,1H*,1HO /
      XL=XMIN
      XU=XMAX
      YL=YMIN
      YU=YMAX
      IF(XL.LT.XU) GO TO 15
      XL=X(1)
      XU=X(1)
      DO 10 I=2,N
      IF(X(I).LT.XL) XL=X(I)
      IF(X(I).GT.XU) XU=X(I)
   10 CONTINUE
   15 IF(YL.LT.YU) GO TO 25
      YL=Y(1)
      YU=Y(1)
      DO 20 I=2,N
      IF(Y(I).LT.YL) YL=Y(I)
      IF(Y(I).GT.YU) YU=Y(I)
   20 CONTINUE
   25 DX=(XU-XL)/100.0
      DY=(YU-YL)/50.0
      DO 30 I=1,51
      DO 30 J=1,101
      XY2(I,J)=BLANK
   30 XY(I,J)=BLANK
      DO 50 I=1,N
      AX=(X(I)-XL)/DX
      IF(AX.LE.-0.5.OR.AX.GE.100.5) GO TO 50
      LX=AX+1.5
      AY=(Y(I)-YL)/DY
      IF(AY.LE.-0.5.OR.AY.GE.50.5) GO TO 50
      LY=51-IFIX(AY+0.5)
      IF(LN.EQ.1) XY(LY,LX)=PLUS
      IF(LN.EQ.1) GO TO 50
      IF(I.LE.N/2) XY(LY,LX)=PLUS
      IF(I.GT.N/2) XY2(LY,LX)=ASTER
   50 CONTINUE
      WRITE(6,62) TITL
   62 FORMAT(1H1/1H ,15X,23A4/ )
      DO 80 I=1,51
      IF(MOD(I,5).NE.1) GO TO 72
      YA=YL+DY*FLOAT(51-I)
      WRITE(6,70) YA
   70 FORMAT(1H ,1PE9.2,1X,10(10H+---------),1H+)
      GO TO 76
   72 WRITE(6,74)
   74 FORMAT(1H ,10X,10(10HI         ),1HI)
   76 WRITE(6,78)(XY(I,J),J=1,101)
      WRITE(6,78)(XY2(I,J),J=1,101)
   78 FORMAT(1H+,10X,101A1)
   80 CONTINUE
      DO 90 I=1,11
   90 XA(I)=XL+DX*FLOAT((I-1)*10)
      WRITE(6,95) XA
   95 FORMAT(1H ,6X,11(1PE9.2,1X))
      WRITE(6,92) AXIS
   92 FORMAT(1HO,1H ,50X,7A4/ )
      RETURN
      END
```

```
      SUBROUTINE SAJT(M,M1,M0,A,PD,PMD,BM,X,Y,HI)
C     THIS SUBROUTINE PROGRAM IS USED FOR CALCULATION OF JURY'S
C     STABILITY PARAMETERS.
C     INPUTS REQUIRED :
C        M : ORDER OF THE CHARACTERISTIC EQUATION.
C        M : EVEN ONLY
C        M1 : M+1
C        M0 : M-1
C        A(M1) : COEFFICIENTS OF THE CHARACTERISTIC EQUATION.
C     OUTPUTS :
C        PD(M) : STABILITY DETERMINANTS.
      REAL*8 PMD(M),BM(M0,M0),S
      DIMENSION PD(M),A(M1)
      DIMENSION X(M0,M0),Y(M0,M0),HI(M0,M0)
CC    INITIAL CLEARING : START
      MD2=M/2
      IH2=0
      III=0
      DO 100 I=1,M0
      DO 100 J=1,M0
      X(I,J)=0.0
      Y(I,J)=0.0
  100 CONTINUE
CC    INITIAL CLEARING : END
CC    X(KK,I) COMPUTATION : START
      DO 1100 KK=1,M0
      DO  110 I=KK,M0
      II=M1+KK-I
      X(KK,I)=A(II)
  110 CONTINUE
 1100 CONTINUE
CC    X(KK,I) COMPUTATION : END
CC    Y(KK,I) COMPUTATION : START
      IM2=M0
      DO 2100 KK=1,M0
      DO  210 I=1,IM2
      II=M1-KK-I
      Y(KK,I)=A(II)
  210 CONTINUE
      IM2=IM2-1
 2100 CONTINUE
CC    Y(KK,I) COMPUTATION : END
CC    HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : START
  300 CONTINUE
      IM1=MD2
      P=1.0
      IF(IH2.EQ.1) P=-1.0
      DO 3000 KK=1,MD2
      IM2=M0
      DO 320 I=1,M0
      DO 320 J=1,M0
      HI(I,J)=X(I,J)+Y(I,J)*P
      BM(I,J)=0.0
  320 CONTINUE
      IM2=IM2-(MD2-IM1)*2
      DO 330 I=1,IM2
      DO 330 J=1,IM2
      II=MD2-IM1+I
```

```
      JJ=MD2-IM1+J
      BM(I,J)=HI(II,JJ)
  330 CONTINUE
      S=0.0
      IF(IM2.EQ.2) GO TO 332
      IF(IM2.EQ.1) GO TO 331
      ILL=0
C     THIS PROGRAM USES A STANDARD SUBROUTINE MDETD(BM,MO,IM2,1.0D-14,S,
C     ILL) TO GIVE THE VALUE S, OF THE DETERMINANT BM(IM2,IM2).
      CALL MDETD(BM,MO,IM2,1.0D-14,S,ILL)
      GO TO 333
  331 CONTINUE
      S=BM(1,1)
      GO TO 333
  332 CONTINUE
      S=(BM(1,1)*BM(2,2)-BM(1,2)*BM(2,1))
      GO TO 333
  333 CONTINUE
      III=III+1
      PMD(III)=S
      IF(ILL.NE.0) PMD(III)=9999.9
      IM1=IM1-1
 3000 CONTINUE
      IF(IH2.EQ.1) GO TO 340
      IH2=IH2+1
      GO TO 300
  340 CONTINUE
CC    HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : END
CC    THE INPUTS TO THE MAIN PROGRAM : START
      DO 400 I=1,M
      PD(I)=SNGL(PMD(I))
  400 CONTINUE
CC    THE INPUTS TO THE MAIN PROGRAM : END
      RETURN
      END
```

Output for program JURY-CE4-EB

TABLE OF AR COEF. AND STABILITY PARAMETERS

NO.= 1	Q= 0.6970	B4= 0.10000D+01	B3= -0.38706D+01	B2= 0.57200D+01	B1= -0.38226D+01	B0= 0.97522D+00
NO.= 1	Q= 0.6970	G+1= 0.19198E-02	G-1= 0.15388E+02	F+3= 0.79716E-02	F+1= 0.19752E+01	F+2= 0.97539E-01
NO.= 1	Q= 0.6970	G+1= 0.19198E-02	G-1= 0.15388E+02	F-3= 0.41491E-06	F-1= 0.24777E-01	F-3= 0.42651E-06
NO.= 2	Q= 0.7240	B4= 0.10000D+01	B3= -0.38708D+01	B2= 0.57155D+01	B1= -0.38134D+01	B0= 0.97045D+00
NO.= 2	Q= 0.7240	G+1= 0.17543E-02	G-1= 0.15370E+02	F+3= 0.91374E-02	F+1= 0.19705E+01	F+2= 0.11642E+00
NO.= 2	Q= 0.7240	G+1= 0.17543E-02	G-1= 0.15370E+02	F-3= 0.53357E-06	F-1= 0.29546E-01	F-3= 0.54967E-06
NO.= 3	Q= 0.7720	B4= 0.10000D+01	B3= -0.38764D+01	B2= 0.57306D+01	B1= -0.38272D+01	B0= 0.97470D+00
NO.= 3	Q= 0.7720	G+1= 0.17179E-02	G-1= 0.15409E+02	F+3= 0.85031E-02	F+1= 0.19747E+01	F+2= 0.99789E-01
NO.= 3	Q= 0.7720	G+1= 0.17179E-02	G-1= 0.15409E+02	F-3= 0.40902E-06	F-1= 0.25296E-01	F-3= 0.42440E-06
NO.= 4	Q= 0.8020	B4= 0.10000D+01	B3= -0.38692D+01	B2= 0.57114D+01	B1= -0.38098D+01	B0= 0.96946D+00
NO.= 4	Q= 0.8020	G+1= 0.19347E-02	G-1= 0.15360E+02	F+3= 0.10795E-01	F+1= 0.19695E+01	F+2= 0.12047E+00
NO.= 4	Q= 0.8020	G+1= 0.19347E-02	G-1= 0.15360E+02	F-3= 0.49821E-06	F-1= 0.30536E-01	F-3= 0.52175E-06
NO.= 5	Q= 0.8230	B4= 0.10000D+01	B3= -0.38778D+01	B2= 0.57342D+01	B1= -0.38297D+01	B0= 0.97519D+00
NO.= 5	Q= 0.8230	G+1= 0.18804E-02	G-1= 0.15417E+02	F+3= 0.75496E-02	F+1= 0.19752E+01	F+2= 0.97809E-01
NO.= 5	Q= 0.8230	G+1= 0.18804E-02	G-1= 0.15417E+02	F-3= 0.22622E-06	F-1= 0.24814E-01	F-3= 0.24329E-06
NO.= 6	Q= 0.8360	B4= 0.10000D+01	B3= -0.38732D+01	B2= 0.57221D+01	B1= -0.38189D+01	B0= 0.97203D+00
NO.= 6	Q= 0.8360	G+1= 0.20235E-02	G-1= 0.15386E+02	F+3= 0.90543E-02	F+1= 0.19720E+01	F+2= 0.11028E+00
NO.= 6	Q= 0.8360	G+1= 0.20235E-02	G-1= 0.15386E+02	F-3= 0.27297E-06	F-1= 0.27970E-01	F-3= 0.27846E-06
NO.= 7	Q= 0.8470	B4= 0.10000D+01	B3= -0.38867D+01	B2= 0.57581D+01	B1= -0.38514D+01	B0= 0.98185D+00
NO.= 7	Q= 0.8470	G+1= 0.18743E-02	G-1= 0.15478E+02	F+3= 0.52232E-02	F+1= 0.19818E+01	F+2= 0.71550E-01
NO.= 7	Q= 0.8470	G+1= 0.18743E-02	G-1= 0.15478E+02	F-3= 0.79667E-07	F-1= 0.18153E-01	F-3= 0.89669E-07

FITTING OF STRAIGHT LINE AND PARABOLIC CURVE TO STABILITY PARAMETERS

***** G(+1) *****

I	Q(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.1919804E-02
2	0.7240000E+00	0.1754311E-02
3	0.7720000E+00	0.1717871E-02
4	0.8020000E+00	0.1934658E-02
5	0.8230000E+00	0.1880396E-02
6	0.8360000E+00	0.2023462E-02
7	0.8470000E+00	0.1874301E-02

PREDICTED Q FOR INSTABILITY = -0.1619606E+01

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, 0.7185265E-03 0.1307435E-02

FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABILITY

***** G(-1) *****

I	Q(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.1538844E+02
2	0.7240000E+00	0.1537011E+02
3	0.7720000E+00	0.1540886E+02
4	0.8020000E+00	0.1535976E+02
5	0.8230000E+00	0.1541686E+02
6	0.8360000E+00	0.1538619E+02
7	0.8470000E+00	0.1547806E+02

PREDICTED Q FOR INSTABILITY = -0.4361302E+02

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, 0.3468781E+00 0.1512840E+02

FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABILITY

***** F+3 *****

I	Q(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.7971630E-02
2	0.7240000E+00	0.9137370E-02
3	0.7720000E+00	0.8503117E-02
4	0.8020000E+00	0.1079517E-01
5	0.8230000E+00	0.7549625E-02
6	0.8360000E+00	0.9054273E-02
7	0.8470000E+00	0.5223237E-02

PREDICTED Q FOR INSTABILITY = 0.1795109E+01

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, -0.8242857E-02 0.1479683E-01

I	Q(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.7971630E-02
2	0.7240000E+00	0.9137370E-02
3	0.7720000E+00	0.8503117E-02
4	0.8020000E+00	0.1079517E-01
5	0.8230000E+00	0.7549625E-02
6	0.8360000E+00	0.9054273E-02
7	0.8470000E+00	0.5223237E-02

PREDICTED Q FOR INSTABILITY = 0.9069713E+00

COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.4507822E+00 0.6874999E+00 -0.2527307E+00

***** F+1 *****

I	Q(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.1975223E+01
2	0.7240000E+00	0.1970453E+01
3	0.7720000E+00	0.1974704E+01
4	0.8020000E+00	0.1969463E+01
5	0.8230000E+00	0.1975185E+01
6	0.8360000E+00	0.1972029E+01
7	0.8470000E+00	0.1981847E+01

PREDICTED Q FOR INSTABILITY = -0.8410272E+02

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, 0.2325535E-01 0.1955838E+01

FITTING TO THIS PARAMETER DOES NOT PREDICT THE INSTABILITY

***** F+2 *****

I	θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.9753942E-01
2	0.7240000E+00	0.1164151E+00
3	0.7720000E+00	0.9978908E-01
4	0.8020000E+00	0.1204739E+00
5	0.8230000E+00	0.9780931E-01
6	0.8360000E+00	0.1102798E+00
7	0.8470000E+00	0.7154977E-01

PREDICTED θ FOR INSTABILITY = 0.1928276E+01

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, -0.8926499E-01 0.1721275E+00

I	θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.9753942E-01
2	0.7240000E+00	0.1164151E+00
3	0.7720000E+00	0.9978908E-01
4	0.8020000E+00	0.1204739E+00
5	0.8230000E+00	0.9780931E-01
6	0.8360000E+00	0.1102798E+00
7	0.8470000E+00	0.7154977E-01

PREDICTED θ FOR INSTABILITY = 0.9283137E+00

COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.3886291E+01 0.5906579E+01 -0.2134084E+01

***** F-3 *****

I	θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.4149108E-06
2	0.7240000E+00	0.5335715E-06
3	0.7720000E+00	0.4090179E-06
4	0.8020000E+00	0.4982120E-06
5	0.8230000E+00	0.2262224E-06
6	0.8360000E+00	0.2729712E-06
7	0.8470000E+00	0.7966730E-07

PREDICTED θ FOR INSTABILITY = 0.9558252E+00

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, -0.2046195E-05 0.1955805E-05

I	θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.4149108E-06
2	0.7240000E+00	0.5335715E-06
3	0.7720000E+00	0.4090179E-06
4	0.8020000E+00	0.4982120E-06
5	0.8230000E+00	0.2262224E-06
6	0.8360000E+00	0.2729712E-06
7	0.8470000E+00	0.7966730E-07

PREDICTED θ FOR INSTABILITY = 0.8604007E+00

COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.3692410E-04 0.5496826E-04 -0.1996021E-04

***** F-1 *****

I	θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.2477694E-01

2	0.7240000E+00	0.2954632E-01
3	0.7720000E+00	0.2529585E-01
4	0.8020000E+00	0.3053647E-01
5	0.8230000E+00	0.2481437E-01
6	0.8360000E+00	0.2797049E-01
7	0.8470000E+00	0.1815277E-01

PREDICTED Θ FOR INSTABILITY = 0.1918117E+01

COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, -0.2284816E-01 0.4382544E-01

I	Θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.2477694E-01
2	0.7240000E+00	0.2954632E-01
3	0.7720000E+00	0.2529585E-01
4	0.8020000E+00	0.3053647E-01
5	0.8230000E+00	0.2481437E-01
6	0.8360000E+00	0.2797049E-01
7	0.8470000E+00	0.1815277E-01

PREDICTED Θ FOR INSTABILITY = 0.9286213E+00

COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.9798660E+00 0.1488897E+01 -0.5376464E+00

***** F-3 *****

I	Θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.4265086E-06
2	0.7240000E+00	0.5496722E-06
3	0.7720000E+00	0.4243958E-06
4	0.8020000E+00	0.5217505E-06
5	0.8230000E+00	0.2432935E-06
6	0.8360000E+00	0.2784562E-06
7	0.8470000E+00	0.8966919E-07

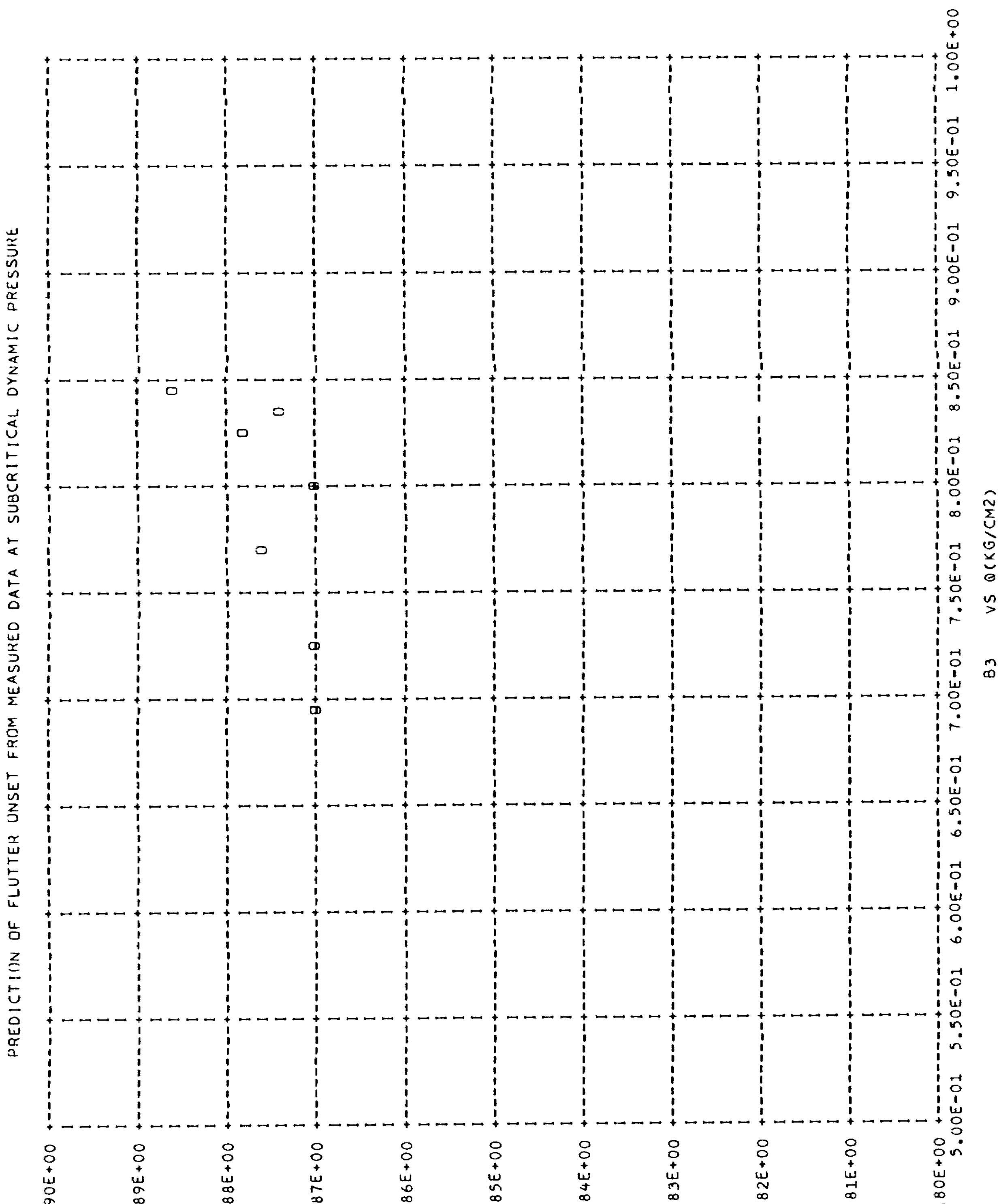
PREDICTED Θ FOR INSTABILITY = 0.9612810E+00

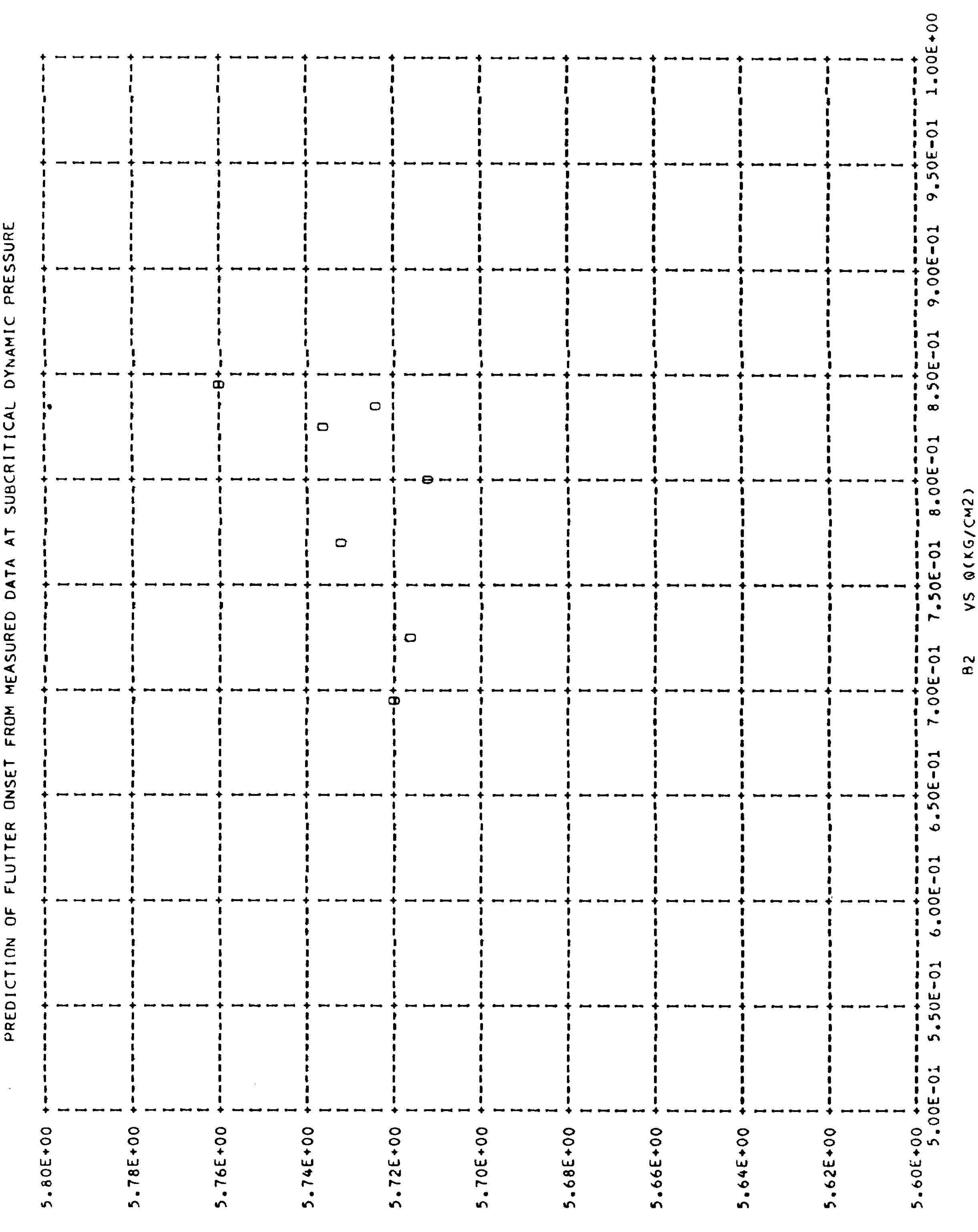
COEFFICIENTS A1 AND A0 OF THE FITTED STRAIGHT LINE, -0.2063305E-05 0.1983416E-05

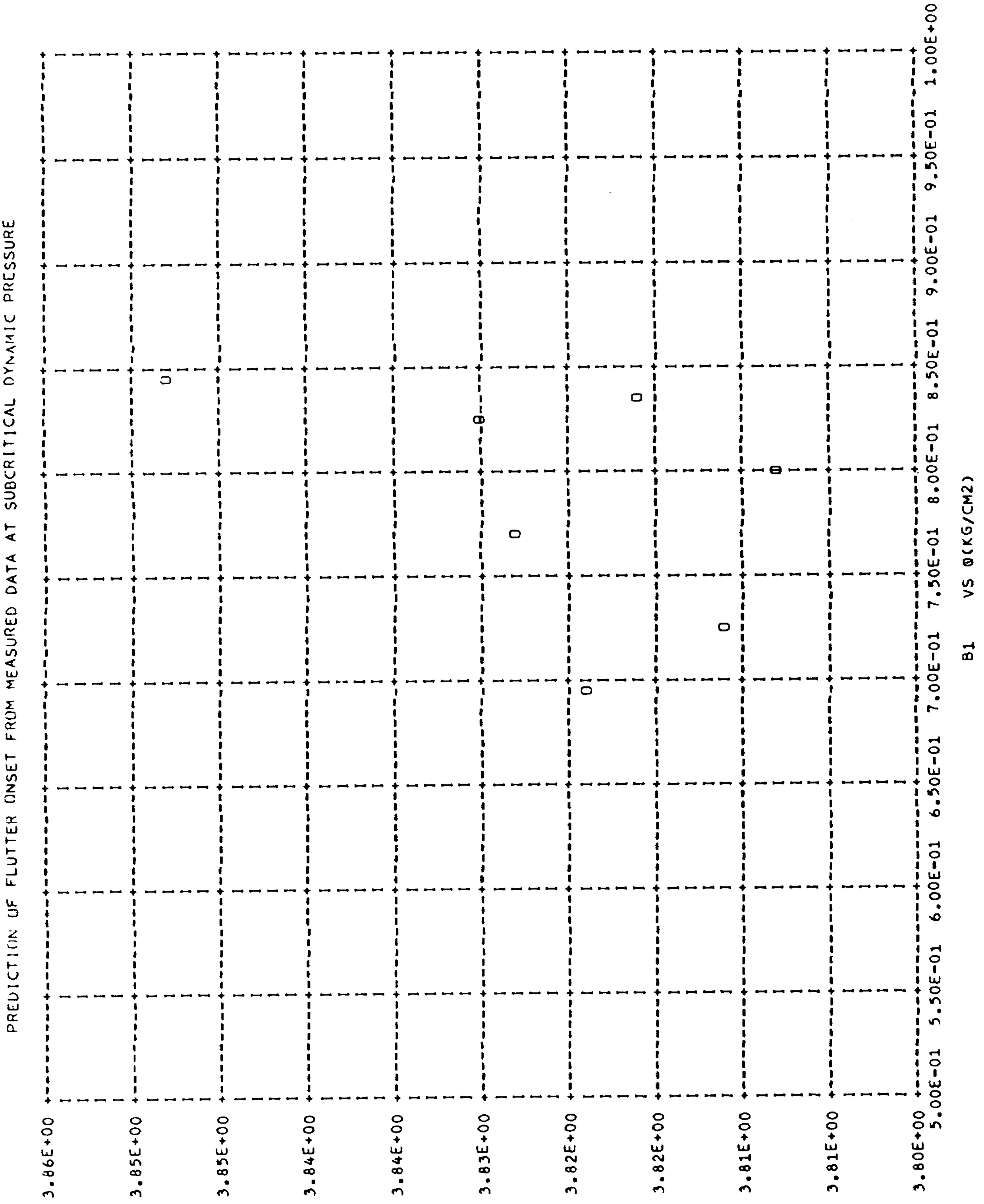
I	Θ(KG/CM2)	VALUES OF PARAMETER
1	0.6970000E+00	0.4265086E-06
2	0.7240000E+00	0.5496722E-06
3	0.7720000E+00	0.4243958E-06
4	0.8020000E+00	0.5217505E-06
5	0.8230000E+00	0.2432935E-06
6	0.8360000E+00	0.2784562E-06
7	0.8470000E+00	0.8966919E-07

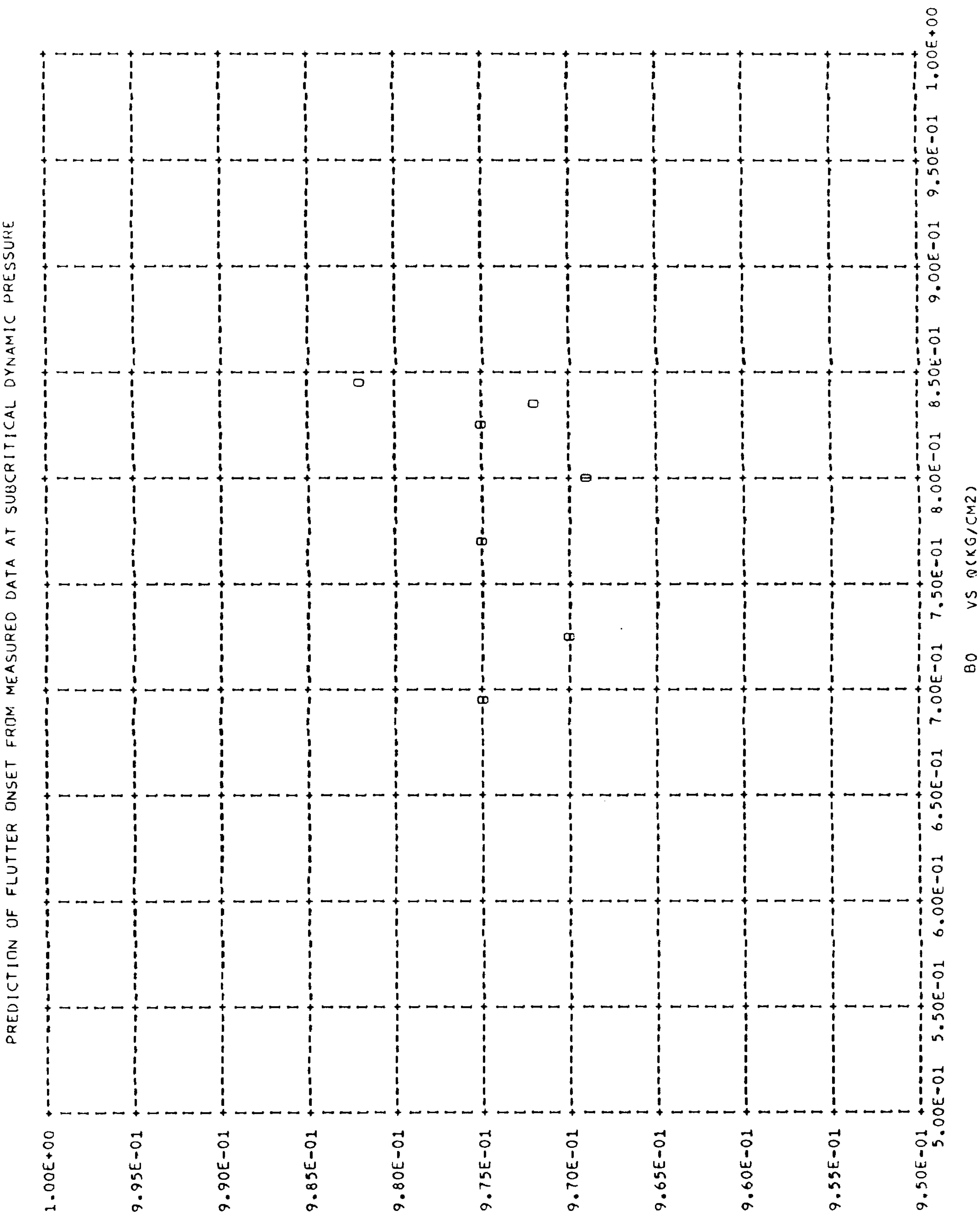
PREDICTED Θ FOR INSTABILITY = 0.8608606E+00

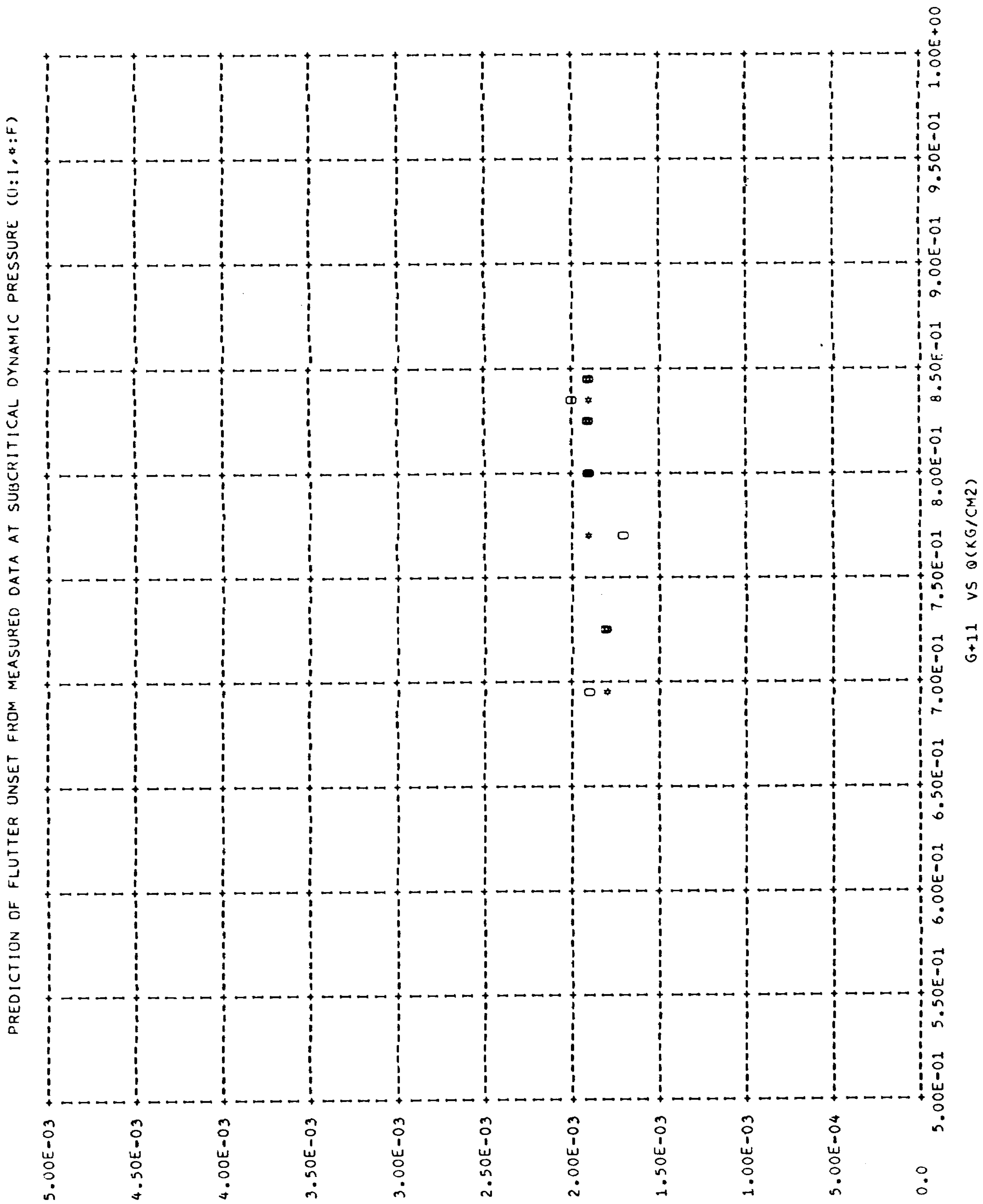
COEFFICIENTS A2, A1 AND A0 OF THE FITTED PARABOLIC CURVE, -0.3860769E-04 0.5755090E-04 -0.2093188E-04

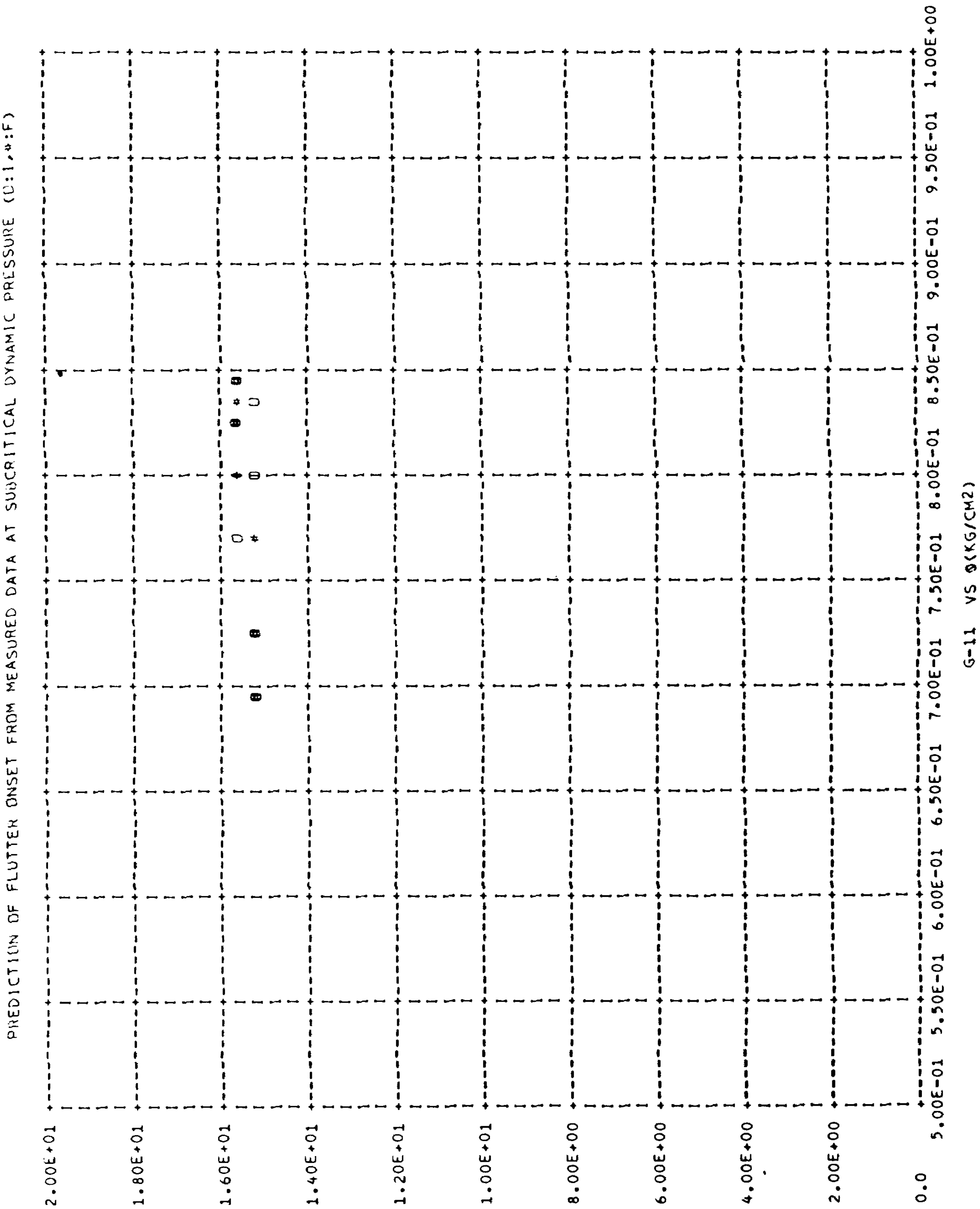

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
3.90E+00
3.89E+00
3.88E+00
3.87E+00
3.86E+00
3.85E+00
3.84E+00
3.83E+00
3.82E+00
3.81E+00
3.80E+00
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00
B3 VS Q(KG/CM2)

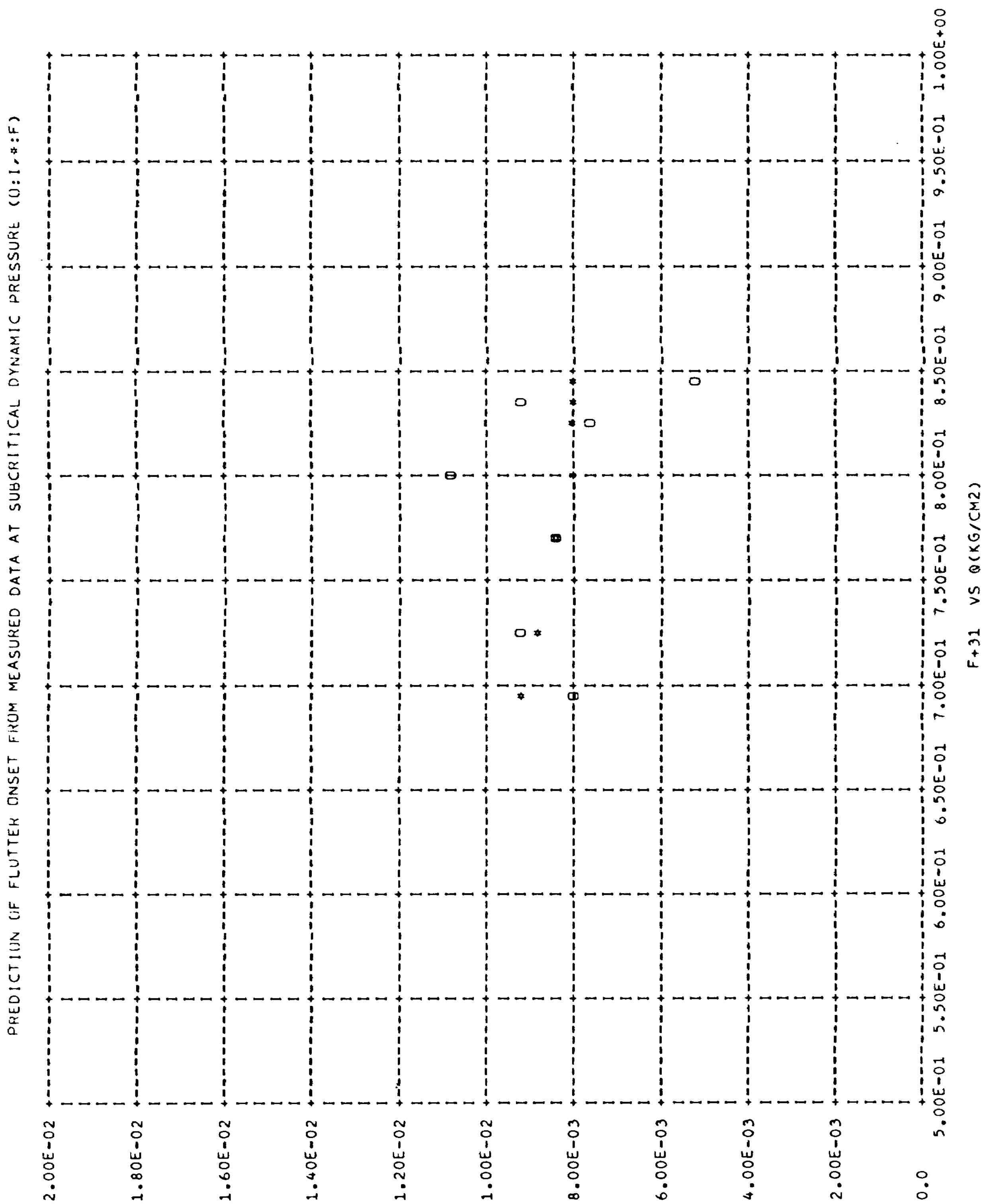

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
5.80E+00
5.78E+00
5.76E+00
5.74E+00
5.72E+00
5.70E+00
5.68E+00
5.66E+00
5.64E+00
5.62E+00
5.60E+00
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
B2 VS Q(KG/CM2)

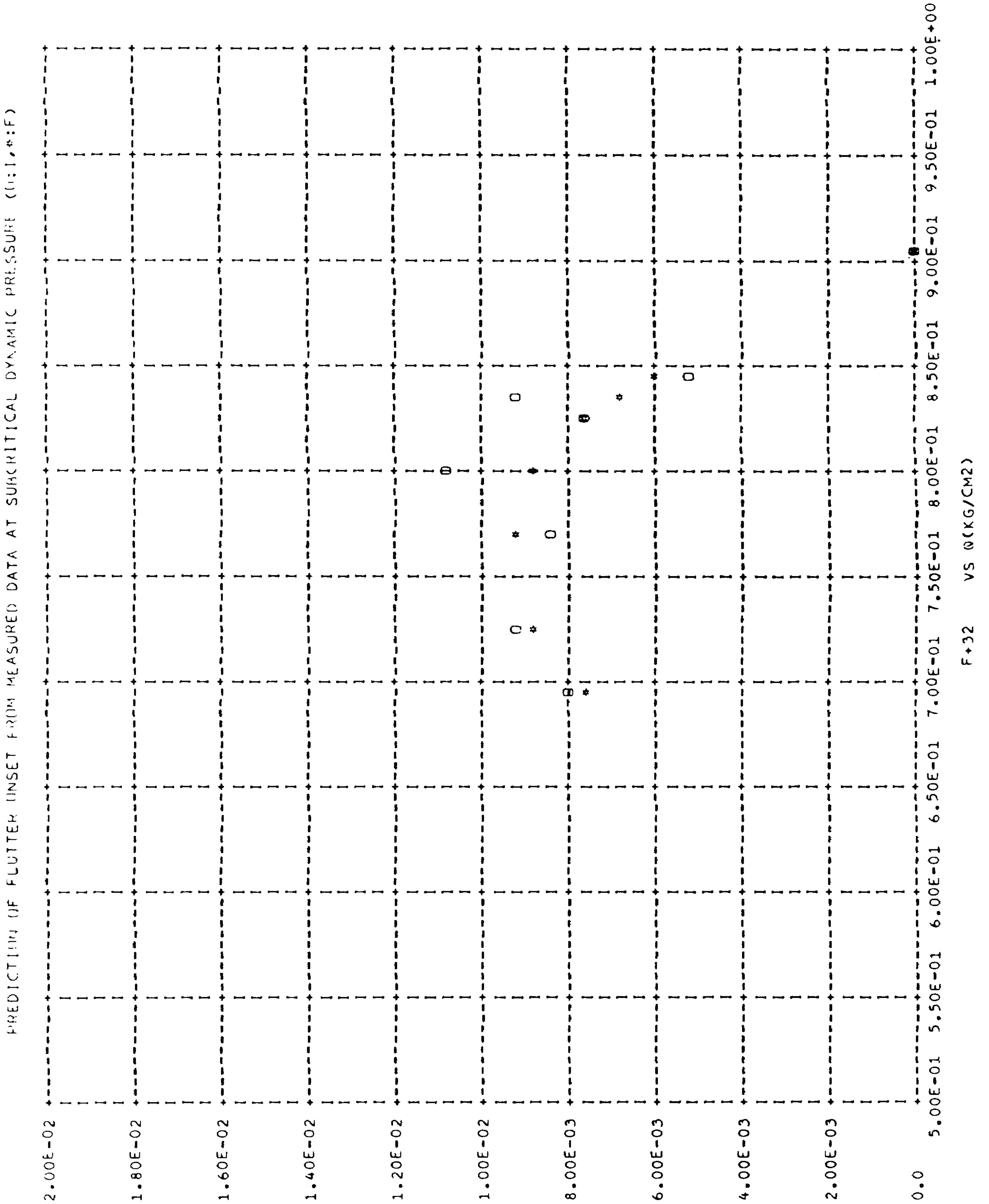

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
3.86E+00
3.85E+00
3.85E+00
3.84E+00
3.84E+00
3.83E+00
3.82E+00
3.82E+00
3.81E+00
3.81E+00
3.80E+00
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
B1 VS Q(KG/CM2)

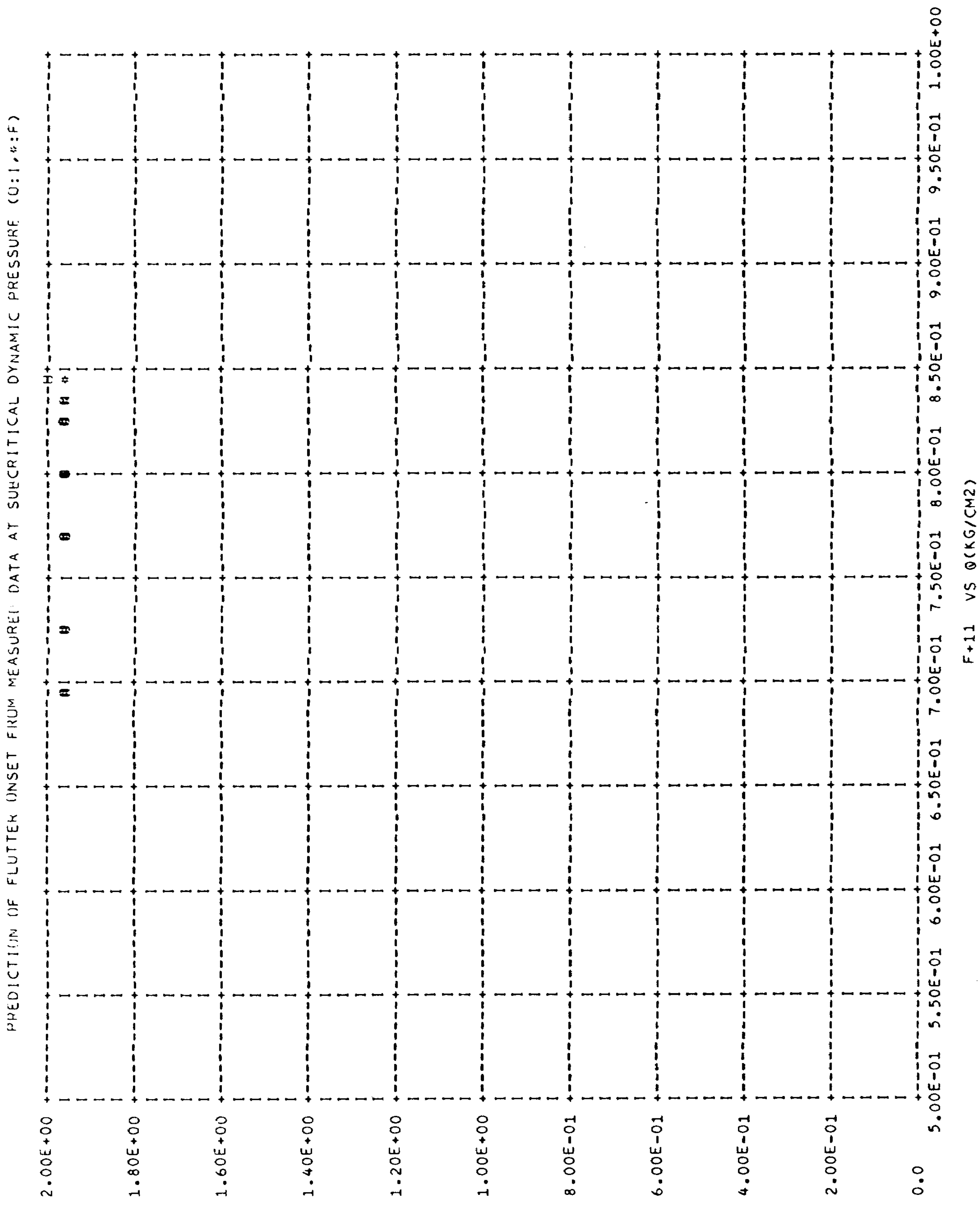

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
B0 VS Q(KG/CM2)
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00
9.50E-01
9.55E-01
9.60E-01
9.65E-01
9.70E-01
9.75E-01
9.80E-01
9.85E-01
9.90E-01
9.95E-01
1.00E+00

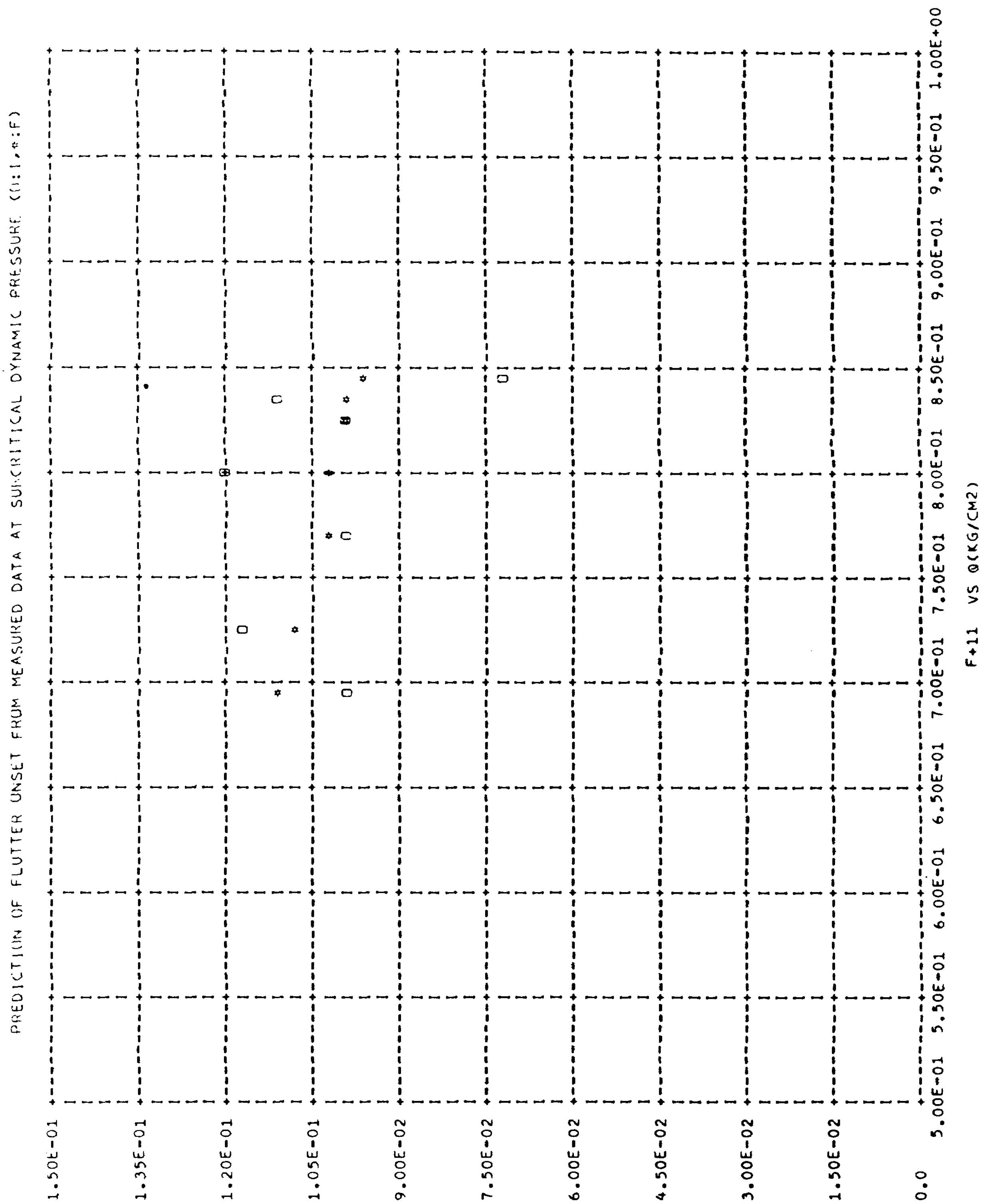

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:I,*:F)
5.00E-03
4.50E-03
4.00E-03
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
G+11 VS Q(KG/CM2)

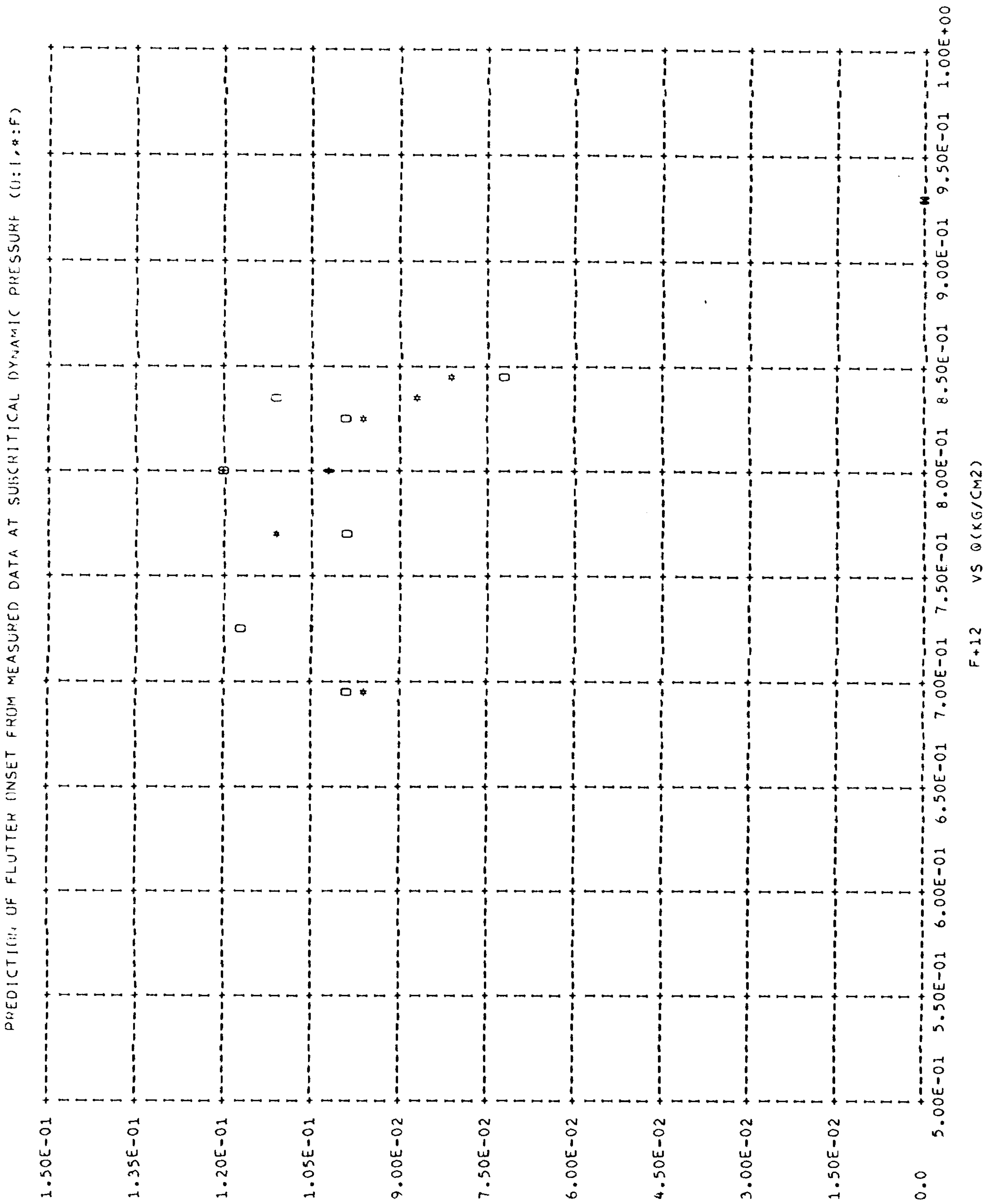

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (U:1,*:F)
2.00E+01
1.80E+01
1.60E+01
1.40E+01
1.20E+01
1.00E+01
8.00E+00
6.00E+00
4.00E+00
2.00E+00
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
G-11 VS Q(KG/CM2)

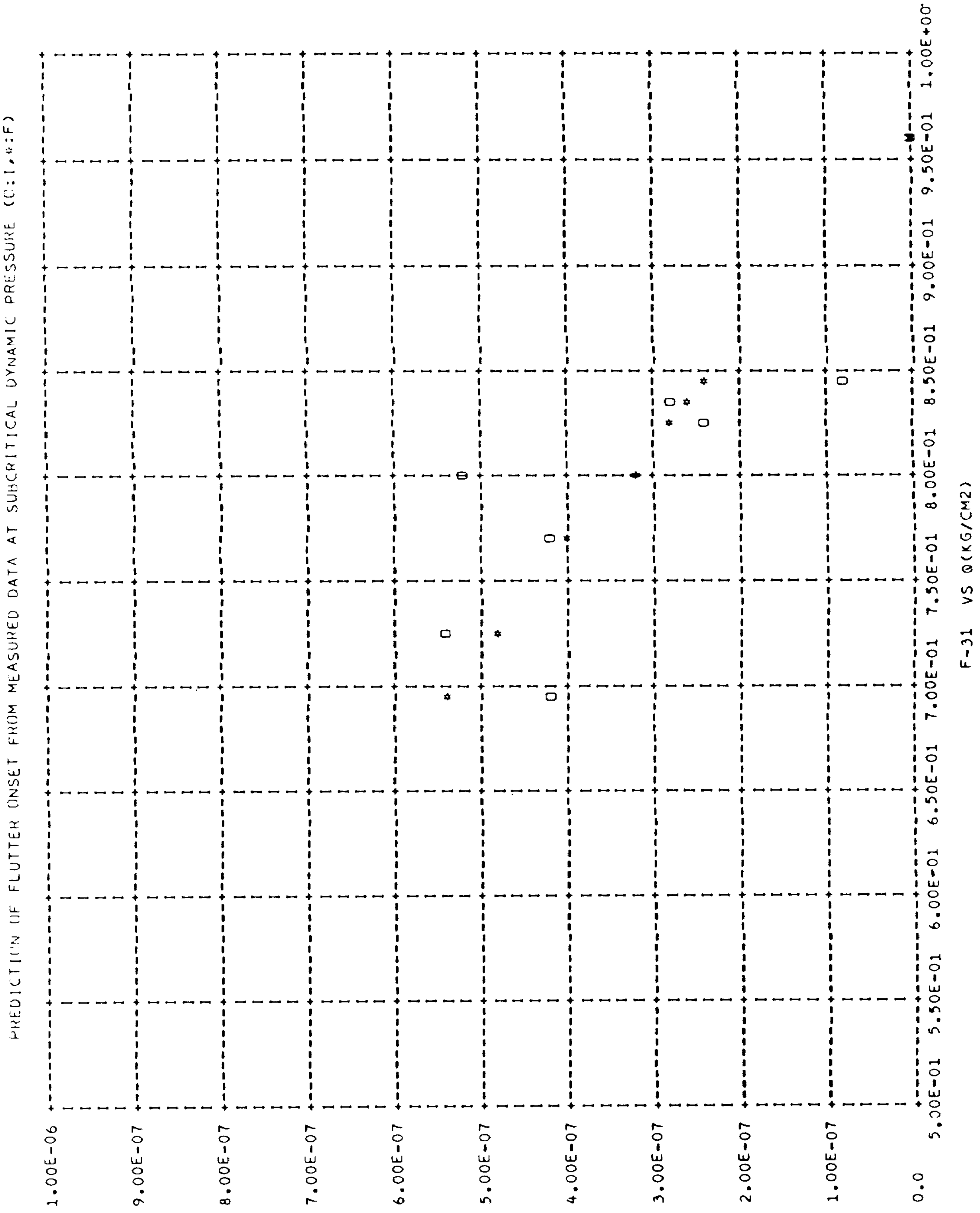

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:I,*:F)
F+31 VS Q(KG/CM2)
2.00E-02
1.80E-02
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.0
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00

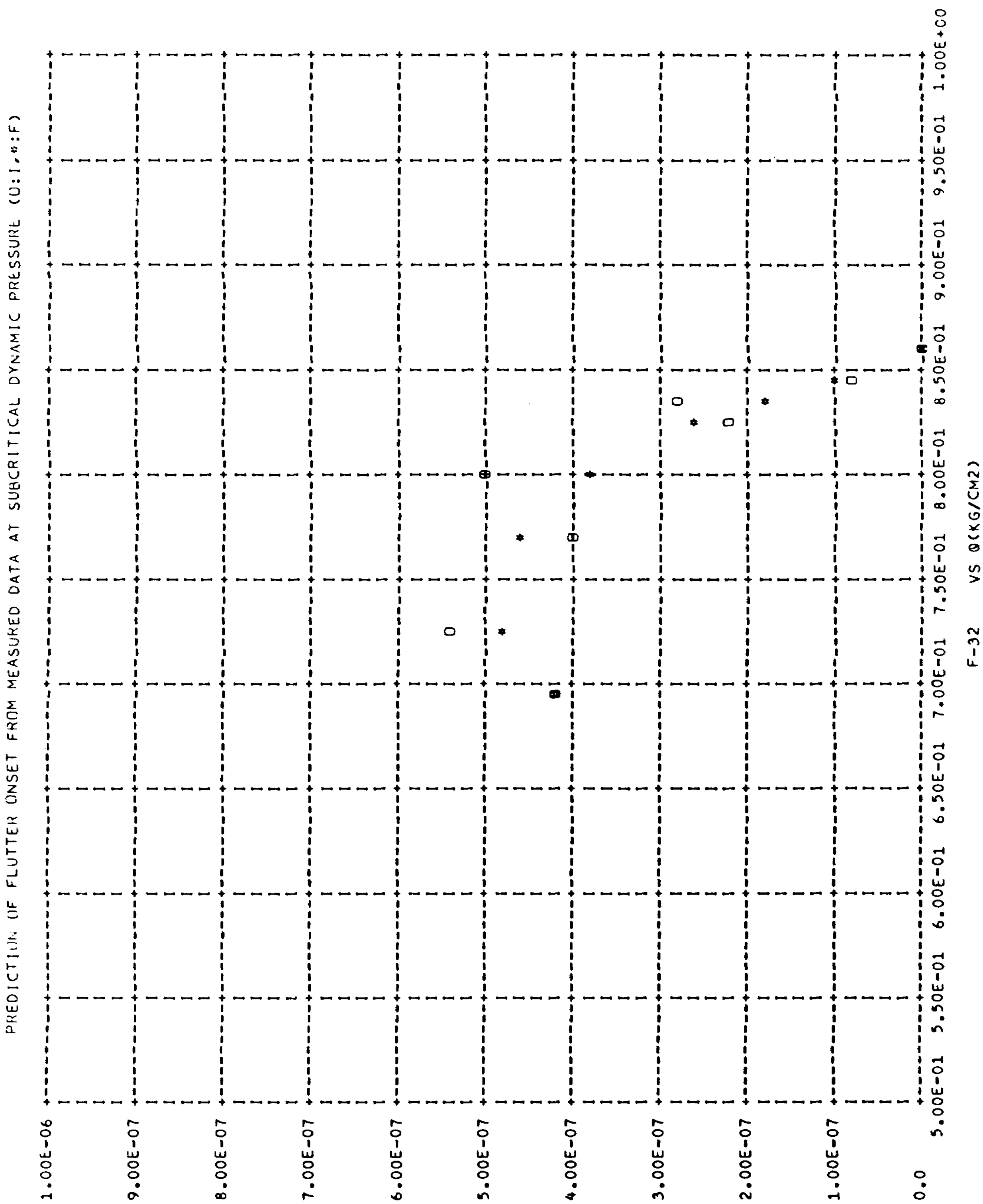

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:1,*:F)
F+32 VS Q(KG/CM2)
2.00E-02
1.80E-02
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.0
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00

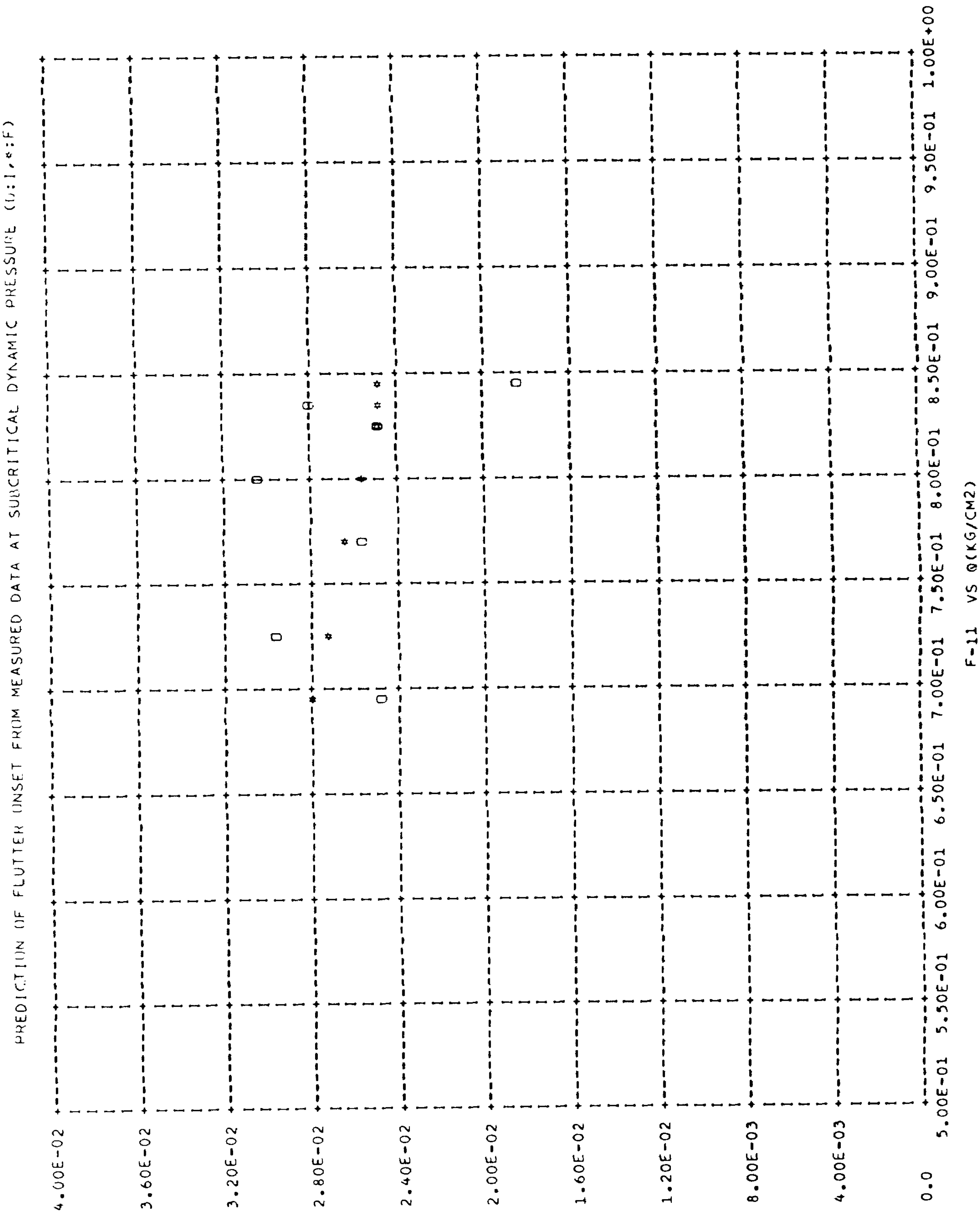

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (U:1,*:F)
F+11 VS Q(KG/CM2)
2.00E+00
1.80E+00
1.60E+00
1.40E+00
1.20E+00
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.0
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00

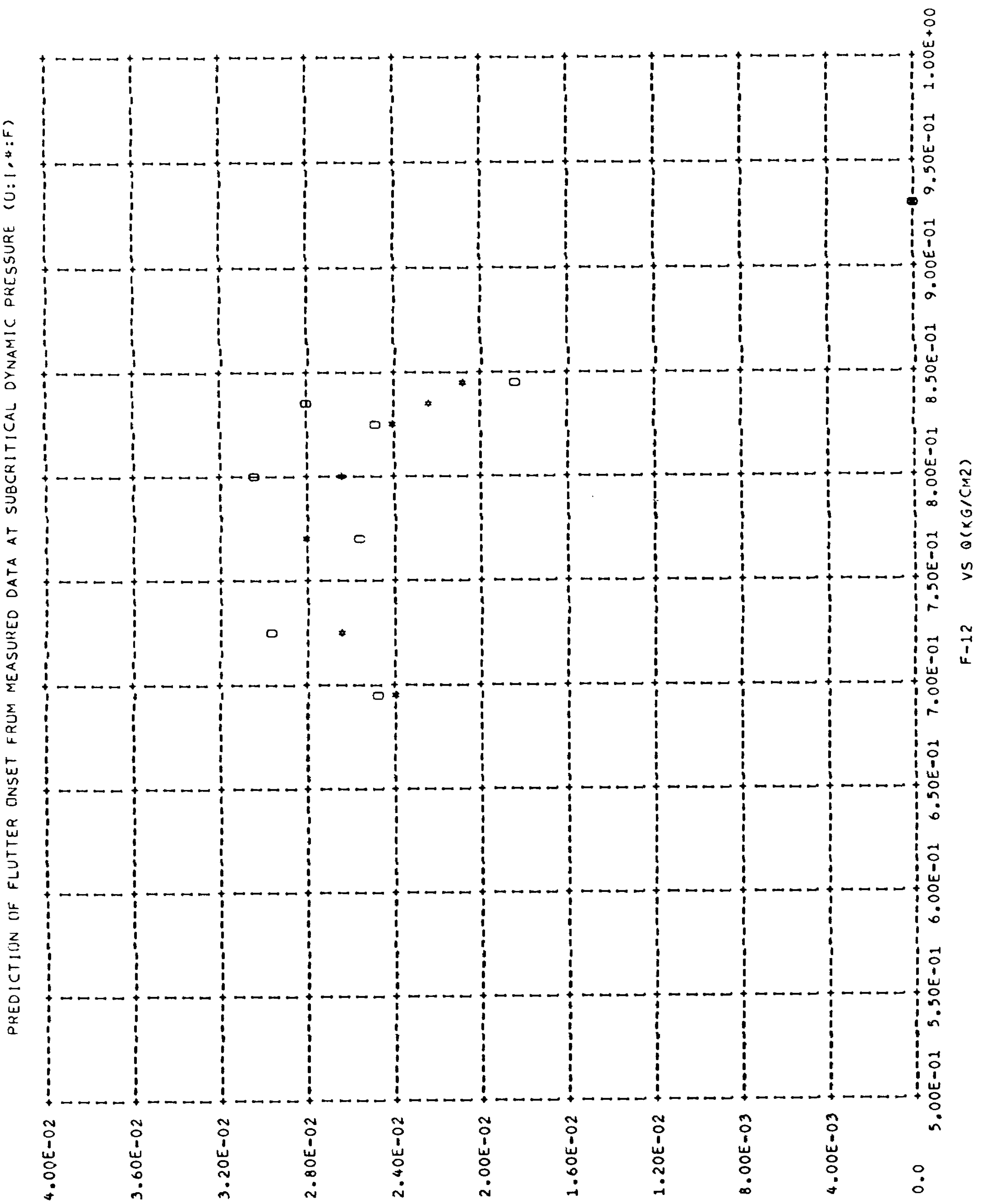

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
1.50E-01
1.35E-01
1.20E-01
1.05E-01
9.00E-02
7.50E-02
6.00E-02
4.50E-02
3.00E-02
1.50E-02
0.0
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00
F+11 VS Q(KG/CM2)

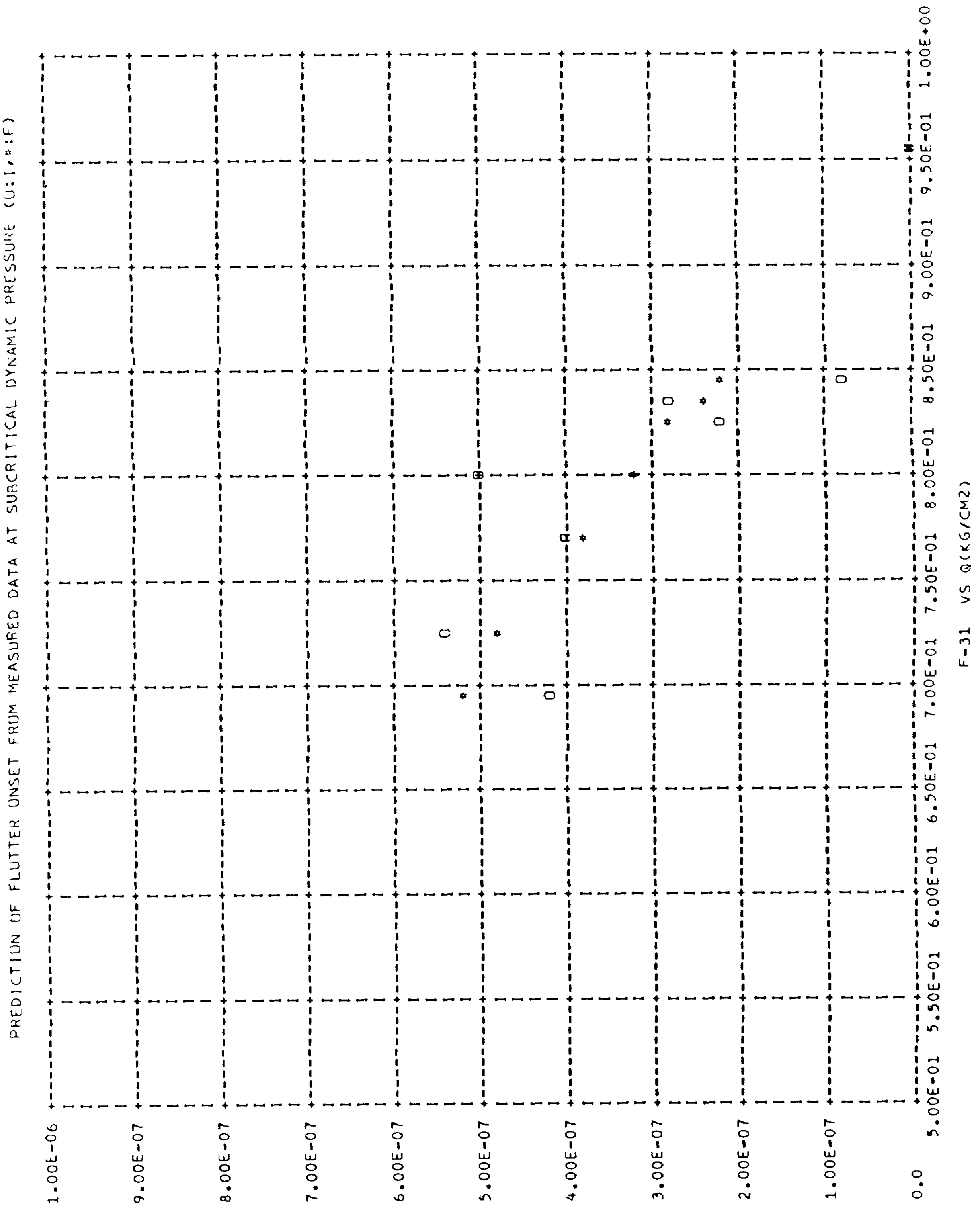

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:I,*:F)
F+12 VS Q(KG/CM2)
1.50E-01
1.35E-01
1.20E-01
1.05E-01
9.00E-02
7.50E-02
6.00E-02
4.50E-02
3.00E-02
1.50E-02
0.0
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00

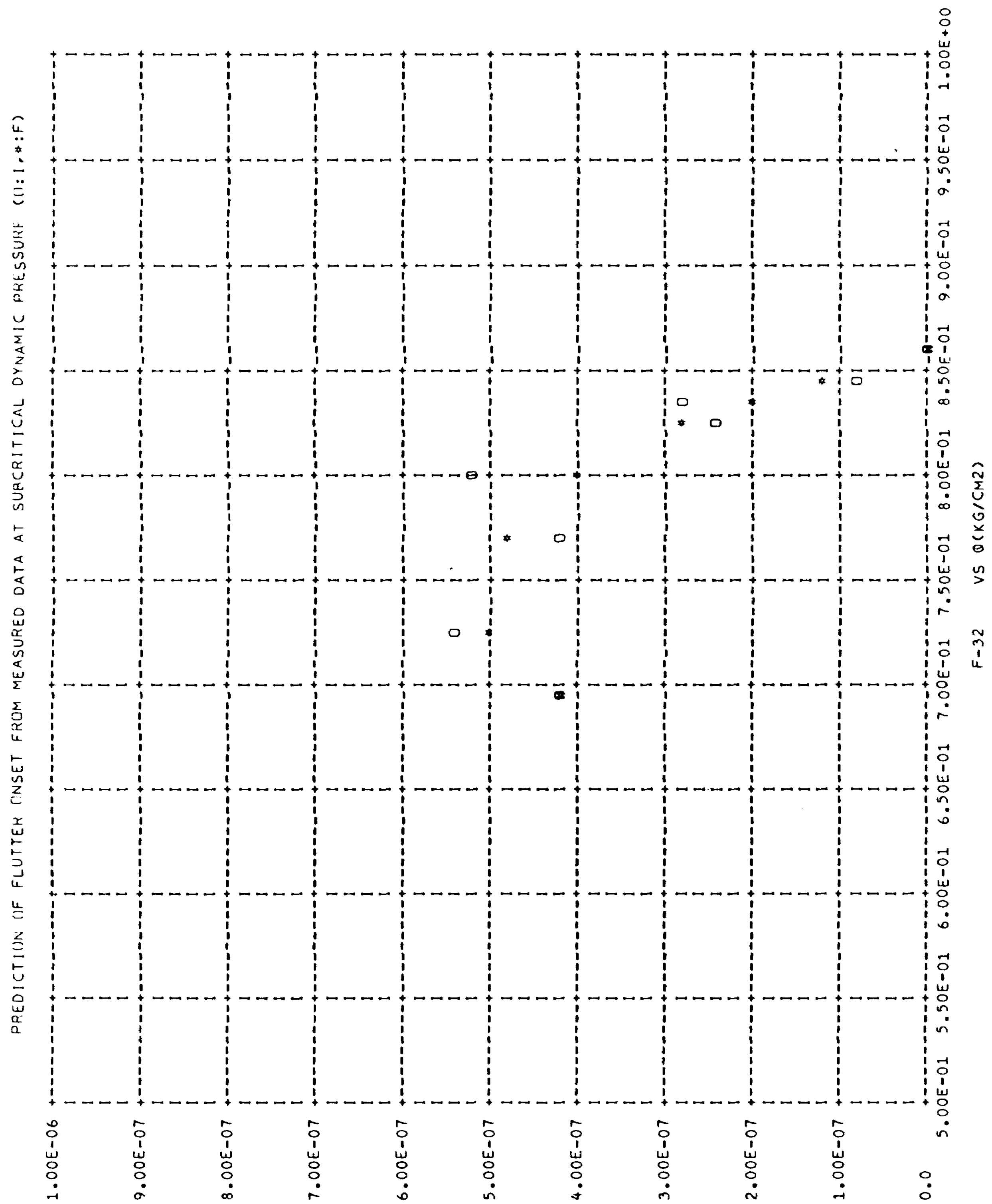

PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
1.00E-06
9.00E-07
8.00E-07
7.00E-07
6.00E-07
5.00E-07
4.00E-07
3.00E-07
2.00E-07
1.00E-07
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
F-31 VS Q(KG/CM2)


PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:I,*:F)
1.00E-06
9.00E-07
8.00E-07
7.00E-07
6.00E-07
5.00E-07
4.00E-07
3.00E-07
2.00E-07
1.00E-07
0.0
5.00E-01
5.50E-01
6.00E-01
6.50E-01
7.00E-01
7.50E-01
8.00E-01
8.50E-01
9.00E-01
9.50E-01
1.00E+00
F-32 VS Q(KG/CM2)


PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE
4.00E-02
3.60E-02
3.20E-02
2.80E-02
2.40E-02
2.00E-02
1.60E-02
1.20E-02
8.00E-03
4.00E-03
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
F-11 VS Q(KG/CM2)


PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (U:I,*:F)
4.00E-02
3.60E-02
3.20E-02
2.80E-02
2.40E-02
2.00E-02
1.60E-02
1.20E-02
8.00E-03
4.00E-03
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
F-12 VS Q(KG/CM2)


PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:I,*:F)
1.00E-06
9.00E-07
8.00E-07
7.00E-07
6.00E-07
5.00E-07
4.00E-07
3.00E-07
2.00E-07
1.00E-07
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
F-31 VS Q(KG/CM2)


PREDICTION OF FLUTTER ONSET FROM MEASURED DATA AT SUBCRITICAL DYNAMIC PRESSURE (O:I,*:F)
1.00E-06
9.00E-07
8.00E-07
7.00E-07
6.00E-07
5.00E-07
4.00E-07
3.00E-07
2.00E-07
1.00E-07
0.0
5.00E-01 5.50E-01 6.00E-01 6.50E-01 7.00E-01 7.50E-01 8.00E-01 8.50E-01 9.00E-01 9.50E-01 1.00E+00
F-32 VS Q(KG/CM2)

Program listing for JURY-CE8

```
      C     KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
      C     SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PURUGURAMU.
      C     ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
      C     CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL,S
      C     METHOD.
      C     NAL ESBACS - 2 - 0005
      C     ******************************************************************
      C     PROGRAM JURY-CE8 COMPUTES JURY'S STABILITY PARAMETERS OF THE
      C     EIGHTH-ORDER EQUATION.
      C     KO    : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
      C     KAISU : DATA NO. FOR THE LAST SET OF DATA.
      C     QQ(KO): DYNAMIC PRESSURE.
      C     B0,...,B7 : AR COEFFICIENTS B(0),...,B(7).
      C     *
      C     * STABILITY PARAMETERS *
      C     *
      C     G+1 AND G-1 : G(1) AND G(-1)
      C     F+I AND F-I : DET(XI+YI) AND DET(XI-YI)  FOR I=1,3,5,7.
      C     FOR EXAMPLE, F-1 : DET(X1-Y1).
            REAL*8 SPMD(12),SBM( 9, 9)
            REAL*8    B8(12),B7(12),B6(12),B5(12)
            REAL*8    B4(12),B3(12),B2(12),B1(12),B0(12)
            DIMENSION SX( 7, 7),SY( 7, 7),SHI( 7, 7)
            DIMENSION CC(13),PD(12)
            DIMENSION D1(21),D2(21),D5(21),D6(21),D7(21),D8(21)
            DIMENSION E5(21),E6(21),E7(21),E8(21),QQ(42)
      CC
            READ(5,556) KO,KAISU
            WRITE(6,100)
            M=8
        555 CONTINUE
            READ(5,500) QQ(KO)
            B8(KO)=1.0
            READ(5,510) B7(KO),B6(KO),B5(KO),B4(KO)
           *            ,B3(KO),B2(KO),B1(KO),B0(KO)
            D1(KO)=B8(KO)+B6(KO)+B4(KO)+B2(KO)+B0(KO)+
           *        (B7(KO)+B5(KO)+B3(KO)+B1(KO))
            D2(KO)=B8(KO)+B6(KO)+B4(KO)+B2(KO)+B0(KO)-
           *        (B7(KO)+B5(KO)+B3(KO)+B1(KO))
      CC
            CC(1)=B0(KO)
            CC(2)=B1(KO)
            CC(3)=B2(KO)
            CC(4)=B3(KO)
            CC(5)=B4(KO)
            CC(6)=B5(KO)
            CC(7)=B6(KO)
            CC(8)=B7(KO)
            CC(9)=B8(KO)
            M0=M-1
            M1=M+1
            DO 95 I=1,M
         95 PD(I)=0.0
            CALL SAJT(M,M1,M0,CC,PD,SPMD,SBM,SX,SY,SHI)
            D5(KO)=PD(1)
            D6(KO)=PD(2)
            D7(KO)=PD(3)
            D8(KO)=PD(4)
```

```
      E5(KO)=PD(5)
      E6(KO)=PD(6)
      E7(KO)=PD(7)
      E8(KO)=PD(8)
CC
CC    PRINTS OUT :
      WRITE(6,681) KO,QQ(KO),B8(KO),B7(KO),B6(KO),B5(KO),B4(KO)
      WRITE(6,181) KO,QQ(KO),B3(KO),B2(KO),B1(KO),B0(KO)
      WRITE(6,682) KO,QQ(KO),D1(KO),E5(KO),E6(KO),E7(KO),E8(KO)
      WRITE(6,182) KO,QQ(KO),D2(KO),D5(KO),D6(KO),D7(KO),D8(KO)
CC    PRINTS END
      IF(KO.EQ.KAISU) GO TO 558
      KO=KO+1
      GO TO 555
  558 CONTINUE
      STOP
  100 FORMAT(1H0,10X,'TABLE OF AR COEF. AND STABILITY PARAMETERS',//)
  681 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'  B8=',E13.5,2X,'  B7=',
     * E13.5,2X,'  B6=',E13.5,2X,'  B5=',E13.5,2X,'  B4=',E13.5,/)
  181 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,'  B3=',E13.5,2X,'  B2=',
     * E13.5,2X,'  B1=',E13.5,2X,'  B0=',E13.5,/)
  682 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,' G+1=',E13.5,2X,' F-7=',
     * E13.5,2X,' F-5=',E13.5,2X,' F-3=',E13.5,2X,' F-1=',E13.5,/)
  182 FORMAT(1H ,'NO.=',I2,2X,'Q=',F7.4,2X,' G-1=',E13.5,2X,' F+7=',
     * E13.5,2X,' F+5=',E13.5,2X,' F+3=',E13.5,2X,' F+1=',E13.5,//)
  500 FORMAT(F10.0)
  510 FORMAT(4D20.10)
  556 FORMAT(2I5)
      END
```

```
000057          SUBROUTINE SAJT(M,M1,M0,A,PD,PMD,BM,X,Y,HI)
        C       THIS SUBROUTINE PROGRAM IS USED FOR CALCULATION OF JURY'S
        C       STABILITY PARAMETERS.
        C       INPUTS REQUIRED :
        C          M : ORDER OF THE CHARACTERISTIC EQUATION.
        C          M : EVEN ONLY
        C          M1 : M+1
        C          M0 : M-1
        C          A(M1) : COEFFICIENTS OF THE CHARACTERISTIC EQUATION.
        C       OUTPUTS :
        C          PD(M) : STABILITY DETERMINANTS.
000058          REAL*8 PMD(M),BM(M0,M0),S
000059          DIMENSION PD(M),A(M1)
000060          DIMENSION X(M0,M0),Y(M0,M0),HI(M0,M0)
        CC      INITIAL CLEARING : START
000061          MD2=M/2
000062          IH2=0
000063          III=0
000064          DO 100 I=1,M0
000065          DO 100 J=1,M0
000066          X(I,J)=0.0
000067          Y(I,J)=0.0
000068      100 CONTINUE
        CC      INITIAL CLEARING : END
        CC      X(KK,I) COMPUTATION : START
000069          DO 1100 KK=1,M0
000070          DO  110 I=KK,M0
000071          II=M1+KK-I
000072          X(KK,I)=A(II)
000073      110 CONTINUE
000074     1100 CONTINUE
        CC      X(KK,I) COMPUTATION : END
        CC      Y(KK,I) COMPUTATION : START
000075          IM2=M0
000076          DO 2100 KK=1,M0
000077          DO  210 I=1,IM2
000078          II=M1-KK-I
000079          Y(KK,I)=A(II)
000080      210 CONTINUE
000081          IM2=IM2-1
000082     2100 CONTINUE
        CC      Y(KK,I) COMPUTATION : END
        CC      HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : START
000083      300 CONTINUE
000084          IM1=MD2
000085          P=1.0
000086          IF(IH2.EQ.1) P=-1.0
000087          DO 3000 KK=1,MD2
000088          IM2=M0
000089          DO 320 I=1,M0
000090          DO 320 J=1,M0
000091          HI(I,J)=X(I,J)+Y(I,J)*P
000092          BM(I,J)=0.0
000093      320 CONTINUE
000094          IM2=IM2-(MD2-IM1)*2
000095          DO 330 I=1,IM2
000096          DO 330 J=1,IM2
000097          II=MD2-IM1+I
```

```
            JJ=MD2-IM1+J
            BM(I,J)=HI(II,JJ)
      330   CONTINUE
            S=0.0
            IF(IM2.EQ.2) GO TO 332
            IF(IM2.EQ.1) GO TO 331
            ILL=0
C           THIS PROGRAM USES A STANDARD SUBROUTINE MDETD(BM,M0,IM2,1.0D-14,S,
C           ILL) TO GIVE THE VALUE S, OF THE DETERMINANT BM(IM2,IM2).
            CALL MDETD(BM,M0,IM2,1.0D-14,S,ILL)
            GO TO 333
      331   CONTINUE
            S=BM(1,1)
            GO TO 333
      332   CONTINUE
            S=(BM(1,1)*BM(2,2)-BM(1,2)*BM(2,1))
            GO TO 333
      333   CONTINUE
            III=III+1
            PMD(III)=S
            IF(ILL.NE.0) PMD(III)=9999.9
            IM1=IM1-1
     3000   CONTINUE
            IF(IH2.EQ.1) GO TO 340
            IH2=IH2+1
            GO TO 300
      340   CONTINUE
CC          HI(I,J)=X(I,J)+Y(I,J)*P COMPUTATION : END
CC          THE INPUTS TO THE MAIN PROGRAM : START
            DO 400 I=1,M
            PD(I)=SNGL(PMD(I))
      400   CONTINUE
CC          THE INPUTS TO THE MAIN PROGRAM : END
            RETURN
            END
```

Input example for program JURY-CE8

```
    1    9
0.534
  -0.2715692377D+01  0.3842079297D+01  -0.4065511467D+01  0.3984584738D+01
  -0.3721756970D+01  0.2906377400D+01  -0.1489682187D+01  0.3913684648D+00
0.591
  -0.2675895162D+01  0.3641065223D+01  -0.3657062409D+01  0.3513628614D+01
  -0.3357981809D+01  0.2760215840D+01  -0.1495700535D+01  0.4109626468D+00
0.745
  -0.2899370966D+01  0.4129639291D+01  -0.4079726919D+01  0.3792268948D+01
  -0.3658605802D+01  0.3148905740D+01  -0.1803834414D+01  0.5044672000D+00
0.760
  -0.3121613055D+01  0.4887520836D+01  -0.5169967891D+01  0.4658272133D+01
  -0.4119895296D+01  0.3342321717D+01  -0.1861002866D+01  0.5104094043D+00
0.796
  -0.3055353207D+01  0.4617551593D+01  -0.4679205165D+01  0.4207004739D+01
  -0.3934139659D+01  0.3426909547D+01  -0.2012491650D+01  0.5761573568D+00
0.829
  -0.3182858025D+01  0.5046220343D+01  -0.5258827640D+01  0.4533574673D+01
  -0.3818077890D+01  0.3106518021D+01  -0.1802072117D+01  0.5257021418D+00
```

0.839

-0.3214077461D+01	0.5173210864D+01	-0.5449561651D+01	0.4663370830D+01
-0.3826612151D+01	0.3042027174D+01	-0.1734830485D+01	0.4992287417D+00

0.861

-0.3255758500D+01	0.5344256589D+01	-0.5782626509D+01	0.5079568758D+01
-0.4162857411D+01	0.3202496055D+01	-0.1768643290D+01	0.4994606448D+00

0.902

-0.3194140282D+01	0.5100088471D+01	-0.5281837934D+01	0.4473940944D+01
-0.3711514060D+01	0.3027580949D+01	-0.1760075824D+01	0.5172326015D+00

Output for program JURY-CE8

TABLE OF AR COEF. AND STABILITY PARAMETERS

NO.= 1	Q= 0.5340	B8= 0.10000D+01	B7= -0.27157D+01	B6= 0.38421D+01	B5= -0.40655D+01	B4= 0.39846D+01
NO.= 1	Q= 0.5340	B3= -0.37218D+01	B2= 0.29064D+01	B1= -0.14897D+01	B0= 0.39137D+00	
NO.= 1	Q= 0.5340	G+1= 0.13177E+00	F-7= 0.25736E-02	F-5= 0.47654E-01	F-3= 0.18499E+00	F-1= 0.60863E+00
NO.= 1	Q= 0.5340	G-1= 0.24117E+02	F+7= 0.48808E+00	F+5= 0.88417E+00	F+3= 0.13349E+01	F+1= 0.13914E+01
NO.= 2	Q= 0.5910	B8= 0.10000D+01	B7= -0.26759D+01	B6= 0.36411D+01	B5= -0.36571D+01	B4= 0.35136D+01
NO.= 2	Q= 0.5910	B3= -0.33580D+01	B2= 0.27602D+01	B1= -0.14957D+01	B0= 0.41096D+00	
NO.= 2	Q= 0.5910	G+1= 0.13923E+00	F-7= 0.29284E-02	F-5= 0.62015E-01	F-3= 0.21245E+00	F-1= 0.58904E+00
NO.= 2	Q= 0.5910	G-1= 0.22513E+02	F+7= 0.63194E+00	F+5= 0.97033E+00	F+3= 0.13040E+01	F+1= 0.14110E+01
NO.= 3	Q= 0.7450	B8= 0.10000D+01	B7= -0.28994D+01	B6= 0.41296D+01	B5= -0.40797D+01	B4= 0.37923D+01
NO.= 3	Q= 0.7450	B3= -0.36586D+01	B2= 0.31489D+01	B1= -0.18038D+01	B0= 0.50447D+00	
NO.= 3	Q= 0.7450	G+1= 0.13374E+00	F-7= 0.10253E-02	F-5= 0.58379E-01	F-3= 0.21516E+00	F-1= 0.49553E+00
NO.= 3	Q= 0.7450	G-1= 0.25017E+02	F+7= 0.53595E+00	F+5= 0.91759E+00	F+3= 0.11201E+01	F+1= 0.15045E+01
NO.= 4	Q= 0.7600	B8= 0.10000D+01	B7= -0.31216D+01	B6= 0.48875D+01	B5= -0.51700D+01	B4= 0.46583D+01
NO.= 4	Q= 0.7600	B3= -0.41199D+01	B2= 0.33423D+01	B1= -0.18610D+01	B0= 0.51041D+00	
NO.= 4	Q= 0.7600	G+1= 0.12604E+00	F-7= 0.51171E-03	F-5= 0.33633E-01	F-3= 0.28449E+00	F-1= 0.48959E+00
NO.= 4	Q= 0.7600	G-1= 0.28671E+02	F+7= 0.29507E+00	F+5= 0.11524E+01	F+3= 0.10634E+01	F+1= 0.15104E+01
NO.= 5	Q= 0.7960	B8= 0.10000D+01	B7= -0.30554D+01	B6= 0.46176D+01	B5= -0.46792D+01	B4= 0.42070D+01
NO.= 5	Q= 0.7960	B3= -0.39341D+01	B2= 0.34269D+01	B1= -0.20125D+01	B0= 0.57616D+00	
NO.= 5	Q= 0.7960	G+1= 0.14643E+00	F-7= 0.34472E-03	F-5= 0.32092E-01	F-3= 0.22121E+00	F-1= 0.42384E+00
NO.= 5	Q= 0.7960	G-1= 0.27509E+02	F+7= 0.31416E+00	F+5= 0.94201E+00	F+3= 0.98328E+00	F+1= 0.15762E+01
NO.= 6	Q= 0.8290	B8= 0.10000D+01	B7= -0.31829D+01	B6= 0.50462D+01	B5= -0.52588D+01	B4= 0.45336D+01
NO.= 6	Q= 0.8290	B3= -0.38181D+01	B2= 0.31065D+01	B1= -0.18021D+01	B0= 0.52570D+00	
NO.= 6	Q= 0.8290	G+1= 0.15018E+00	F-7= 0.23250E-03	F-5= 0.33264E-01	F-3= 0.30592E+00	F-1= 0.47430E+00
NO.= 6	Q= 0.8290	G-1= 0.28274E+02	F+7= 0.31711E+00	F+5= 0.12317E+01	F+3= 0.11540E+01	F+1= 0.15257E+01
NO.= 7	Q= 0.8390	B8= 0.10000D+01	B7= -0.32141D+01	B6= 0.51732D+01	B5= -0.54496D+01	B4= 0.46634D+01
NO.= 7	Q= 0.8390	B3= -0.38266D+01	B2= 0.30420D+01	B1= -0.17348D+01	B0= 0.49923D+00	
NO.= 7	Q= 0.8390	G+1= 0.15276E+00	F-7= 0.14865E-03	F-5= 0.25041E-01	F-3= 0.33861E+00	F-1= 0.50077E+00
NO.= 7	Q= 0.8390	G-1= 0.28603E+02	F+7= 0.23895E+00	F+5= 0.12980E+01	F+3= 0.11696E+01	F+1= 0.14992E+01
NO.= 8	Q= 0.8610	B8= 0.10000D+01	B7= -0.32558D+01	B6= 0.53443D+01	B5= -0.57826D+01	B4= 0.50796D+01
NO.= 8	Q= 0.8610	B3= -0.41629D+01	B2= 0.32025D+01	B1= -0.17686D+01	B0= 0.49946D+00	
NO.= 8	Q= 0.8610	G+1= 0.15590E+00	F-7= 0.13050E-03	F-5= 0.27261E-01	F-3= 0.32070E+00	F-1= 0.50054E+00
NO.= 8	Q= 0.8610	G-1= 0.30096E+02	F+7= 0.27626E+00	F+5= 0.13111E+01	F+3= 0.12089E+01	F+1= 0.14995E+01
NO.= 9	Q= 0.9020	B8= 0.10000D+01	B7= -0.31941D+01	B6= 0.51001D+01	B5= -0.52818D+01	B4= 0.44739D+01
NO.= 9	Q= 0.9020	B3= -0.37115D+01	B2= 0.30276D+01	B1= -0.17601D+01	B0= 0.51723D+00	
NO.= 9	Q= 0.9020	G+1= 0.17127E+00	F-7= 0.11178E-03	F-5= 0.26312E-01	F-3= 0.32033E+00	F-1= 0.48277E+00
NO.= 9	Q= 0.9020	G-1= 0.28066E+02	F+7= 0.26486E+00	F+5= 0.12852E+01	F+3= 0.11676E+01	F+1= 0.15172E+01

Program listing for FRED

```
C     KOUGIKEN NO HOOHOU NI YORU FURATSUTA ARUIWA DAIBAAZENSU GENKAI
C     SOKUDO OYOBI KUURIKIDANSEI TOKUSEI SUITEI NO KEISAN PUROGURAMU.
C     ESTIMATION OF BOUNDARY FOR FLUTTER OR DIVERGENCE AND AEROELASTIC
C     CHARACTERISTICS AT SUBCRITICAL SPEEDS WITH THE AID OF NAL,S
C     METHOD.
C     NAL ESBACS - 1 - 0007
C     ****************************************************************
C     PROGRAM FRED.
C     CALCULATION OF FREQUENCIES AND DAMPING RATIOS.
C     THIS PROGRAM INPUTS THE ORDER AND COEFFICIENTS OF AR PART AND
C     COMPUTES FREQUENCIES AND DAMPING RATIOS OF AN EQUIVALENT J-DEGREE-
C     OF-FREEDOM SYSTEM WITH VISCOS DAMPING.
C     KO    : DATA NO. FOR THE FIRST SET OF DATA, (USUALLY KO=1).
C     KAISU : DATA NO. FOR THE LAST SET OF DATA.
C     DT    : SAMPLED INTERVAL
C     IQ    : ORDER OF AR PART, M=IQ
C     IP    : ORDER OF MA PART, N=IQ-1=M-1=IP
C     CXXO  : VARIANCE
C     C(I),I=1,M : COEFFICIENTS OF AR PART
C     A(I),I=1,N : COEFFICIENTS OF MA PART
C     F(I),I=1,M : FREQUENCIES
C     R(I),I=1,M : DAMPING RATIOS
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION B(26),PR(25),PI(25),F(25),R(25)
      DIMENSION A(26),C(26)
CC
      READ(5,556) KO,KAISU
      READ(5,500) IQ,IP,DT
      M=IQ
      N=IP
CC
  555 CONTINUE
      WRITE(6,557) KO
CC
      READ(11) IQ,IP,CXXO,(C(I),I=1,M),(A(I),I=1,N)
      M1=M+1
      DO 5 I=1,M
      II=I+1
      B(II)=C(I)
    5 CONTINUE
      B(1)=1.0
      WRITE(6,650)
      WRITE(6,600) DT,M,(J,B(J),J=1,M1)
C     THIS PROGRAM USES A STANDARD SUBROUTINE JARATD(B,M,1.0D-15,PR,PI,
C     ILL) TO CALCULATE REAL AND IMAGINARY PARTS, PR AND PI , OF COMPLEX
C     ROOTS OF M-TH ORDER POLINOMIAL EQUATION WITH REAL COEFFICIENTS
C     B(1),...,B(M) .
      CALL JARATD(B,M,1.0D-15,PR,PI,ILL)
      WRITE(6,610) ILL
      IF(ILL.EQ.0) GO TO 10
      IF(ILL.EQ.30000) STOP
      IL1=ILL-1
      WRITE(6,620)(J,PR(J),PI(J),J=1,IL1)
      M=IL1
   10 AT=0.5/DT
      P2=0.159154943091895
      DO 20 J=1,M
```

```
          P=PR(J)*PR(J)+PI(J)*PI(J)
          PP=(PR(J)*PR(J)-PI(J)*PI(J))/P
          PQ=DACOS(PP)
          F(J)=PQ*AT*P2
          IF(PQ.NE.0.0) GO TO 30
          R(J)=9999.
          GO TO 20
       30 R(J)=-DLOG(P)/PQ
       20 CONTINUE
CC
          DO 3 I=1,M
          II=I
          DO 2 J=I,M
          IF(F(J)-F(II)) 1,2,2
        1 II=J
        2 CONTINUE
          FP1=F(I)
          FP2=R(I)
          FP3=PR(I)
          FP4=PI(I)
          F(I)=F(II)
          R(I)=R(II)
          PR(I)=PR(II)
          PI(I)=PI(II)
          F(II)=FP1
          R(II)=FP2
          PR(II)=FP3
          PI(II)=FP4
        3 CONTINUE
CC
          WRITE(6,630)
          WRITE(6,640)(J,PR(J),PI(J),F(J),R(J),J=1,M)
CC
          WRITE(51) M,N,DT,(F(I),I=1,M),(R(I),I=1,M)
          CONTINUE
          IF(KO.EQ.KAISU) GO TO 559
          KO=KO+1
          GO TO 555
      559 CONTINUE
          STOP
      500 FORMAT(2I5,F10.0)
      510 FORMAT(4D20.10)
      556 FORMAT(2I5)
      557 FORMAT(1H1,' NO.=',I5,//)
      600 FORMAT(1H /5X,'SAMPLING PERIOD(SEC) DT=',D10.3,5X,'ORDER OF CHARAC
     ATERISTIC EQ. M=',I5/5X,'COEFFICIENT OF EQ.'/(10X,I3,D25.16))
      610 FORMAT(/  ,5X,8H*RESULT*,5X,4HILL=I5)
      620 FORMAT(10X,I3,2D25.16)
      630 FORMAT(1H ,2H M,3X,12HREAL PART(M),14X,17HIMAGINARY PART(M),14X,
     A                   12HFREQUENCY(M),8X,16HDAMPING RATIO(M))
      640 FORMAT(I3,2X,D25.16,2X,D25.16,2X,D20.10,2X,D20.10)
      650 FORMAT(1H0,'DETERMINANT OF FREQ. AND DAMPING FROM COEF. OF AR(I)
     AIN AR_MA MODEL BY JARRATT MODIFIED METHOD')
          END
```

Input example for program FRED

```
    1    11

    2     1     0.001

// EXPAND USDK,RNO=11,FILE='C01.M2015'

// EXPAND USDK,RNO=51,FILE='C01.M2056',DISP=NEW,RECFM=VBS
```

Output for program FRED

```
 NO.=     1


DETERMINANT OF FREQ. AND DAMPING FROM COEF. OF AR(I)  IN AR_MA MODEL BY JARRATT MODIFIED METHOD

    SAMPLING PERIOD(SEC) DT= 0.100D-02      ORDER OF CHARACTERISTIC EQ. M=    2
    COEFFICIENT OF EQ.
            1   0.1000000000000000D+01
            2  -0.1981765129499938D+01
            3   0.9877462556321171D+00

    *RESULT*      ILL=     0
 M   REAL PART(M)                 IMAGINARY PART(M)              FREQUENCY(M)          DAMPING RATIO(M)
 1     0.9908825647499690D+00       0.7679842776151434D-01        0.1231070558D+02        0.7969857998D-01
 2     0.9908825647499691D+00      -0.7679842776151434D-01        0.1231070558D+02        0.7969857998D-01
```

Acknowledgment

The authors would like to express their sincere thanks to Dr. H. Akaike of the Institute of Statistical Mathematics Tokyo, for his invaluable comments on the application of his minimum AIC procedure.

REFERENCES

[1] Matsuzaki, Y., and Ando, Y., "New Estimation Method for Flutter or Divergence Boundary from Random Responses at Subcritical Speeds," NAL TR—667T, National Aerospace Laboratory, Tokyo, April 1981.

[2a] Matsuzaki, Y., and Ando, Y., "Estimation of Flutter Boundary from Random Responses Due to Turbulence at Subcritical Speeds," J. of Aircraft, Vol. 18, No. 10, October 1981, pp. 862 — 868.

[2b] Matsuzaki, Y., and Ando, Y., "Reply to the Technical Comment on Estimation of Flutter Boundary from Random Responses Due to Turbulence at Subcritical Speeds," J. of Aircraft, Vol. 19, No. 7, July 1982, p. 606.

[3] Ando, Y., Matsuzaki, Y., Ejiri, H., and Kikuchi, T., "The Estimation Method on Flutter Boundary from Subcritical Random Responses Due to Air Turbulence -- Problems in Test Procedure and Data Analysis (in Japanese)," NAL TR—718, National Aerospace Laboratory Tokyo, July 1982.

[4] Akaike, H., Arahata, E., and Ozaki, T., "TIMSAC—74, A Time Series Analysis and Control Program Package — (1)," Computer Science Monographs, No. 5, The Institute of Statistical Mathematics, Tokyo, March 1975.

[5] Jury, I.E., *Theory and Application of the z-Transform Method*, John Wiley, New York, 1964.

TECHNICAL REPORT OF NATIONAL AEROSPACE LABORATORY
TR-737T

航空宇宙技術研究所報告737T号(欧文)

昭和57年9月発行

発行所　航空宇宙技術研究所
東京都調布市深大寺町1,880
電話 武蔵野三鷹(0422)47-5911(大代表)
印刷所　株式会社　実業公報社
東京都千代田区九段南4-2-12

Published by
NATIONAL AEROSPACE LABORATORY
1,880 Jindaiji, Chōfu, Tokyo
JAPAN

Printed in Japan