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PULSE MODE PERFORMANCE MODEL COMPUTER PROGRAM DOCUMENTATION AND USER'S GUIDE. VOLUME II. APPENDIX A. SOURCE PROGRAM LISTING. APPENDIX B. CARD CHANGES FOR SPECIAL DECK SETUP. APPENDIX C. INPUT DATA DECK LISTING FOR EXAMPLE CASE

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Rockwell International Corporation

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VOLUME II

APPENDIX A: SOURCE PROGRAM LISTING
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Programs (Computers)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Pulse Mode Performance Model computer program has been developed to provide an analytical tool for accurately predicting the pulse-mode performance of attitude control rocket engines. Specifically, the principal performance parameters predicted are propellant flows, total impulse and mean specific impulse for individual pulses and for overall mission duty cycles. The pulse mode operation is applicable for pulse widths which are long enough for thrust to approach its steady-state level and for pulse rates which are

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not so rapid as to prevent thrust from decaying below 10 percent of its steady-state level between pulses.

This volume of the Users Guide, along with three others, and the final report (AFRPL-TR-72-16), contains sufficient descriptive information and instructions for knowledgeable people to use the Pulse Mode Performance Model computer program with a minimum of difficulty. The first volume describes the computer program, its required input data, special operating instructions and output. Volume II contains a listing of the source program coding (excluding subprogram TDK), of card changes for special desk set ups and of the input data used in the example case. Volume III contains the complete printout of the example case. The last volume (IV) is a listing of the TDK source program coding.

AFRPL-TR-73-116, VOL. II

PULSE MODE PERFORMANCE MODEL
COMPUTER PROGRAM DOCUMENTATION
AND USER'S GUIDE

VOLUME II

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Canoga Park, California

FOREWORD

This computer program documentation was prepared by the Advanced Programs division of Rocketdyne, a division of North American Rockwell Corporation, 6633 Canoga Avenue, Canoga Park, California. This document was prepared in accordance with and in partial fulfillment of Contract F04611-70-C-0074, Pulse Mode Performance Model (Project No. 3058, Program Element No. 6.23.02F), during the period 1 July 1970 to 21 September 1972. This contract was administrered by the Air Force Rocket Propulsion Laboratory, Edwards, California. The Air Force Project Officer was Capt. S. Rosen, who replaced Dr. Clark Hawk. Initially Mr. T. A. Coultas was the Rocketdyne Program Manager, with Mr. L. P. Combs replacing him just prior to the program extension.

APPENDIX A

SOURCE PROGRAM LISTING

(OTHER THAN PMDER/TDK SUBPROGRAM)

```
C       PULSE  MODE  PERFORMANCE  MODEL  ( P M P M )  CONTROL  PROGRAM   PMPM0010
      COMMON  /HEAD/   AMAT(72),      CDATE(2),                          PMPM0020
     1                 ILISP,  ISTC,   ITRANS, ITDK,   IPULSE, IDCYCL   PMPM0030
C                                                                        PMPM0100
        CALL  PMPMID                                                     PMPM0110
      IF(JLISP.NE.0 .OR. JSTC.NE.0 .OR. JPULSE.NE.0)CALL  PPIN           PMPM0114
      GO TO 20                                                           PMPM0116
   10   CALL  PMPMID                                                    PMPM0118
   20 IF(ILISP.NE.0 .OR. ISTC.NE.0 .OR. ITDK.NE.0)  CALL  PMDER         PMPM0120
      IF(IPULSE.NE.0 .AND. ILISP.EQ.0 .AND. ISTC.EQ.0)                   PMPM0124
     1                                              CALL  ENGBAL(0,K)   PMPM0126
      IF(IPULSE.EQ.1)                               CALL  PULSE         PMPM0130
      IF(IDCYCL.EQ.1)                               CALL  DCYCLE        PMPM0140
        CALL  PMPMID                                                     PMPM0200
      GO TO 10                                                           PMPM0800
      END                                                                PMPM0820


      SUBROUTINE  PMPMID                                                 PMID0010
      COMMON  /HEAD/   AMAT(72),      CDATE(2),                          PMID0020
     1                 ILISP,  ISTC,   ITRANS, ITDK,   IPULSE, IDCYCL   PMID0030
     2               , JLISP, JSTC, JPULSE, JBOIL, JIGN                  PMID0032
      DATA  KOUNT/ 0 /                                                   PMID0040
      KOUNT = KOUNT + 1                                                  PMID0050
      IF(KOUNT.GT.1)  GO TO 30                                           PMID0060
        READ(5,10,END=74)  AMAT                                          PMID0070
   10   FORMAT(18A4)                                                     PMID0080
        READ(5,20)      ILISP,  ISTC,   ITDK,   IPULSE, IDCYCL         PMID0090
        READ(5,20)      JLISP,  JSTC,   JPULSE, JBOIL,  JIGN           PMID0092
   20   FORMAT(5I12)                                                     PMID0100
        CALL  CDATEV(CDATE)                                              PMID0110
   30 WRITE(6,40)                                                        PMID0120
   40 FORMAT(1H1 //// 39X 31HROCKET  ENGINE  THRUST  CHAMBER //         PMID0130
     1 27X 55HSTEADY-STATE  AND  PULSE  MODE  PERFORMANCE  SIMULATION    PMID0140
     2 ////  42X 26HP M P M   COMPUTER   MODEL   //                      PMID0150
```

```
     3 25X 43HDEVELOPED BY   W D CHADWICK  AND  L P COMBS   /              PMID0160
     4 40X                  42HADVANCED PROGRAMS (D/569-197),  ROCKETDYNE/PMID0170
     5 40X                  31HNORTH  AMERICAN  ROCKWELL  CORP /           PMID0180
     6 40X                  30HCANOGA PARK, CALIFORNIA  91304  )           PMID0190
      WRITE(6,50)  AMAT                                                    PMID0200
   50 FORMAT( //                                                           PMID0210
     1 25X 53HSPONSORED BY   AIR FORCE ROCKET PROPULSION LABORATORY /      PMID0220
     2 40X                  35HEDWARDS AIR FORCE BASE,  CALIFORNIA   /     PMID0230
     3 40X                  36HUNDER CONTRACT NO.  F04611-70-C-0074  /// PMID0240
     4 25X 31HVERSION         JULY 72 REVISION                  ///PMID0250
     5 47X                      11H THIS  CASE   // (20X 18A4) )           PMID0260
      WRITE(6,60)  CDATE                                                   PMID0270
   60 FORMAT(1H0 50X 2A4)                                                  PMID0280
        IF(KOUNT.GT.1)  GO TO 80                                           PMID0290
      WRITE(6,70)       ILISP,  ISTC,   ITDK,   IPULSE, IDCYCL           PMID0300
     1                , JLISP,  JSTC,   JPULSE, JBOIL,  JIGN             PMID0302
   70 FORMAT(1H1 36X 37HPRIMARY  PROGRAM  CONTROL  INDICATORS  /// 18X     PMID0310
     1   7HILISP = I2, 4X 7HISTC  = I2, 4X                                 PMID0320
     2   7HITDK  = I2, 4X 7HIPULSE= I2, 4X 7HIDCYCL= I2/  18X              PMID0322
     3   7HJLISP = I2, 4X 7HJSTC  = I2, 4X 7HJPULSE= I2, 4X                PMID0324
     4   7HJBOIL = I2, 4X 7HJIGN  = I2)                                    PMID0326
      IF((JLISP.NE.0 .OR. ILISP.EQ.0) .AND. (JSTC.NE.0 .OR. ISTC.EQ.0)     PMID0328
     1   .AND. (JPULSE.NE.0 .OR. IPULSE.EQ.0))  GO TO 78                   PMID0330
        WRITE(6,72)                                                        PMID0332
   72   FORMAT(18H0 INPUT  E R R O R/2X 56HINSUFFICIENT PROPELLANT PROPEPMID0334
     1RTY DATA SPECIFIED FOR CASE // 16H  JOB TERMINATED )                 PMID0336
   74   CALL  EXIT                                                         PMID0338
        STOP                                                               PMID0340
   78 CALL  TINT                                                           PMID0346
      RETURN                                                               PMID0348
   80 WRITE(6,90)                                                          PMID0350
   90 FORMAT(// 39X 33H*  *  E N D  O F  C A S E  *  * )                   PMID0360
      KOUNT = 0                                                            PMID0370
        RETURN                                                             PMID0800
      END                                                                  PMID0810
```

```
      SUBROUTINE PPIN                                                    PPIN0010
C       PROPELLANT PROPERTIES INPUT SUB FOR P M P M                      PPIN0020
C                                                                        PPIN0030
      DIMENSION TITLEP(18), TSTAT(18), TVSON(18)                         PPIN0080
      COMMON /HEAD/   AMAT(72), CDATE(2), ILISP, ISTC, ITRANS, ITDK,     PPIN0100
     1                IPULSE, IDCYCL, JLISP, JSTC, JPULSE, JBOIL, JIGN  PPIN0110
      COMMON /TBL/IMR(18), TTO(18,3), TVIS(18,3),TGAM(18,3),TMW(18,3),   PPIN0120
     1          CSTR(18),TEPS(6),   TMACH(3),  TCF(18,6)                 PPIN0140
     2        , TCXERP(18), XMRM, TVSONO(18,3)                           PPIN0160
      COMMON /IGNFED/ TDFPF,  CPLF,   TDFPO,  CPLO,   NRHOF,  NRHOO,    PPIN0170
     1                NPVAPF, NPVAPO, TTRLF(12), TRHOF(12), TTRLO(12),  PPIN0172
     2           TRHOO(12), TTPVF(12), TPVAPF(12),TTPVO(12), TPVAPO(12) PPIN0174
      COMMON /KP/AKF(19),    AKO(19),    TVF(20),    TVO(20),           PPIN0180
     1          CPVAPF(20), CPVAPO(20), TCONVF(20), TCONVO(20),         PPIN0200
     2          FTKP(95),   OTKP(95),   FKP(95),    OKP(95)            PPIN0220
      COMMON /SVV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,     PPIN0240
     1              RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,    PPIN0260
     2             WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,    PPIN0280
     3              NSSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,    PPIN0300
     4                PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,    PPIN0320
     5                NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,    PPIN0340
     6                IPR,  IZPR,    ND,   NPO,  SNCR,    IZ,   II1,    PPIN0360
     7               ETA1,  ETA2,   SCS, ZINCR,  IKPF,  IKPO,  LAXI     PPIN0380
     8             , ISEQ, NASEG, MSTI, NEPS, PAMB, AEXIT, ECFVAC,      PPIN0400
     9               NMACH, ECSTR1, PNS,  PIE,  RVAPF, RVAPO            PPIN0420
      COMMON /IGN2/   OFINT, AIIMI, EINT,  AQIGN, EIGN,  DELHRC,DELHRV,PPIN0440
     1                TINT,  TCV,   QEXIGN,DPRT                         PPIN0460
      COMMON /IGN5A/  LIWF,  LITF,  LIMPF, CPSF,  CPVF,  MUVF,  KCF,    PPIN0480
     1                LMBDSF,LMBDFF,ALPHAF,STENF, THTF,  FMAXF, FMINF   PPIN0500
     2              , EVF,   EDVF,  CVVF,  PVF,   DELTNF,THETAF,NF,     PPIN0520
     3                MVF,   MDVF,  MWALLF,KDF,   N1F                   PPIN0540
      COMMON /IGN6A/  LIWO,  LITO,  LIMPO, CPSO,  CPVO,  MUVO,  KCO,    PPIN0560
     1                LMBDSO,LMBDFO,ALPHAO,STENO, THTO,  FMAXO, FMINO   PPIN0580
     2              , EVO,   EDVO,  CVVO,  PVO,   DELTNO,THETAO,NO,     PPIN0600
     3                MVO,   MDVO,  MWALLO,KDO,   N1O                   PPIN0620
      COMMON /LAB1/   DRADM,  DTHETM, ZOM,    THETAR, DPINJ1, DPINJ2,   PPIN0630
```

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     1                  DENS1,  DENS2,  CKP1,   CKP2,   DNSAT1, DNSAT2,  PPIN0632
     2                  PX,     DNSAX1, DNSAX2, SDNSA1, SDNSA2           PPIN0634
      COMMON  /LA22/ VISC1,VISC2,RHOG, EPS, IDBAR(10), STEN1,STEN2,CDBARPPIN0640
      REAL  MUVF, KCF, LMBDSF, LMBDFF, MUVO, KCC, LMBDSC, LMBDFO        PPIN0700
    5 FORMAT (18A4)                                                     PPIN0740
    8 FORMAT(1H )                                                       PPIN0760
   10 FORMAT (6I12)                                                     PPIN0780
C                                                                       PPIN0878
C * * * * TABLES OF COMBUSTION GAS PROPERTIES VS MIXTURE RATIO.        PPIN0880
C           AND  MACH NUMBER.                                           PPIN0882
      READ(5,5)     TITLEP                                              PPIN0890
      READ(5,10)   NMR,     NMACH,  NEPS,   NTK                       PPIN0892
      WRITE(6,12)  NMR,     NMACH,  NEPS,   NTK                       PPIN0894
   12 FORMAT( 9H0 NMR    = I9, 9H, NMACH = I9, 9H, NEPS  = I9,         PPIN0895
     1        9H, NTK    = I9)                                         PPIN0896
      READ(5,15) (TMR(I),I=1,NMR)                                       PPIN0900
        NMR2 = (NMR+1)/2                                                PPIN0902
        XMRM = TMR(NMR2)                                                PPIN0904
        DO 14 I=1,NMR                                                   PPIN0905
   14   TOXFRP(I) = TMR(I)/(TMR(I)+XMRM)                                PPIN0906
        IF(JSTG.EQ.0 .AND. JPULSE.EQ.0 .AND. JLISP.NE.2)  GO TO 32      PPIN0908
   15 FORMAT(6E12.8)                                                    PPIN0910
      READ(5,15) (TMACH(J),J=1,NMACH)                                   PPIN0920
        DO 17 J=1,NMACH                                                 PPIN0940
        READ(5,15) (TSTAT(I),I=1,NMR)                                   PPIN0960
        READ(5,15) (IVIS(I,J),I=1,NMR)                                  PPIN0980
        READ(5,15) (TGAM(I,J),I=1,NMR)                                  PPIN1000
        READ(5,15) (TMW(I,J),I=1,NMR)                                   PPIN1020
        READ(5,15) (TVSON(I),I=1,NMR)                                   PPIN1030
          DO 16 I=1,NMR                                                 PPIN1040
          GAMFAC = 1. + (TGAM(I,J)-1.)/2.*TMACH(J)**2                   PPIN1050
          TTO(I,J) = TSTAT(I)*GAMFAC                                    PPIN1060
   16     TVSONC(I,J) = TVSON(I)*SQRT(GAMFAC)                           PPIN1070
   17     WRITE(6,20)  TMACH(J), TITLEP, (TMR(I), TSTAT(I), TVIS(I,J),  PPIN1090
     1    TGAM(I,J), TMW(I,J), TVSON(I), TOXFRP(I), I=1,NMR)            PPIN1100
   20 FORMAT(1H1 21X 59HEQUILIBRIUM  COMBUSTION  GAS  PROPERTIES  AT MACPPIN1120
```

```
     1H  NUMBER = F7.4 // 19X 18A4 // 8X 3HTMP 11X 5HTSTAT 10X 4HTVIS    PPIN1130
     2 11X 4HTCAM 12X 3HTMW 11X 5HTVSCN 9X 6HTCXERP // (1P7E15.5) )      PPIN1140
          DO 21  J=1,NMACH                                               PPIN1162
            DO 21 I=1,NMR                                                PPIN1164
21        TVIS(I,J) = TVIS(I,J)/360C.                                    PPIN1166
       IF(JSTC.EQ.C .AND. JPULSE.EQ.0)  GO TO 34                         PPIN1170
      READ(5,15) (CSTR(I),I=1,NMR)                                       PPIN1180
      READ(5,15) (TEPS(J),J=1,NEPS)                                      PPIN1200
      DO 22  J=1,NEPS                                                    PPIN1220
22    READ(5,15) (TCF(I,J),I=1,NMR)                                      PPIN1240
      WRITE(6,24)  TITLEP, (TEPS(I),I=1,NEPS)                            PPIN1260
24    FORMAT(1H1 41X 26HC-STAR  &  C-SUB-F  TABLES / 19X 18A4 // 8X      PPIN1280
     1 3HTMR  7X 5HCSTAR10X 1H* 28X 15HC-SUB-F  VACUUM 28X 1H* /         PPIN1300
     2 34X  4HEPS1 9X  4HEPS2  9X  4HEPS3  9X  4HEPS4  9X               PPIN1320
     3 4HEPS5 9X 4HEPS6 / 25X 6F13.2)                                    PPIN1340
       WRITE(6,1)                                                        PPIN1360
       DO 26 I=1,NMR                                                     PPIN1380
26     WRITE(6,28)  TMR(I),CSTR(I),(TCF(I,J),J=1,NEPS)                   PPIN1400
28     FORMAT(F13.2, F11.1, 3X 6F13.5)                                   PPIN1420
      GO TO 38                                                           PPIN1430
C                                                                        PPIN1440
30    FORMAT(6E12.8)                                                     PPIN1700
C                                                                        PPIN1702
32    WRITE(6,33) TITLEP, (TMR(I),I=1,NMR)                               PPIN1710
33    FORMAT(2H0 18A4 / 2X 7HTMR    = 1P6E13.4 / (9X 6E13.4) )           PPIN1720
34    READ(5,30) (CSTR(I),I=1,NMR)                                       PPIN1730
      WRITE(6,36) (CSTR(I),I=1,NMR)                                      PPIN1740
36    FORMAT( 9H  CSTR  = 1P6E13.4 / (9X 6E13.4) )                       PPIN1750
38    READ(5,30)  DENS1,  DENS2                                          PPIN1770
      WRITE(6,40) DENS1,  DENS2                                          PPIN1780
40    FORMAT( 9H0 DENS1 = 1PE10.3, 8H DENS2 = E10.3)                     PPIN1790
C                                                                        PPIN1810
       IF(JLISP.EQ.0)  GO TO 50                                          PPIN1820
      READ(5,30)  PX,     DNSAX1, DNSAX2, SDNSA1, SDNSA2, CKP1,          PPIN1830
     1            CKP2,   STEN1,  STEN2,  VISC1,  VISC2                 PPIN1840
      WRITE(6,44) PX,     DNSAX1, DNSAX2, SDNSA1, SDNSA2, CKP1,          PPIN1850
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     1          ,CKP2,    STEN1,  STEN2,  VISC1,  VISC2                        PPIN1860
   44 FORMAT( 9HC PX     =   E10.3, 8H DNSAX1= E10.3, 8H DNSAX2= E10.3,        PPIN1870
     1          8H SDNSA1=   E10.3, 8H SDNSA2= E10.3, 8H CKP1  = E10.3/       PPIN1880
     2          8H CKP2  =   E10.3, 8H STEN1 = E10.3, 8H STEN2 = E10.3,       PPIN1882
     3          8H VISC1 =   E10.3, 8H VISC2 = E10.3)                         PPIN1884
C               END  OF  L I S P  INPUTS                                       PPIN1910
C                                                                              PPIN1920
   50   IF(JSTC.EQ.0)  GO TO 200                                               PPIN2020
C * * * * DATA NEEDED FOR CALCULATION OF K-PRIME.                             PPIN2040
      READ(5,15) (   TVF(I),I=1,NTK)                                          PPIN2060
      READ(5,15) (CPVAPF(I),I=1,NTK)                                          PPIN2080
      READ(5,15) (TCONVF(I),I=1,NTK)                                          PPIN2100
      READ(5,15) (   TVC(I),I=1,NTK)                                          PPIN2120
      READ(5,15) (CPVAPC(I),I=1,NTK)                                          PPIN2140
      READ(5,15) (TCONVC(I),I=1,NTK)                                          PPIN2160
      WRITE(6,70)  (TVF(I),CPVAPF(I),TCONVF(I),TVC(I),CPVAPC(I),              PPIN2180
     1                  TCONVC(I),I=1,NTK)                                   PPIN2200
   70 FORMAT(1HI/11X,3HTVF,12X,4HCPVF,11X,6HTCONVF,12X,3HTVC,12X,4HCPVC,PPIN2220
     1 11X,6HTCONVC //(2X,1P6E16.5))                                          PPIN2240
C                                                                              PPIN2320
      READ(5,15)   TNBF,   TNBC,   RHOFNB, RHOCNB, TCRITF, TCRITC,            PPIN2340
     1             TBF,    TBC,    RHOBF,  RHOBC                             PPIN2342
      WRITE(6,90)  TNBF,   TNBC,   RHOFNB, RHOCNB, TCRITF, TCRITC,            PPIN2350
     1             TBF,    TBC,    RHOBF,  RHOBC                             PPIN2352
   90 FORMAT( 9H  TNBF  = 1PE10.3, 8H TNBC  = E10.3, 8H RHOFNB= E10.3,        PPIN2360
     1          8H RHOCNB=  E10.3, 8H TCRITF= E10.3, 8H TCRITC= E10.3/       PPIN2362
     2          9H  TBF  =  E10.3, 8H TBC   = E10.3, 8H RHOBF = E10.3,       PPIN2364
     3          8H RHOBC = E10.3)                                            PPIN2366
      RHONBF = RHOFNB/1728.                                                    PPIN2370
      RHONBC = RHOCNB/1728.                                                    PPIN2380
      RHOLF  = RHOBF /1728.                                                    PPIN2390
      RHOLC  = RHOBC /1728.                                                    PPIN2400
C                                                                              PPIN2420
  200   IF(JSTC.EQ.0 .AND. JBOIL.EQ.0 .AND. JIGN.EQ.0)  GO TO 250              PPIN2440
      READ(5,15)  WTMLLF, WTMLLC, WTMLVF, WTMLVC, DHVF,   DHVC                PPIN2450
      WRITE(6,230)WTMLLF, WTMLLC, WTMLVF, WTMLVC, DHVF,   DHVC                PPIN2460
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  230 FORMAT( 9H  WTMLLF= 1PE10.3, 8H WTMLLO= E10.3, 8H WTMLVF= E10.3,   PPIN2470
     1          9H WTMLVO=  E10.3, 8H DHVF  = E10.3, 8H DHVO  = E10.3)  PPIN2480
C                END  OF  S T C  INPUTS                                  PPIN2490
C                                                                        PPIN2560
C                                                                        PPIN2570
  250   IF(JPULSE.EQ.0)  GO TO 400                                       PPIN2580
C                                                                        PPIN2600
  270 READ(5,10)  NRHOF,  NRHOO,  NPVAPF, NPVAPO                         PPIN2620
      WRITE(6,274)                                                       PPIN2640
  274   FORMAT(24HO    PROPELLANT PROPERTIES )                           PPIN2660
      READ(5,30) (TTRLF(I),I=1,NRHOF)                                   PPIN2680
      READ(5,30) (TPHOF(I),I=1,NRHOF)                                   PPIN2700
      READ(5,30) (TTRLO(I),I=1,NRHOO)                                   PPIN2720
      READ(5,30) (TRHOO(I),I=1,NRHOO)                                   PPIN2740
      READ(5,30) (TTPVF(I),I=1,NPVAPF)                                  PPIN2760
      READ(5,30) (TPVAPF(I),I=1,NPVAPF)                                 PPIN2780
      READ(5,30) (TTPVO(I),I=1,NPVAPO)                                  PPIN2800
      READ(5,30) (TPVAPO(I),I=1,NPVAPO)                                 PPIN2820
      WRITE(6,280)  NRHOF,  NRHOO,  NPVAPF, NPVAPO                      PPIN2840
  280 FORMAT(2X 7HNRHOF = I10, 8H NRHOO = I10, 8H NPVAPF= I10,          PPIN2860
     X          8H NPVAPO= I10)                                         PPIN2880
      WRITE(6,290) (TTRLF(I),I=1,NRHOF)                                 PPIN2900
  290 FORMAT(2X 7HTTRLF = 1P6E13.3 / (9X 6E13.3) )                      PPIN2920
      WRITE(6,300) (TPHOF(I),I=1,NRHOF)                                 PPIN2940
  300 FORMAT(2X 7HTPHOF = 1P6E13.3 / (9X 6E13.3) )                      PPIN2960
      WRITE(6,310) (TTRLO(I),I=1,NRHOO)                                 PPIN2980
  310 FORMAT(2X 7HTTRLO = 1P6E13.3 / (9X 6E13.3) )                      PPIN3000
      WRITE(6,320) (TRHOO(I),I=1,NRHOO)                                 PPIN3020
  320 FORMAT(2X 7HTRHOO = 1P6E13.3 / (9X 6E13.3) )                      PPIN3040
      WRITE(6,322) (TTPVF(I),I=1,NPVAPF)                                PPIN3060
  322 FORMAT(2X 7HTTPVF = 1P6E13.3 / (9X 6E13.3) )                      PPIN3080
      WRITE(6,324) (TPVAPF(I),I=1,NPVAPF)                               PPIN3100
  324 FORMAT(2X 7HTPVAPF= 1P6E13.3 / (9X 6E13.3) )                      PPIN3120
      WRITE(6,326) (TTPVO(I),I=1,NPVAPO)                                PPIN3140
  326 FORMAT(2X 7HTTPVO = 1P6E13.3 / (9X 6E13.3) )                      PPIN3160
      WRITE(6,328) (TPVAPO(I),I=1,NPVAPO)                               PPIN3180
  328 FORMAT(2X 7HTPVAPO= 1P6E13.3 / (9X 6E13.3) )
```

```
C                                                                               PPIN3200
      IF(JBEIL.EQ.0 .AND. JIGN.EQ.0)  GO TO 400                                 PPIN3210
      READ(5,30)   TDFPF,   CPLF,   TDFPO,   CPLO                               PPIN3240
      WRITE(6,350) TDFPF,   CPLF,   TDFPO,   CPLO                               PPIN3250
  350 FORMAT( 9H  TDFPF = 1PE10.3, 8H CPLF  = E10.3, 8H TDFPO = E10.3,          PPIN3260
     1        8H CPLO  =   E10.3)                                                PPIN3270
C                                                                               PPIN3280
      IF(JIGN.EQ.0)  GO TO 400                                                  PPIN3300
      READ(5,30)  CPSF,   CPVF,   MUVF,   KCF,    LMBDSF, LMBDFF,               PPIN3420
     1            ALPHAF, STENF                                                 PPIN3440
      WRITE(6,370)  CPSF,   CPVF,   MUVF,   KCF,    LMBDSF, LMBDFF,             PPIN3460
     1            ALPHAF, STENF                                                 PPIN3480
  370 FORMAT(2X 7HCPSF  = 1PE10.3, 8H CPVF  = E10.3, 8H MUVF  = E10.3,          PPIN3500
     1        8H KCF   =   E10.3, 8H LMBDSF=E10.3, 8H LMBDFF= E10.3             PPIN3520
     2     / 2X 7HALPHAF=   E10.3, 8H STENF = E10.3)                            PPIN3540
      READ(5,30)  CPSO,   CPVO,   MUVO,   KCO,    LMBDSO, LMBDFO,               PPIN3560
     1            ALPHAO, STENO                                                 PPIN3580
      WRITE(6,380)  CPSO,   CPVO,   MUVO,   KCO,    LMBDSO, LMBDFO,             PPIN3600
     1            ALPHAO, STENO                                                 PPIN3620
  380 FORMAT(2X 7HCPSO  = 1PE10.3, 8H CPVO  = E10.3, 8H MUVO  = E10.3,          PPIN3640
     1        8H KCO   =   E10.3, 8H LMBDSO= E10.3, 8H LMBDFO= E10.3            PPIN3660
     2     / 2X 7HALPHAO=   E10.3, 8H STENO = E10.3)                            PPIN3680
      WRITE(6,384)                                                              PPIN3700
  384 FORMAT(4X 43H PROPELLANT REACTION PROPERTIES FOR SUB IGN )                 PPIN3720
      READ(5,30)  CPINT,  AIIMI,  EINT,   AQIGN,  EIGN,   QEXIGN,              PPIN3740
     1            DELHRO, DELHRV, TINT,   TCV                                   PPIN3760
      WRITE(6,390)  CPINT,  AIIMI,  EINT,   AQIGN,  EIGN,   QEXIGN,            PPIN3780
     1            DELHRO, DELHRV, TINT,   TCV                                   PPIN3800
  390 FORMAT(2X 7HCPINT = 1PE10.3, 8H AIIMI = E10.3, 8H EINT  = E10.3,          PPIN3820
     1        8H AQIGN =   E10.3, 8H EIGN  = E10.3, 8H QEXIGN= E10.3            PPIN3840
     2     / 2X 7HDELHRO=   E10.3, 8H DELHRV= E10.3, 8H TINT  = E10.3,          PPIN3860
     3        8H TCV   =   E10.3)                                                PPIN3880
C                                                                               PPIN3990
  400 CONTINUE                                                                  PPIN4000
      RETURN                                                                    PPIN5000
      END                                                                       PPIN5010
```

```
      SUBROUTINE ENGBAL(IEE,IEBCC)                                          ENGB0010
C                                                                           ENGB0020
      COMMON /EBCOM/ C1, CFSF, CFSO, PVALVF, PVALVO, IEBX, PMF, PMO         ENGB0030
     1               , PIE1, TMFLF1, TMFLO1                                 ENGB0032
      COMMON /CMPM/  CPMD1(4), AT, LCHAM, DCHAM, CPMD2(3), ECSTAR,          ENGB0040
     1               CPMD3(3), CSTAR, CF, CXFP, HTLOSS, CR, ECSMIX,         ENGB0042
     2               ECSENR, ZIMPF, ZIMPO, FCSMR, RPCIN                     ENGB0044
      COMMON /TEL/   TMR(18), TLLD1(216), CSTR(18), TBLD2(117),             ENGB0060
     1               TCXFRP(18), XMRM                                       ENGB0062
C                                                                           ENGB0070
      COMMON /SVV/   NP, NAP, NMR, SVVD1(4), RHOLF, SVVD2(5), RHOLO,        ENGB0080
     1               SVVD3(24), TMFLF, TMFLO, XMRI, TCSTR, SVVD4(9),        ENGB0090
     2               SCS, SVVD5(5), NASEG, SVVD6(5), NMACH, ECSTR1,         ENGB0100
     3               PNS, PIE, RVAPF, RVAPO                                 ENGB0110
      COMMON /COM7/  GA, RR, COM7D(45), PTVAP, CD                           ENGB0120
      COMMON /PULSE/ PED1(92),                                              ENGB0130
     1               ALF,  LLF, RFLF,    ALO,  LLO, RFLO,                 ENGB0140
     2               AMF,  LMF, RFMF,    AMO,  LMO, RFMO,                 ENGB0150
     3               SAIF, LIF, RFIF,    SAIO, LIO, RFIO, CFIF, CFIO      ENGB0152
      COMMON /LAG1/  LAG1D(6), DENS1, DENS2                                 ENGB0160
      DIMENSION TCP(7), TRPNI(7)                                            ENGB0170
      EXTERNAL PCTPIE                                                       ENGB0172
      DATA TCP, TRPNI/ 1.00,1.25,1.50, 2.00,2.50,3.00, 10.0,               ENGB0180
     1                 .816,.865,.900, .950,.965,.980, 1.00/               ENGB0182
      DATA MITER, TOLP, PI4/ 20, 0.0002, .785398/                           ENGB0186
C                                                                           ENGB0188
      IEEX = IEE                                                            ENGB0190
      KOUNT = 0                                                             ENGB0192
C  IEE = 0(PULSE ONLY), = 1(PRIOR TO LISP), = 2(SST), = 3(SST/LISP),        ENGB0194
C      = 4(MST)                                                             ENGB0195
        IF(IEE.EQ.2)  GO TO 310                                             ENGB0198
        IF(IEE.GT.1)  GO TO 100                                             ENGB0200
      JK = 1                                                                ENGB0202
      READ(5,10,END=700)  NTYPEB, NDIA                                      ENGB0210
   10 FORMAT(2I10)                                                          ENGB0220
      WRITE(6,20)  NTYPEB, NDIA                                             ENGB0230
```

```
20 FORMAT(1H1 //  42X 25HINPUT  TO  ENGINE  BALANCE  //                    ENGB0240
     1       2X 7HNTYPES=  I10, 8H,NDIA  =  I10)                          ENGB0242
      SAIF = 0.                                                           ENGB0246
      SAIC = 0.                                                           ENGB0248
      DO 26 I=1,NDIA                                                      ENGB0250
      READ(5,22)   NIF,    NIC,    DIF,    DIC                          ENGB0252
22 FORMAT(2I12,2F12.8)                                                    ENGB0254
      WRITE(6,24)  NIF,    NIC,    DIF,    DIC                          ENGB0260
24 FORMAT( 8H  NIF   =   I10,   8H NIC   = I10, 8H DIF   = 1PE10.3,       ENGB0262
     1       8H DIC   =   E10.3)                                          ENGB0264
      SAIF = SAIF + FLOAT(NIF)*PI4*DIF**2                                 ENGB0266
      SAIC = SAIC + FLOAT(NIC)*PI4*DIC**2                                 ENGB0268
      READ(5,30)  PVALVF, PVALVC, XMRI,   PIE,    RPCIN                   ENGB0270
30 FORMAT(5E12.8)                                                         ENGB0280
      IF(.NOT.EOF(5,1))  GO TO 50                                         ENGB0282
      WRITE(6,40)  PVALVF, PVALVC, XMRI,   PIE,    RPCIN                  ENGB0290
40 FORMAT(2X 8HPVALVF= 1PE10.3, 8H PVALVC= E10.3, 8H XMRIF = E10.3,       ENGB0300
     1       8H PIE   =   E10.3, 8H RPCIN = E10.3)                        ENGB0302
      PMAX = AMIN1(PVALVF,PVALVC)                                         ENGB0303
      PIE = AMIN1(PIE,.99*PMAX)                                           ENGB0304
      IF(PIE.EQ.0.)  PIE = .80*PMAX                                       ENGB0305
      IF(XMRI.EQ.0.) XMRI = XMRM                                          ENGB0306
50    IF(NTYPES.EQ.1)  GO TO 70                                           ENGB0310
      WRITE(6,60)  NIF,    XMRI                                           ENGB0330
60 FORMAT(4X 8HNIF   = 1PE10.3, 8H XMRI  = F10.3)                         ENGB0340
C                                                                         ENGB0350
70 READ(5,72)  RVAPF,  RVAPL,  ECSMIX, ECSENR                            ENGB0360
      WRITE(6,72)  RVAPF,  RVAPO,  ECSMIX, ECSENR                         ENGB0370
72 FORMAT(1X 7HRVAPCF= 1PE10.3, 8H RVAPCL= E10.3, 8H ECSMXE= E10.3,       ENGB0380
     1       8H ECSENR=   E10.3)                                          ENGB0390
      READ(5,20)   RR,     DCHAM,  ESTOL,  ESTOL2                       ENGB0400
      WRITE(6,74)  RR,     DCHAM,  ESTOL,  ESTOL2                       ENGB0410
74 FORMAT(1X 7H RR    = 1PE10.3, 8H DCHAM = E10.3, 8H ESTOL = E10.3,      ENGB0420
     1       8H ESTOL2= E10.3)                                            ENGB0430
      READ(5,76)  CLF,    RFLF,   AMF,    RFMF,   RFIF,   CFIF,         ENGB0440
     1            CLO,    RFLO,   AMO,    RFMO,   RFIO,   CFIO          ENGB0442
```

```
      WRITE(6,...) RLF,    RFLF,   AMF,    RFMF,   RFIF,   CFIF,          ENGB0450
     1             RLO,    RFLO,   AMO,    RFMO,   RFIO,   CFIO           ENGB0452
   80 FORMAT(1X 7HRLF   = 1PE10.3, 8H RFLF  = E10.3, 8H AMF   = E10.3,    ENGB0460
     1       8H RFMF  =  E10.3, 8H RFIF  = E10.3, 8H CFIF  = E10.3/       ENGB0462
     2       1X 7HRLO  =  E10.3, 8H RFLO  = E10.3, 8H AMO   = E10.3,      ENGB0464
     3       8H RFMO  =  E10.3, 8H RFIO  = E10.3, 8H CFIO  = E10.3)       ENGB0466
C                                                                          ENGB0550
      RTLOSS = 1.-RCOUPL**2                                                ENGB0560
      JL = 1                                                               ENGB0570
      X = 1.E-3                                                            ENGB0572
      CALL CUBIC(X)                                                        ENGB0574
      CP = (1.0+X**2/2)**2                                                 ENGB0576
      IF(ABS(CP-1.0-X**2/2.) .LT. .02) GO TO 82                            ENGB0578
      CALL LOCATE(JL,CP,TCP,7, JX,FX)                                      ENGB0580
      APCIN = 1./(TRPNI(JX)+FX*(TRPNI(JX+1)-TRPNI(JX)))                    ENGB0590
C     PWS = PI./APCIN                                                      ENGB0594
      AT = PI*RTLOSS/4.                                                    ENGB0598
      ALF = RTLOSS*RLF**2                                                  ENGB0600
      ALO = RTLOSS*RLO**2                                                  ENGB0602
      FFACF = ALF/SLF**2 + RFMF/AMF**2 + RFIF/SAIF**2                      ENGB0616
      FFACO = ALO/SLO**2 + RFMO/AMO**2 + RFIO/SAIO**2                      ENGB0617
C       1.0E-20*3.14159/144. = 0.43297                                     ENGB0620
        IF(CFIF) 90,100,100                                                ENGB0621
   90   CFSF = -1.E-20*CFIF*SIN(SENS1)                                     ENGB0622
        CFIF = (1.+0.43297*CFSF**2 - FFACF)/(1./SAIF**2 - 1./AMF**2)       ENGB0623
        GO TO 60                                                           ENGB0624
  100 T = CFIF*(1./SAIF**2 - 1./AMF**2) + FFACF                            ENGB0626
      CFSF = SQRT(0.43297*CFNS1/T)                                         ENGB0627
  60  IF(CFIO) 110,120,120                                                 ENGB0630
  110   CFSO = -1.E-20*SQRT(SENS2)                                         ENGB0631
        CFIO = (1.+0.43297*SENS2/CFSO**2 - FFACO)/(1./SAIO**2 - 1./AMO**2) ENGB0632
        GO TO 60                                                           ENGB0634
  120 T = CFIO*(1./SAIO**2 - 1./AMO**2) + FFACO                            ENGB0636
      CFSO = SQRT(0.43297*CFNS2/T)                                         ENGB0637
  60  WRITE(6,61)   CFSF, CFSO, CU, APCIN, CFIF, CFIO                      ENGB0650
  61  FORMAT(1H1/// 40X 23HENGINE BALANCE OUTPUT // 2X 7HCFSF  = 1PE10.3,ENGB0652
```

```
     1        1H CFSD  = E10.3, 6H CL    = E10.3, 8H RPCIN = E10.3,      ENGB0653
     A        1H CFIF  = E10.3, 6H CFIC  = E10.3)                        ENGB0654
      IF(CFIF.NE.0. .AND. CFIC.GE.0.)  GO TO 110                        ENGB0655
        WRITE(1,6H)                                                     ENGB0656
  6H    FORMAT(47H  ERROR SYSTEM INPUT DATA CANNOT BE SOLVED //         ENGB0657
     1          21H0  * *  JOB  TERMINATED  * * )                      ENGB0658
        CALL  EXIT                                                      ENGB0659
  110 RPCIN = 2.*(1.-RPCIN + PIF/PNS)                                   ENGB0664
        IF(ITER.NE.1) GO TO 110                                         ENGB0670
        IPPL=1 = IMPLP                                                  ENGB0672
        IPPL=1 = IMPLG                                                  ENGB0674
  110 XMPIF = 0.0                                                       ENGB0680
        XMPIF = XMPIF*VAPC/VAPF                                         ENGB0690
        CALL  LOCATE(JX,XMPIF/(XMPLGL+XMPIF),ICXFRP,NMP, JG,FG)         ENGB0692
        CSTPIF = CSTP(JX) + FX*(CSTP(JG+1)-CSTP(JG))                    ENGB0694
        XMPLGP = XMPIF /(1.+XMPIF)                                      ENGB0700
        XMPIF = XMPIF/(1.+XMPIF)                                        ENGB0702
        VAPLXP = VAPF*(1.-CXFRC) + RVLPC*CXFRC                          ENGB0710
        CALL  LOCATE(JG,XMPLGP,ICXFRP,NMP, JX,FX)                       ENGB0720
        ICSTP =  CSTP(JX) + FX*(CSTP(JX+1)-CSTP(JX))                    ENGB0730
        PCPMP = CSTP+CPIC                                               ENGB0732
          CSTP = PCPMP*RATIO*PCOMP*ECDENP                               ENGB0734
          CSTP = CSTP/RHOSTP                                            ENGB0736
          IF(ITER .NE.1) GO TO 200                                      ENGB0740
                                                                        ENGB0744
C         WRITE  PVALVP  C  PVALVC                                      ENGB0746
        PIF = 0.                                                        ENGB0750
        CL = DELPCP*(1.-.34*RT)                                         ENGB0752
          CALL  PUMP(1,1,XMPP,DELPP, PCIPIE,PIFE, TOLP, NITER,IER)      ENGB0760
          PIF = P - CL*(PIE-.9*PVALVP-.9*PVALVD)                        ENGB0762
          IF(IER .NE. 0)  GO TO 130                                     ENGB0770
        WRITE(1,1 )  PIF, PMPP, DERR, PILE, TOLP, NITER, IER            ENGB0780
  130 FORMAT(1H1 2LH ERROR P P C R - ITERATION IN SUB  RNTI,  CALLED FROMENGB0790
     1  1H  2H=I2, 1H ,                                                 ENGB0792
     2  7H PIF= E12.5, 6H PIPE= E12.5, 6H TOLP= E12.5, 7H NITER= I2,     ENGB0794
     3  7H IER= I2)                                                     ENGB0796
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      CALL EXIT                                                         ENGB0800
      STOP                                                              ENGB0810
C                                                                       ENGB0820
  130 TMFLF = CFSF*SQRT(PVALVF-PIE)                                     ENGB0830
      TMFLO = CFSO*SQRT(PVALVO-PIE)                                     ENGB0840
      XMRI = TMFLO/TMFLF                                                ENGB0850
      ERRMR = (XMRI1-XMRI)/XMRI                                         ENGB0860
      KOUNT = KOUNT+1                                                   ENGB0870
        IF(KOUNT.EQ.1) WRITE(6,140)                                     ENGB0874
  140 FORMAT(32X 4HENGINE BALANCE ITERATION STEPS )                     ENGB0876
      WRITE(6,140) KOUNT, XMRI, PIE, TMFLF, TMFLO, CSTAR, ERRMR         ENGB0880
  140 FORMAT(2X 4HIT = I3, 7H XMRI = 1PE10.3, 6H PIE = E10.3,           ENGB0890
     1 6H TMFLF = E10.3, 6H TMFLO = E10.3, 8H CSTAR = 0PF7.0,           ENGB0892
     2 6H ERRMR = F7.4)                                                 ENGB0894
      IF(ABS(ERRMR).LT.2.*TOLP) GO TO 300                               ENGB0900
      IF(KOUNT.LT.10) GO TO 110                                         ENGB0910
        WRITE(6,150)                                                    ENGB0920
  150   FORMAT(/// 32X 44HENGINE  BALANCE  FAILED  ON  MR  CONVERGENCE) ENGB0930
        CALL EXIT                                                       ENGB0940
        STOP                                                            ENGB0950
C                                                                       ENGB0954
C       FIXED PIE & XMRI                                                ENGB0956
  200 TMFL = 32.174*AT*PIE/(RPCIN*CSTAR)                                ENGB0960
      TMFLO = TMFL*XMRI/(XMRI+1)                                        ENGB0970
      TMFLF = TMFL - TMFLO                                              ENGB0980
      PVALVF = PIE + (TMFLF/CFSF)**2                                    ENGB0990
      PVALVO = PIE + (TMFLO/CFSO)**2                                    ENGB1000
C                                                                       ENGB1140
  300 IF(IEB.EQ.1) GO TO 312                                            ENGB1150
      IF(IEB.EQ.0) GO TO 500                                            ENGB1152
        EBT = EBTOL                                                     ENGB1156
        IF(IEB.EQ.4) EBT = 2.*EBTOL                                     ENGB1158
        IF(ABS(PVAPF1-PVAPF).GT.EBT)   GO TO 320                        ENGB1160
        IF(ABS(PVAPO1-PVAPO).GT.EBT)   GO TO 320                        ENGB1170
        IF(ABS(CSMX1-CSMIX).GT.EBT)  GO TO 320                          ENGB1180
        IF(ABS(RPCIN1-RPCIN).GT.EBT)   GO TO 320                        ENGB1190
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      GO TO 314                                                          ENGB1192
  310 WRITE(6,311) TMFLF1, TMFLF, TMFLC1, TMFLC                          ENGB1194
  311 FORMAT(// 2X 31HESTIMATED AND CALCULATED VALUES / 2X 7HTMFLF =     ENGB1196
     1       2(1PE13.5,1H,), 8H TMFLC = E13.5, 1H, E13.5)                ENGB1197
      IF(ABS(TMFLF1-TMFLF)/TMFLF.GT.EPSCL2)  GO TO 320                   ENGB1200
      IF(ABS(TMFLC1-TMFLC)/TMFLC.GT.EPSCL2)  GO TO 320                   ENGB1202
      GO TO 314                                                          ENGB1203
  312   TMFLF1 = TMFLF                                                   ENGB1204
        TMFLC1 = TMFLC                                                   ENGB1206
  314 IF(ICC = 1                                                         ENGB1210
      GO TO 322                                                          ENGB1220
  320 IF(ICC = 2                                                         ENGB1230
  322   IF(IPRT.EQ.0) RETURN                                             ENGB1234
      IF(IPRT.GT.1) GO TO 400                                            ENGB1236
      WRITE(6,330) RVAPF1,RVAPF, RVAPC1,RVAPC, ECSMX1,ECSMIX,            ENGB1240
     !             RPCIN1,RPCIN                                          ENGB1250
  330 FORMAT(// 2X 31HESTIMATED AND CALCULATED VALUES / 2X 7HRVAPF =     ENGB1260
     1 2(F7.4,1H,), 7H RVAPC = 2(F7.4,1H,), 9H ECSMIX = 2(F7.4,1H,),     ENGB1262
     2 1H RPCIN = F7.4, 1H, F7.4)                                        ENGB1264
  400   RVAPF1 = RVAPF                                                   ENGB1280
        RVAPC1 = RVAPC                                                   ENGB1290
        ECSMX1 = ECSMIX                                                  ENGB1300
        RPCIN1 = RPCIN                                                   ENGB1310
        RIF1 = RIF                                                       ENGB1332
C           1.1/7.2 = 144/(2*32.174)                                     ENGB1390
      XMRI = (RMF*VMF**2*7.0*RMS1 / (RFIF/SAIF**2+CFIF*(1./SAIF**2-1./AMF**2))ENGB1400
        CFSMF = SQRT(CFSMF)                                              ENGB1402
      TMFLF = PIS * (TMFLF/CFSMF)**2                                     ENGB1410
      XMRC = .5*1.4*7.0*RMS2 / (RFIC/SAIC**2+CFIC*(1./SAIC**2-1./AMC**2))ENGB1420
        CFSMC = SQRT(CFSMC)                                              ENGB1422
      TMFLC = PIC * (TMFLC/CFSMC)**2                                     ENGB1430
      PIC = PIC / PLIN                                                   ENGB1470
      WRITE(6,410)                                                       ENGB1480
  410 FORMAT(1H1 ,20X 24HENGINE  BALANCE  SUMMARY  )                     ENGB1490
      WRITE(6,420)  PIS,    PIF,    XMRI,   CSTAR,  TMFLF,  TMFLC,     ENGB1500
     1              PVALVF, PVALVC, PMF,    PMC,    CFSF,   CFSC,      ENGB1510
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     2              FCSTAR, ECSMIX, ECSENR, RATVAP, RVAPF,  RVAPO,        ENGB1520
     3              TCSTR , RPCIN,  CD                                    ENGB1530
  620 FORMAT(6HO PNS   = 1PE10.3, 8H PIE   = E10.3, 8H XMRI  = E10.3,     ENGB1540
     1       8H CSTAR =   E10.3, 8H TMFLF = E10.3, 8H TMFLO = E10.3/      ENGB1550
     2       9H PVALVF=   E10.3, 8H PVALVO= E10.3, 8H PMF   = E10.3,      ENGB1560
     3       8H PMC   =   E10.3, 8H CFSF  = E10.3, 8H CFSO  = E10.3/      ENGB1570
     4       8H FCSTAR=   E10.3, 8H ECSMIX= E10.3, 8H ECSENR= E10.3,      ENGB1580
     5       8H RATVAP=   E10.3, 8H RVAPF = E10.3, 8H RVAPO = E10.3/      ENGB1590
     6       9H TCSTR =   E10.3, 8H RPCIN = E10.3, 8H CD    = E10.3)      ENGB1600
C                                                                          ENGB1990
      RETURN                                                               ENGB2000
  700   IFSCC = 100                                                        ENGB2020
        CALL  EXIT                                                         ENGB2024
        RETURN                                                             ENGB2030
      END                                                                  ENGB2100


C         SUBROUTINE RTNI                                                  RTNI0040
C                                                                          RTNI0050
C         PURPOSE                                                          RTNI0060
C            TO SOLVE GENERAL NONLINEAR EQUATIONS OF THE FORM F(X)=0       RTNI0070
C            BY MEANS OF NEWTON-S ITERATION METHOD.                        RTNI0080
C                                                                          RTNI0090
C         USAGE                                                            RTNI0100
C            CALL RTNI (X,F,DERF,FCT,XSI,EPS,IEND,IER)                     RTNI0110
C            PARAMETER FCT REQUIRES AN EXTERNAL STATEMENT.                 RTNI0120
C                                                                          RTNI0130
C         DESCRIPTION OF PARAMETERS                                        RTNI0140
C            X      - RESULTANT ROOT OF EQUATION F(X)=0.                   RTNI0150
C            F      - RESULTANT FUNCTION VALUE AT ROOT X.                  RTNI0160
C            DERF   - RESULTANT VALUE OF DERIVATIVE AT ROOT X.             RTNI0170
C            FCT    - NAME OF THE EXTERNAL SUBROUTINE USED. IT COMPUTES    RTNI0180
C                     TO GIVEN ARGUMENT X FUNCTION VALUE F AND DERIVATIVE  RTNI0190
C                     DERF. ITS PARAMETER LIST MUST BE X,F,DERF.           RTNI0200
C            XSI    - INPUT VALUE WHICH SPECIFIES THE INITIAL GUESS OF     RTNI0210
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C                     THE ROOT X.                                          RTNI0220
C           EPS     - INPUT VALUE WHICH SPECIFIES THE UPPER BOUND OF THE   RTNI0230
C                     ERROR OF RESULT X.                                   RTNI0240
C           IEND    - MAXIMUM NUMBER OF ITERATION STEPS SPECIFIED.         RTNI0250
C           IER     - RESULTANT ERROR PARAMETER CODED AS FOLLOWS           RTNI0260
C                      IER=0 - NO ERROR,                                   RTNI0270
C                      IER=1 - NO CONVERGENCE AFTER IEND ITERATION STEPS,  RTNI0280
C                      IER=2 - AT ANY ITERATION STEP DERIVATIVE DERF WAS   RTNI0290
C                              EQUAL TO ZERO.                              RTNI0300
C                                                                          RTNI0310
C         REMARKS                                                          RTNI0320
C            THE PROCEDURE IS BYPASSED AND GIVES THE ERROR MESSAGE IER=2   RTNI0330
C            IF AT ANY ITERATION STEP DERIVATIVE OF F(X) IS EQUAL TO 0.    RTNI0340
C            POSSIBLY THE PROCEDURE WOULD BE SUCCESSFUL IF IT IS STARTED   RTNI0350
C            ONCE MORE WITH ANOTHER INITIAL GUESS XST.                     RTNI0360
C                                                                          RTNI0370
C         SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                    RTNI0380
C            THE EXTERNAL SUBROUTINE FCT(X,F,DERF) MUST BE FURNISHED       RTNI0390
C            BY THE USER.                                                  RTNI0400
C                                                                          RTNI0410
C         METHOD                                                           RTNI0420
C            SOLUTION OF EQUATION F(X)=0 IS DONE BY MEANS OF NEWTON-S      RTNI0430
C            ITERATION METHOD, WHICH STARTS AT THE INITIAL GUESS XST OF    RTNI0440
C            A ROOT X. CONVERGENCE IS QUADRATIC IF THE DERIVATIVE OF       RTNI0450
C            F(X) AT ROOT X IS NOT EQUAL TO ZERO. ONE ITERATION STEP       RTNI0460
C            REQUIRES ONE EVALUATION OF F(X) AND ONE EVALUATION OF THE     RTNI0470
C            DERIVATIVE OF F(X). FOR TEST ON SATISFACTORY ACCURACY SEE     RTNI0480
C            FORMULAE (2) OF MATHEMATICAL DESCRIPTION.                     RTNI0490
C            FOR REFERENCE, SEE R. ZURMUEHL, PRAKTISCHE MATHEMATIK FUER    RTNI0500
C            INGENIEURE UND PHYSIKER, SPRINGER, BERLIN/GOETTINGEN/         RTNI0510
C            HEIDELBERG, 1963, PP.12-17.                                   RTNI0520
C                                                                          RTNI0530
C     ..................................................................   RTNI0540
C                                                                          RTNI0550
      SUBROUTINE RTNI(X,F,DERF,FCT,XST,EPS,IEND,IER)                       RTNI0560
C                                                                          RTNI0570
```

```
C                                                                       RTNI0580
C     PREPARE ITERATION                                                 RTNI0590
      IER=0                                                             RTNI0600
      X=XST                                                             RTNI0610
      TOL=X                                                             RTNI0620
      CALL FCT(TOL,F,DERF)                                              RTNI0630
      TOLF=100.*EPS                                                     RTNI0640
C                                                                       RTNI0650
C                                                                       RTNI0660
C     START ITERATION LOOP                                              RTNI0670
      DO 6 I=1,IEND                                                     RTNI0680
      IF(F)1,7,1                                                        RTNI0690
C                                                                       RTNI0700
C     EQUATION IS NOT SATISFIED BY X                                    RTNI0710
    1 IF(DERF)2,8,2                                                     RTNI0720
C                                                                       RTNI0730
C     ITERATION IS POSSIBLE                                             RTNI0740
    2 DX=F/DERF                                                         RTNI0750
      X=X-DX                                                            RTNI0760
      TOL=X                                                             RTNI0770
      CALL FCT(TOL,F,DERF)                                              RTNI0780
C                                                                       RTNI0790
C     TEST ON SATISFACTORY ACCURACY                                     RTNI0800
      TOL=EPS                                                           RTNI0810
      A=ABS(X)                                                          RTNI0820
      IF(A-1.)4,4,3                                                     RTNI0830
    3 TOL=TOL*A                                                         RTNI0840
    4 IF(ABS(DX)-TOL)5,5,6                                              RTNI0850
    5 IF(ABS(F)-TOLF)7,7,6                                              RTNI0860
    6 CONTINUE                                                          RTNI0870
C     END OF ITERATION LOOP                                             RTNI0880
C                                                                       RTNI0890
C                                                                       RTNI0900
C     NO CONVERGENCE AFTER IEND ITERATION STEPS. ERROR RETURN.          RTNI0910
      IER=1                                                             RTNI0920
    7 RETURN                                                            RTNI0930
```

```
C                                                                       RTNI0940
C     ERROR RETURN IN CASE OF ZERO DIVISOR                              RTNI0950
    8 IER=2                                                             RTNI0960
      RETURN                                                            RTNI0970
      END                                                               RTNI0980


      SUBROUTINE  FCTPIE(P,F,DERF)                                      FCTPI010
      COMMON  /BBCOM/ C1, CF, CO, PVF, PVO                              FCTPI020
C                                                                       FCTPI030
      SRDPF = SQRT(AMAX1(0.,PVF-P))                                     FCTPI040
      SRDPO = SQRT(AMAX1(0.,PVO-P))                                     FCTPI050
   10 F = P - 2.*C1*(CF*SRDPF+CO*SRDPO)                                 FCTPI090
      DERF = 1. + C1*(CF/SRDPF+CO/SRDPO)                                FCTPI100
C                                                                       FCTPI800
      RETURN                                                            FCTPI810
      END                                                               FCTPI820


      SUBROUTINE  CDTRAN                                                CDTR0020
C                                                                       CDTR0040
C * * SUBROUTINE PROVIDES TRANSONIC NOZZLE FLOW DISCHARGE COEFFICIENT.  CDTR0060
C        EQN DUE TO KLIEGEL AND LEVINE, AIAA JOUR.,V.7,NO.7,JULY 1969.  CDTR0080
C                                                                       CDTR0100
      COMMON /COM7/ GA, RR, DUM(46), CD                                 CDTR0120
C                                                                       CDTR0140
      RR1 = RR + 1.                                                     CDTR0160
      CD = 1. - (GA+1.)/(RR1)**2 *( 1./96. - (8.*GA - 27.)/(2304.*RR1)  CDTR0170
     1           + (745.*GA**2 - 757.*GA + 3633.)/(276408.*RR1**2) )    CDTR0180
C                                                                       CDTR0200
      WRITE(6,20)  CD                                                   CDTR0220
   20 FORMAT(/// 10X 31H NOZZLE DISCHARGE COEFFICIENT = F9.5 )         CDTR0240
C                                                                       CDTR0260
      RETURN                                                            CDTR0280
```

```
      SUBROUTINE TIME                                                    TIME0010
      DIMENSION DATE(2)                                                  TIME0020
      DATA INIT/0/                                                       TIME0022
      CALL CDATEV(DATE)                                                  TIME0030
      CALL CLOCK(TIME)                                                   TIME0040
      IF(INIT.EQ.1) GO TO 5                                              TIME0042
      INIT = 1                                                           TIME0044
      CALL  COUNTV                                                       TIME0046
    5 CALL  TIMEV(DTIME)                                                 TIME0048
      IHR = TIME/60.                                                     TIME0050
      TMIN = TIME-60*IHR                                                 TIME0060
      WRITE(6,10) DATE, IHR, TMIN, DTIME                                 TIME0070
   10 FORMAT(1H0,32X, 7HDATE :  2A4,13X,6HTIME : I3,1H: F5.2 /33X,       TIME0080
     1 32HCUMULATIVE CPU TIME IN SECONDS :  F8.3 // )                    TIME0082
      RETURN                                                             TIME0090
      END                                                                TIME0100


      SUBROUTINE  LOCFAC(JK, X,TX,NX, JX,FX)                             LOCF0010
C       IF JK .EQ. 1, CHECKS ORDER OF TX ARRAY (NX ITEMS) FOR            LOCF0020
C         CONSISTANTLY INCREASING OR DECREASING VALUES.                  LOCF0030
C       FINDS LOCATION OF FIRST (OR ONLY) ARRAY ITEM FOR SCALING         LOCF0040
C         LOCATION OF X FROM TX(JX)                                      LOCF0050
C       CALCULATES SCALING FACTOR FX = (X-TX(JX)) / (TX(JX+1)-TX(JX))    LOCF0060
      DIMENSION  TX(1)                                                   LOCF0070
      JX = 1                                                             LOCF0080
      FX = 0.                                                            LOCF0090
      IF(NX.LE.1)  GO TO 200                                             LOCF0100
      S = 1.                                                             LOCF0110
      IF(TX(1).GT.TX(NX))  S = -1.                                       LOCF0120
      XP2 = ABS(TX(NX)-TX(1))*0.5                                        LOCF0130
      IF(JK.NE.1)  GO TO 90                                              LOCF0140
      JK = 0                                                             LOCF0141
      IF(S.GT.0.)  GO TO 30                                              LOCF0142
        DO 20 I=2,NX                                                     LOCF0150
```

```
      IF(TX(I).GT.TX(I-1))  GO TO 50                                    LOCF0160
20    CONTINUE                                                          LOCF0170
      GO TO 90                                                          LOCF0180
30    DO 40 I=2,NX                                                      LOCF0190
      IF(TX(I).LT.TX(I-1))  GO TO 50                                    LOCF0200
40    CONTINUE                                                          LOCF0210
      GO TO 90                                                          LOCF0220
50  WRITE(6,60)                                                         LOCF0230
60  FORMAT(1H1 41X 27HE R R O R   I N   T A B L E )                     LOCF0240
70   WRITE(6,80)  X,(TX(I),I=1,NX)                                      LOCF0250
80    FORMAT(1HO 41X 37HREFER TO SUBROUTINE  LOCFAC  //                 LOCF0260
     1           8X 3HX = 1PE15.4 / 4X 4HTX = 6E15.4 / (8X 6E15.4) )   LOCF0262
      CALL  EXTRA                                                       LOCF0264
       CALL  EXIT                                                       LOCF0270
       STOP                                                             LOCF0280
90  NX1 = 2                                                           LOCF0290
    IF(NX.LE.20)  GO TO 110                                             LOCF0300
      DO 100 I=10,NX,10                                                 LOCF0310
      JX = I                                                            LOCF0320
      IF((TX(I)-X)*S) 100,200,110                                       LOCF0330
100   NX1 = I + 1                                                       LOCF0340
110     DO 120 I=NX1,JX                                                 LOCF0350
        JX = I                                                          LOCF0360
        IF((TX(I)-X)*S) 120,200,130                                     LOCF0370
120     CONTINUE                                                        LOCF0380
130 IF(JX.GT.1)  JX = JX-1                                              LOCF0390
    FX = (X-TX(JX)) / (TX(JX+1)-TX(JX))                                 LOCF0400
      IF(X.LT.AMIN1(TX(1),TX(NX))-XR2)  GO TO 150                       LOCF0410
      IF(X.GT.AMAX1(TX(1),TX(NX))+XR2)  GO TO 150                       LOCF0420
        GO TO 200                                                       LOCF0430
150 WRITE(6,160)                                                        LOCF0440
160 FORMAT(1H1 22X 64HE R R O R  -  EXTRAPOLATION OF TABLE IS BEYOND RLOCF0450
   1EASONABLE LIMITS )                                                  LOCF0460
    GO TO 70                                                            LOCF0470
200     RETURN                                                          LOCF0900
    END                                                                 LOCF0910
```

```
      FUNCTION  DINTRP(A,L)                                              DINTR010
      COMMON  /COMDIT/ J,K,N,F1,F2                                       DINTR020
      DIMENSION  A(1)                                                    DINTR030
C       L  IS  BYPASS  INDICATOR                                         DINTR040
      IF(L.EQ.1)  GO TO 10                                               DINTR050
        F3 = 1.-F2                                                       DINTR052
        I11 = (K-1)*N + J                                                DINTR060
        I21 = I11 + 1                                                    DINTR070
        I12 = I11 + N                                                    DINTR080
        I22 = I12 + 1                                                    DINTR090
        D1 = 1.                                                          DINTR092
        D2 = 1.                                                          DINTR094
      IF(J.GT.N .OR. K.GT.1000)  GO TO 30                                DINTR098
   10 IF(F1.EQ.0.)  GO TO 20                                             DINTR100
        D1 = A(I21)-A(I11)                                               DINTR102
        D2 = A(I22)-A(I12)                                               DINTR104
   20 DINTRP = A(I11) + F1*D1                                            DINTR110
      IF(F2.NE.0.)  DINTRP = F3*DINTRP + F2*(A(I12)+F1*D2)               DINTR120
      RETURN                                                             DINTR130
   30   CALL  ERRTRA                                                     DINTR132
        CALL  EXIT                                                       DINTR134
        STOP                                                             DINTR136
      END                                                                DINTR140


      FUNCTION YOF(X,XT,YT,N,NP)                                         YOF00010
C                                                                        YOF00020
C       SINGLE LAGRANGIAN INTERPOLATION FUNCTION SUBPROGRAM              YOF00030
C         NP POINT INTERPOLATION USING POINTS FROM XT,YT ARRAYS          YOF00040
C            YOF = F(X)                                                  YOF00050
C     USES SUB LOCATE TO INSPECT XT & YT ARRAYS AND TO LOCATE INTERP PTS YOF00060
C       AND FUNCTION XITRP TO INTERPOLATE                                YOF00070
C         WRITTEN DEC 20, 1967 BY W D CHADWICK, D/991-353                YOF00080
C                                                                        YOF00090
        DATA  NERR / 0 /                                                 YOF00092
```

```
      DIMENSION XT(1),YT(1)                                          YOF00100
C                                                                    YOF00110
      CALL LOCATE(X,XT,N,NP,K,IX,IR)                                 YOF00120
        IF(IR.GT.0) NERR = NERR + 1                                  YOF00130
        IF(NERR.GT.50)  XT(800000) = 0.                              YOF00132
      YOF=XITRP(X,XT(K),YT(K),IX)                                    YOF00140
      RETURN                                                         YOF00200
      END                                                            YOF00210


      SUBROUTINE LOCATE(X,T,NT,II,K,IX,IR)                           LOCA0010
C                                                                    LOCA0011
C     INPUT ARGUMENTS                                                LOCA0012
C       X IS THE INDEPENDENT SCALAR                                  LOCA0013
C       T IS THE TABULAR ARRAY  CONTAINING  NT  VALUES               LOCA0014
C       II IS THE NUMBER OF POINTS TO INTERPOLATE OVER               LOCA0015
C     OUTPUT ARGUMENTS                                               LOCA0016
C       K IS THE FIRST OF  IX  POINTS TO INTERPOLATE OVER            LOCA0017
C       IR IS AN ERROR INDICATOR                                     LOCA0018
C                                                                    LOCA0019
      DIMENSION T(1)                                                 LOCA0020
      DATA IERR/0/                                                   LOCA0030
      IR=0                                                           LOCA0040
      K=1                                                            LOCA0050
      IX=1                                                           LOCA0060
      IF(NT.LE.1.OR.II.LE.1) RETURN                                  LOCA0070
      XR=(T(NT)-T(1))*.5                                             LOCA0090
      IF(ABS(XR).LT.1.E-20) RETURN                                   LOCA0100
        X2=T(NT)+XR                                                  LOCA0110
        X1=T(1)-XR                                                   LOCA0112
        R=(X2-X)/(X2-X1)                                             LOCA0114
      IF(R.LT.0. .OR. R.GT.1.) GO TO 1000                            LOCA0120
C                                                                    LOCA0130
      IX=MINO(II,NT)                                                 LOCA0140
      IF(XR.GT.0.) GO TO 4                                           LOCA0142
```

```
C          DESCENDING  T                                                    LOCA0144
           IF(X.LT.T(NT-1)) GO TO 6                                         LOCA0146
           IF(T(2)-X) 8,10,10                                               LOCA0148
C          ASCENDING  T                                                     LOCA0150
     4  IF(X.LT.T(2)) GO TO 8                                               LOCA0152
        IF(X.LE.T(NT-1)) GO TO 10                                          LOCA0170
     6  K=NT-1                                                             LOCA0180
     8  IX=2                                                               LOCA0190
        RETURN                                                             LOCA0200
    10  IF(IX.EQ.NT) RETURN                                                LOCA0210
        NT1=2                                                              LOCA0212
        IF(NT.LE.20) GO TO 18                                              LOCA0214
        DO 12 I=10,NT,10                                                   LOCA0216
        K=I                                                                LOCA0217
        IF((T(I)-X)/XR) 12,30,18                                           LOCA0218
    12  NT1=I+1                                                            LOCA0220
C                                                                          LOCA0222
    18  DO 20 I=NT1,NT                                                     LOCA0228
        K=I                                                                LOCA0230
        IF((T(I)-X)/XR) 20,30,40                                           LOCA0240
    20  CONTINUE                                                           LOCA0250
        K=NT-IX+1                                                          LOCA0260
        RETURN                                                             LOCA0270
    30  IX=1                                                               LOCA0290
        RETURN                                                             LOCA0300
    40  IXD2=IX/2                                                          LOCA0310
        K=I-IXD2                                                           LOCA0320
        IF(I.LT.2) GO TO 50                                                LOCA0330
        IF(2*IXD2.LT.IX .AND. ABS(T(I)-X).GT.ABS(X-T(I-1))) K=K-1          LOCA0340
        K=MIN0(K,NT-IX+1)                                                  LOCA0350
    50  K=MAX0(K,1)                                                        LOCA0360
        RETURN                                                             LOCA0370
C                                                                          LOCA0380
 1000   IERR=IERR+1                                                        LOCA0390
        IR=1                                                               LOCA0400
        WRITE(6,1010) NT,II,X,(T(I),I=1,NT)                                LOCA0410
```

```
 1010 FORMAT(1H1 15X 76HE R R O R   ENCOUNTERED BY SUB LOCATE, CALLED BYLOCA0420
     1 SUB  YOF  IN READING TABLES //  40X 2I10 // (1P7E15.7) )          LOCA0430
       CALL  ERRTRA                                                      LOCA0432
       RETURN                                                            LOCA0440
       END                                                               LOCA0450



       FUNCTION XITRP(X,XT,YT,N)                                         XITRP010
C                                                                        XITRP020
C        LAGRANGIAN INTERPOLATION                                        XITRP030
C             Y = XITRP = F(X)   INTERPOLATING USING PTS XT(1),YT(1)     XITRP040
C                      TO XT(N),YT(N)                                    XITRP050
C                                                                        XITRP060
C        USE SUB LOCATE TO DETERMINE FIRST POINT FOR INTERP. & CK ARRAYS XITRP070
C        WRITTEN BY W D CHADWICK, D/991-353, DEC 16, 1967                XITRP080
C                                                                        XITRP090
       DIMENSION XT(1), YT(1), DX(10)                                    XITRP100
C                                                                        XITRP120
       IF(N-2) 10,20,30                                                  XITRP130
C                                                                        XITRP140
    10 Y=YT(1)                                                           XITRP150
       GO TO 100                                                         XITRP160
C                                                                        XITRP170
    20 DXT=XT(2)-XT(1)                                                   XITRP180
       IF(ABS(DXT).LT.1.E-20) DXT=1.E-20                                 XITRP190
       Y=YT(1)+(YT(2)-YT(1))*(X-XT(1))/DXT                               XITRP200
       GO TO 100                                                         XITRP210
C                                                                        XITRP220
    30 DX(1)=X-XT(1)                                                     XITRP230
       PIDX=DX(1)                                                        XITRP240
C                                                                        XITRP250
       DO 40 I=2,N                                                       XITRP260
       DX(I)=X-XT(I)                                                     XITRP270
    40 PIDX=PIDX*DX(I)                                                   XITRP280
C                                                                        XITRP290
```

```
      Y=0                                                              XITRP300
      DO 70 I=1,N                                                      XITRP310
      IF(ABS(DX(I)).GT.1.E-20) GO TO 50                                XITRP320
      Y=YT(I)                                                          XITRP330
      GO TO 100                                                        XITRP340
   50 PIDXI=1.                                                         XITRP350
C                                                                      XITRP360
      DO 60 J=1,N                                                      XITRP370
      IF(J.NE.I) PIDXI=PIDXI*(XT(I)-XT(J))                             XITRP380
   60 CONTINUE                                                         XITRP390
C                                                                      XITRP400
   70 Y=Y+YT(I)/(DX(I)*PIDXI)                                          XITRP410
C                                                                      XITRP420
      Y=PIDX*Y                                                         XITRP430
C                                                                      XITRP440
  100 XITRP=Y                                                          XITRP450
      RETURN                                                           XITRP500
      END                                                              XITRP510
```

```
      SUBROUTINE ITRP2(X1,T1,N1,I1, X2,T2,N2,I2, YT,L1, Y)             ITR20010
C                                                                      ITR20020
C        D O U B L E    I N T E R P O L A T I O N                      ITR20030
C     SIMILAR TO ITRP4 - X(N), I PT INTRP   -     W D CHADWICK  4-22-69 ITR20040
C                                                                      ITR20050
      DIMENSION T1(1),T2(1),YT(L1,1),   Y2(10)                         ITR20060
C                                                                      ITR20070
      GO TO 2                                                          ITR20072
      ENTRY ITRP21(T1,N1,I1, T2,N2,I2, YT,L1)                          ITR20074
      RETURN                                                           ITR20076
      ENTRY ITRP2X(X1,X2,Y)                                            ITR20080
C                                                                      ITR20090
    2 I2X = 1                                                          ITR20092
      K2  = 1                                                          ITR20094
    4 CALL LOCATE(X1,T1,N1,I1,K1,I1X,IR)                               ITR20100
```

```
      IF(IR.GT.0) GO TO 8                                                ITR20102
      CALL LOCATE(X2,T2,N2,I2,K2,I2X,IR)                                 ITR20110
      IF(IR.LE.0) GO TO 20                                               ITR20120
    8 WRITE(6,10) N1,N2,X1,X2, (T2(J),J=1,N2)                            ITR20130
   10 FORMAT(1H1 20X 43HS R R O R   IN TABLES DETECTED BY SUB ITRP2 ///  ITR20132
     X 20X 2I8, 1P2E15.5 // (17X 6E15.5))                                ITR20134
      DO 12 I=1,N1                                                       ITR20140
   12 WRITE(6,14)  T1(I),(YT(I,J),J=1,N2)                                ITR20150
   14 FORMAT(2X 1P7E15.5)                                                ITR20152
C                                                                        ITR20170
   20 CONTINUE                                                           ITR20180
        DO 30 J2=1,I2X                                                   ITR20190
        K2X=K2-1+J2                                                      ITR20200
   30   Y2(J2)=XITRP(X1,T1(K1),YT(K1,K2X),I1X)                           ITR20210
C                                                                        ITR20220
      Y = XITRP(X2,T2(K2),Y2,I2X)                                        ITR20230
C                                                                        ITR20240
      RETURN                                                             ITR20500
      END                                                                ITR20510
```

```
      FUNCTION QUAD(A,B,C,X)                                             QUAD0100
C       SOLVES  REAL  ROOTS  OF  A  QUADRATIC  EQUATION                  QUAD0110
C         A*X**2 + B*X + C = 0.          (OR   C*(1/X)**2 +B*(1/X) +A = 0)QUAD0120
C         SETS  QUAD = ROOT WITH SMALLEST ABS. DIFFERENCE FROM  X         QUAD0130
C        X1 = (-B+D)/2A = 2C/(-B-D)                                       QUAD0140
C        X2 = (-B-D)/2A = 2C/(-B+D)                                       QUAD0150
C          WHERE  D  IS DISCRIMINANT    SQRT(B**2-4*A*C)                 QUAD0160
C                                                 MAR 1970    WDC        QUAD0170
      DATA KOUNT/ 0 /                                                    QUAD0172
      IF(A.NE.0.)  GO TO 8                                               QUAD0174
        QUAD = -C/B                                                      QUAD0176
        GO TO 100                                                        QUAD0178
    8 D2 = B*B - 4.*A*C                                                  QUAD0184
      T1 = 2.*A                                                          QUAD0190
```

```
      IF(D2) 10,20,30                                                    QUAD0200
   10 KOUNT = KOUNT + 1                                                  QUAD0204
      IF(KOUNT.LE.3)  WRITE(6,11)                                        QUAD0206
   11 FORMAT(1H1)                                                        QUAD0208
      IF(KOUNT.LT.20)  WRITE(6,12)  A, B, C, D2                          QUAD0210
   12 FORMAT(72HO  FUNCTION  QUAD  ARGUMENTS YIELD COMPLEX ROOTS.  DISCRQUAD0220
     1IMINANT SET = 0. //4X3HA = G15.6, 4X 3HB = G15.6, 4X 3HC = G15.6, QUAD0230
     2 4X 12HB**2-4*A*C = G15.6)                                         QUAD0240
      IF(KOUNT.EQ.20)  WRITE(6,14)                                       QUAD0244
   14 FORMAT(55HO  * * ANY ADDITIONAL QUAD DIAGNOSTICS  SUPPRESSED  * *)QUAD0246
   20 QUAD = -B/TA                                                       QUAD0250
      GO TO 100                                                          QUAD0260
C                                                                        QUAD0270
   30 D = SQRT(D2)                                                       QUAD0280
      IF(B.EQ.0.)  GO TO 32                                              QUAD0282
      R = ABS(1.-D/ABS(B))                                               QUAD0290
      IF(R.LT.0.05) GO TO 40                                             QUAD0300
   32   X1 = (-B+D)/TA                                                  QUAD0310
        X2 = (-B-D)/TA                                                   QUAD0320
      GO TO 60                                                           QUAD0330
   40 IF(B.LT.0.) GO TO 50                                               QUAD0340
        X1 = 2.*C/(-B-D)                                                 QUAD0350
        X2 = (-B-D)/TA                                                   QUAD0360
      GO TO 60                                                           QUAD0370
   50   X1 = (-B+D)/TA                                                  QUAD0380
        X2 = 2.*C/(-B+D)                                                 QUAD0390
   60 QUAD = X1                                                          QUAD0400
      IF(ABS(X1-X).GT.ABS(X2-X))  QUAD = X2                              QUAD0410
C                                                                        QUAD0500
  100 RETURN                                                             QUAD0510
      END                                                                QUAD0520
```

```
      SUBROUTINE  PUN1(A1,A2,A3,A4,A5,A6)                              PUN10010
      COMMON  /PUN1C/ NSEQ, CID                                        PUN10020
      NSEQ = NSEQ + 10                                                 PUN10030
      WRITE(6,10)  A1, A2, A3, A4, A5, A6, CID, NSEQ                   PUN10040
   10 FORMAT(10X 1P6E12.5, A4, I4)                                     PUN10050
      PUNCH 20,    A1, A2, A3, A4, A5, A6, CID, NSEQ                   PUN10060
   20 FORMAT(1P6E12.5, A4, I4)                                         PUN10070
      RETURN                                                           PUN10080
      END                                                              PUN10090


      SUBROUTINE  PUN(A,N,AID,NSEQ)                                    PUN00010
C                                                                      PUN00020
C     LIST  &  PUNCH  ARRAY  A  USING  1PE12.5  FORMAT                 PUN00030
C     !   WITH  ID (AID) IN COL 73-76,  SEQUENCE (NSEQ+1) IN COL 77-80 PUN00040
C                                                                      PUN00050
      DIMENSION  A(1), F(8)                                            PUN00060
      DATA KL,BLANK,SPACE/-1,4H    ,4H 10X /                           PUN00062
C                                                                      PUN00070
      IF(N.GT.6000)  A(800000) = 1.                                    PUN00080
        DO 10 I1=1,N,6                                                 PUN00090
        NSEQ = NSEQ+1                                                  PUN00100
        K = MINO(5,N-I1)                                               PUN00110
        I2 = I1+K                                                      PUN00120
        IF(K.NE.KL) CALL S4MAT(K,F,KL)                                 PUN00130
        F(2) = SPACE                                                   PUN00132
        WRITE(6,F) (A(I),I=I1,I2), AID, NSEQ                           PUN00140
        F(2) = BLANK                                                   PUN00142
   10   PUNCH F, (A(I),I=I1,I2),    AID, NSEQ                         PUN00150
C                                                                      PUN00160
      RETURN                                                           PUN00300
      END                                                              PUN00310
```

```
      SUBROUTINE  S4MAT(N,F,NL)                                          S4MAT010
C                                                                        S4MAT020
C       SETS UP SPECIAL FORMAT TO FILL UP 80 COL ON PUNCHED CARDS        S4MAT030
C                                                                        S4MAT040
      DIMENSION  A(6), B(12), F(8)                                       S4MAT050
C                                                                        S4MAT060
      DATA A/ '  (     E12.5,    A4, I4)'/                               S4MAT080
      DATA B/ ' 1P160X, 1P248X, 1P336X, 1P424X, 1P512X, 1P6     '/       S4MAT090
C                                                                        S4MAT100
      IF(NL.GT.-1) GO TO 10                                              S4MAT110
      F(1) = A(1)                                                        S4MAT120
      F(2) = A(2)                                                        S4MAT122
      F(4) = A(3)                                                        S4MAT130
      F(5) = A(4)                                                        S4MAT132
      F(7) = A(5)                                                        S4MAT140
      F(8) = A(6)                                                        S4MAT150
C                                                                        S4MAT170
   10 J = 2*N+1                                                          S4MAT180
      F(3) = B(J)                                                        S4MAT190
      F(6) = B(J+1)                                                      S4MAT200
      NL = N                                                             S4MAT210
C                                                                        S4MAT220
      WRITE(6,20) N,F                                                    S4MAT230
   20 FORMAT(16,5X 8A4)                                                  S4MAT240
      IF(N.LT.0 .OR. N.GT.5) F(800000)=1                                 S4MAT250
      RETURN                                                             S4MAT400
      END                                                                S4MAT410


      SUBROUTINE  LGRID(K, X1,X2,Y1,Y2, ML,MR,ME,MT, IR)                 LGRID010
C                                                                        LGRID020
C       GENERATES  LINEAR  CRT  GRID                                     LGRID030
C     K = 0  FOR GENERAL GRID,  = 1 FOR DX=DY,  = 2 FOR SQUARE GRID      LGRID040
C     X1,X2, Y1,Y2 ARE MIN & MAX X & Y VALUES WHICH ARE ROUNDED OFF BY   LGRID050
C       SUB SCALE                                                        LGRID060
```

```
C      ML,MR, MB,MT ARE GRID MARGINS IN RASTERS - LEFT,RIGHT,BOTTOM,TOP   LGRID070
C          (24,0,24,45)                                                   LGRID072
C        MR OR MT RESET TO SATISFY  K  OPTION                             LGRID080
C      IR = 0  IF GRID GENERATED,    IR = 1 IF FAILED                    LGRID090
C        WRITTEN BY  W D CHADWICK, D/591, 1/8/68    REVISED  3/10/70      LGRID100
C                                                                         LGRID110
       CALL CAMRAV(9)                                                     LGRID120
         XA = X1                                                          LGRID130
         XB = X2                                                          LGRID140
         YA = Y1                                                          LGRID150
         YB = Y2                                                          LGRID160
C          X & Y  PLOTTING RANGE                                          LGRID170
       XD = XB-XA                                                         LGRID180
       YD = YB-YA                                                         LGRID190
       IF(XA.GT.0. .AND. XA.LT.0.1*XD)  XA = 0.                           LGRID200
       IF(YA.GT.0. .AND. YA.LT.0.3*YD)  YA = 0.                           LGRID210
       XD = XB-XA                                                         LGRID212
       YD = YB-YA                                                         LGRID214
         CALL SCALE(XA,XB,12, XL,XR,DX, IR)                               LGRID220
         IF(IR.EQ.1) RETURN                                               LGRID230
         CALL SCALE(YA,YB,12, YB,YT,DY, IR)                               LGRID240
         IF(IR.EQ.1) RETURN                                               LGRID250
       IF(K.NE.1) GO TO 10                                                LGRID260
C                                                                         LGRID270
C        SET RIGHT AND TOP MARGINS AFTER CALC  RASTERS/INCREMENT          LGRID280
       DRDI = AMIN1(FLOAT(1023-ML-MR)/XD,FLOAT(1023-MB-MT)/YD)            LGRID290
         MGR = 1023 - ML - INT(DRDI*XD)                                   LGRID300
         MGT = 1023 - MB - INT(DRDI*YD)                                   LGRID310
       CALL SETMIV(ML,MGR,MB,MGT)                                         LGRID320
       GO TO 20                                                           LGRID330
C                                                                         LGRID340
    10 CALL SETMIV(ML,MR,MB,MT)                                           LGRID350
C                                                                         LGRID360
C        GENERATE  GRID                                                   LGRID370
    20 CALL DXDYV(1,XL,XR, D,M,J,N, 12.,IR)                               LGRID380
         IF(IR.EQ.1) RETURN                                               LGRID382
```

```
      IF(K.NE.1) GO TO 30                                              LGRID390
C       GRID  WITH  DX = DY     (K=1)                                  LGRID400
      CALL GRIDIV(1,XL,XR,YB,YT, D,D,M,M,J,J, 6,6)                     LGRID410
      GO TO 100                                                        LGRID420
C                                                                      LGRID430
C       GENERAL  GRID  (OR SQUARE IF K=2)                              LGRID432
   30 CALL DXDYV(2,YB,YT, DY,MY,JY,NY, 12.,IR)                         LGRID440
      IF(IR.EQ.1) RETURN                                               LGRID442
      IF(K.EQ.2) MY=-MY                                                LGRID450
      CALL GRIDIV(1, XL,XR,YB,YT, D,DY, M,MY, J,JY, 6,6)               LGRID460
C                                                                      LGRID470
  100 RETURN                                                           LGRID800
      END                                                              LGRID810
```

```
      SUBROUTINE SCALE(XMIN,XMAX,ND,X1,X2,DX, IERR)                    SCALE020
C       DETERMINES INCREMENT AND LIMITS FOR SCALING AXIS               SCALE030
C         INPUT  XMIN, XMAX, ND          OUTPUT  X1, X2, DX, IERR      SCALE040
      XL = 0.0                                                         SCALE100
      IF(XMIN.LT.0.0) XL= -1.0                                         SCALE110
      B = (XMAX-XMIN)/FLOAT(ND)                                        SCALE120
      X6=1.                                                            SCALE122
      IF(B.GT.0.0) GO TO 5                                             SCALE130
      IERR = 1                                                         SCALE140
      WRITE(6,2)  XMIN,XMAX,ND                                         SCALE150
    2 FORMAT(// 9X 24HERROR IN SCALE ARGUMENTS 2E16.5, I8 //)          SCALE160
      RETURN                                                           SCALE170
    5 IF(1.0-B) 10,100,50                                              SCALE180
C       *     *    BRACKET  B  BY  FACTOR  OF  10      *     *       SCALE190
C       * *  B LARGER THAN 1. * *                                      SCALE200
   10 DO 20 I=1,50                                                     SCALE210
      X5=X6*0.1                                                        SCALE220
      B6=6*X5                                                          SCALE222
      NB = B6                                                          SCALE230
      IF(NB) 20,30,20                                                  SCALE240
```

```
   20 CONTINUE                                                    SCALE250
   30 DX=AINT(10.0*BB+.5)/(10.*XB)                                SCALE260
      GO TO 110                                                   SCALE280
C     * *  B LESS THAN 1.    * *                                  SCALE290
   50 DO 60 I=1,50                                                SCALE300
      XB=XB*10.                                                   SCALE310
      BB=B*XB                                                     SCALE312
      NB = BB                                                     SCALE320
      IF(NB) 60,60,70                                             SCALE330
   60 CONTINUE                                                    SCALE340
   70 DX=AINT(BB+.5)/XB                                           SCALE350
      GO TO 110                                                   SCALE370
  100 DX = 1.0                                                    SCALE380
      X1 = AINT(XMIN)+XL                                          SCALE390
      GO TO 120                                                   SCALE392
  110 I1=XMIN/(2.*DX)+XL                                          SCALE400
      X1=FLOAT(I1)*2.*DX                                          SCALE402
  120 NK=(XMAX-X1)/(2.*DX)+.9999                                  SCALE408
      X2=X1+FLOAT(NK)*2.*DX                                       SCALE410
      IERR = 0                                                    SCALE420
      RETURN                                                      SCALE430
      END                                                         SCALE440


      SUBROUTINE LINEG(N,X,Y,NDX,NDY,L)                           LINE0020
      DIMENSION X(1),Y(1)                                         LINE0030
C                                                                 LINE0040
C       C R T   L I N E   G E N E R A T I O N                     LINE0050
C                                                                 LINE0060
C         N  IS  NUMBER  OF  POINTS  TO  PLOT                     LINE0070
C         X  AND  Y  ARE  COORDINANTS  OF  POINTS                 LINE0080
C         NDX  AND  NDY  ARE  SUBSCRIPT  INCREMENTS  BETWEEN  POINTS  LINE0090
C         L  IS  LINE  INTENSITY -  1  NORMAL,  2  AND  3  DARK   LINE0100
C         SPECIAL  FEATURE -  NEG N TO PLOT -Y AS WELL AS +Y      LINE0104
C                                                                 LINE0110
```

```
      JX = 1                                                          LINE0120
      JY = 1                                                          LINE0130
      N1 =IABS(N)-1                                                   LINE0140
      IX1 = NXV(X(JX))                                                LINE0150
      IY1 = NYV(Y,JY))                                                LINE0160
      IF(N.LT.0) IY1M = NYV(-Y(JY))                                   LINE0162
C                                                                     LINE0170
      DO 100 I=1,N1                                                   LINE0180
      JX = JX+NDX                                                     LINE0190
      JY = JY+NDY                                                     LINE0200
      IX2 = NXV(X(JX))                                                LINE0210
      IY2 = NYV(Y(JY))                                                LINE0220
C                                                                     LINE0230
      DO 50 K=1,L                                                     LINE0240
   50 CALL LINEV(IX1,IY1,IX2,IY2)                                     LINE0250
      IF(N.GT.0) GO TO 90                                             LINE0252
C                                                                     LINE0254
      IY2M = NYV(-Y(JY))                                              LINE0256
      DO 60 K=1,L                                                     LINE0258
   60 CALL LINEV(IX1,IY1M,IX2,IY2M)                                   LINE0260
      IY1M = IY2M                                                     LINE0262
C                                                                     LINE0268
   90 IX1 = IX2                                                       LINE0270
  100 IY1 = IY2                                                       LINE0280
C                                                                     LINE0290
      RETURN                                                          LINE0300
      END                                                             LINE0310


      SUBROUTINE CRTLBL(TITLE, AMAT, ABSI,ORD)                        LBL00010
      DIMENSION TITLE(18), AMAT(36), ABSI(9),ORD(9)                   LBL00020
C       SUB DOES NOT ADVANCE FRAME                                    LBL00030
C       NOTE REQUIRED ARRAY SIZES- SET MARGINS  WITH  SETMIV(24,0,24,42)LBL00040
      CALL PRINTV(72,TITLE,262,1017)                                  LBL00050
      IX = 220                                                        LBL00058
```

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      DO 10 I=1,18                                                    LBL00060
      IX = IX + 32                                                    LBL00062
      CALL PRINTV(4,AMAT(I),IX,1002)                                  LBL00070
   10 CALL PRINTV(4,AMAT(I+18),IX,990)                                LBL00072
      CALL RITE2V(9,194,1023,180,3,36,1,ORD,IR)                       LBL00080
      CALL RITE2V(227,9,1023, 90,3,36,1,ABSI,IR)                      LBL00090
      RETURN                                                          LBL00100
      END                                                             LBL00110


      SUBROUTINE MXMN(L,A,N,YMX,YMN)                                  MXMN0020
      DIMENSION A(1)                                                  MXMN0030
C       L = 1  MAX  AND  MIN                                          MXMN0040
C       L = 2  MAX  ONLY                                              MXMN0050
C       L = 3  MIN  ONLY                                              MXMN0060
      YMX = A(1)                                                      MXMN0070
      YMN = A(1)                                                      MXMN0080
      IF(N.LE.1) RETURN                                               MXMN0090
      IF(L.GT.2) GO TO 20                                             MXMN0100
      DO 10 I=2,N                                                     MXMN0110
   10 YMX = AMAX1(YMX,A(I))                                           MXMN0120
      IF(L.EQ.2) RETURN                                               MXMN0130
   20 DO 30 I=2,N                                                     MXMN0140
   30 YMN = AMIN1(YMN,A(I))                                           MXMN0150
      RETURN                                                          MXMN0160
      END                                                             MXMN0170
```

```
      SUBROUTINE  PMDER                                                  DER00050
C                                                                        DER00100
C       D  E  R     DISTRIBUTED  ENERGY  RELEASE                        DER00110
C                   ROCKET ENGINE PERFORMANCE COMPUTER PROGRAM          DER00120
C                                                                        DER00130
      COMMON  /HEAD/   AMAT(72),       CDATE(2),                         DER00200
     1                 ILISP,  ISTC,   ITRANS, ITDK,   IPULSE, IDCYCL   DER00202
      COMMON  /SVV/    SVVD1(30), NST, SVVD2(3), NTL                     DER00220
C                                                                        DER00500
      IPASS = 0                                                          DER00540
      NST = 1                                                            DER00560
      INERR = 0                                                          DER00580
      IERR = 0                                                           DER00600
      CALL  HEADER                                                       DER00620
        IF(ILISP.EQ.0 .AND. ISTC.EQ.0)  GO TO 90                         DER00621
      CALL  ENGBAL(1,IEBCC)                                              DER00622
   10 IF(ILISP.NE.0)  CALL  LISP(INERR)                                  DER00624
        IF(ISTC.EQ.0)  GO TO 90                                          DER00625
        IPASS = IPASS + 1                                                DER00626
      IF(INERR.GT.0)  GO TO 200                                          DER00630
      CALL  PMSTC(1)                                                     DER00640
      IF(ISTC.LT.0)  GO TO 100                                           DER00650
      IF(IPASS.GT.1 .OR. ILISP.EQ.0)  GO TO 30                           DER00660
      CALL  ENGBAL(3,IEBCC)                                              DER00668
        IF(IEBCC.EQ.2)  GO TO 10                                         DER00672
   30 CALL  TRANS                                                        DER00680
      IF(IERR.EQ.25)  GO TO 200                                          DER00700
      CALL  PMSTC(NST)                                                   DER00720
      CALL  CPM2                                                         DER00760
   90 IF(ITDK.NE.0)  CALL TDK                                            DER00800
  100 RETURN                                                             DER00900
C                                                                        DER00910
  200   CONTINUE                                                         DER00920
        CALL  EXIT                                                       DER00930
        STOP                                                             DER00940
      END                                                                DER00950
```

```
      SUBROUTINE  HEADER                                                    HEAD0010
C                                                                           HEAD0020
    8 WRITE(6,10)                                                           HEAD0100
   10 FORMAT(1H1)                                                           HEAD0110
C                                                                           HEAD0120
      WRITE(6,15)                                                           HEAD0130
   15 FORMAT(//// 36X 37HSTEADY-STATE  PERFORMANCE  PREDICTION //          HEAD0140
     1 29X 52HOF  A  BIPROPELLANT  ROCKET  ENGINE  THRUST  CHAMBER //       HEAD0150
     2 38X 34HWITH  DISTRIBUTED  ENERGY  RELEASE /// ///                    HEAD0160
     3 41X 28HP M D E R   COMPUTER   MODEL  //                              HEAD0162
     4 46X 19HREVISED  JULY 1972 )                                          HEAD0166
C                                                                           HEAD0260
      RETURN                                                                HEAD0270
      END                                                                   HEAD0280
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      SUBROUTINE  LISP(INERR)                                               LISP0020
      COMMON  /HEAD/    HEAD1(60), JLISP                                    LISP0050
      COMMON  /COMPM/   CPMD1(4), AT, LCHAM, DCHAM, CPMD2(11), CR, ECSMIXLISP0056
      COMMON  /TBL/     TMR(18), TTC(18,3), TVIS(18,3), TGAM(18,3),         LISP0060
     1                  TMW(18,3), CST(18), TEPS(6), TMACH(3), TCF(18,6),   LISP0062
     2                  TOXERR(18), XMRM                                    LISP0064
      COMMON  /EBCOM/   EEC(5), IEB, PMF, PMO                               LISP0070
      COMMON  /SVV/     NP, NAP, NMR, SVVD1(4), RHOLF, SVVD2(5), RHOLO,     LISP0080
     1                  SVVD3(24), TMFLF, TMFLO, XMRI, SVVD4(25), PIE       LISP0082
      COMMON /ELEM/ NEL, LSPEC(60), RADE(60), THETAE(60), ALFA(60)          LISP0100
      COMMON /ELSPEC/   NLSPEC,                                             LISP0120
     1NTYPE(10), NPROP1(10),NPROP2(10),DIA1(10),  DIA2(10),  CDDIA1(10),LISP0130
     2CDDIA2(10),ZF(10),    GAME(10),  BETA(10),  GAMMA(10),  GAMFAN(10),LISP0140
     3SPFAN(10), SPEL(10),  DBAR1(10), DBAR2(10), WDT1(10),  WDT2(10),  LISP0150
     4AD1(10),   AD2(10),   VDT1(10),  VDT2(10),  SWD1(10),  SWD2(10),  LISP0160
     5WDT11(10), WDT12(10), WDT21(10), WDT22(10), TW1(10),   TW2(10),   LISP0170
     6AVD1(10),  AVD2(10),  XDW1L(10), XDW2L(10), XDW1R(10), XDW2R(10), LISP0180
     7SAL1(10),  SAL2(10),  SAR1(10),  SAR2(10),  VR1(10),   VR2(10),   LISP0190
     8VTM1(10),  VTM2(10),  V21(10),   V22(10),   ALFMOM(10)            LISP0200
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      COMMON /SHAPEC/          SA1(10),    SB1(10),    SA2(10),    SB2(10),   LISP0220
     1SC11(10),  SC21(10),    SC31(10),   SC41(10),   SC51(10),   SC61(10),  LISP0230
     2SC12(10),  SC22(10),    SC32(10),   SC42(10),   SC52(10),   SC62(10)   LISP0240
      COMMON  /LABML/                                                        LISP0440
     1  RADM(400), THETAM(400), STW1(400), STW2(400), STVR1(400)             LISP0460
     6 ,STVR2(400), STVTH1(400), STVTH2(400), STVZ1(400), STVZ2(400)         LISP0480
     7 ,STDD1(400), STDD2(400), TM1(400), STRW1(400), STRW2(400)             LISP0500
     8 ,STRDD1(400), STRDD2(400), TM2(400)                                   LISP0520
     9 ,SVTH1A(400), SVTH2A(400)                                             LISP0540
      COMMON /CPLCT/ KFCRT,KCCRT,KTCRT,KFFCRT, W1F,W2F, W1O,W2O,             LISP0600
     X W1T,W2T, W1FF,W2FF, XXMRI                                             LISP0610
      COMMON /SRGM/ NSEC, NTH, THT(39), NR, RT(20),RC, WT(39,20), JSYM,      LISP0620
     X CTH(36), STH(36)                                                      LISP0630
      COMMON /LAB1/            DRADM,      DTHETM,     ZOM,        THETAR,   LISP0724
     1DPINJ1,     DPINJ2,     DENS1,      DENS2,      CKP1,       CKP2      LISP0726
     2,DNSAT1,    DNSAT2,     PX,         DNSAX1,     DNSAX2,     SDNSA1,   LISP0727
     3SDNSA2                                                                 LISP0728
      COMMON  /LAB2/VISC1,VISC2,RHOG, EPS, IDBAR(10), STEN1, STEN2,CDBARLISP0730
      COMMON  /LAB3/    SWE1, SWE2, THER, THEL,                              LISP0732
     1                  NRML, NTHML, NRWALL, NTHR, NTHL, MESH, NMESH         LISP0733
      COMMON  /LISAVE/ AMAT(36), IRCRT(50), IPUN, KCRT, NCRT, LDTYPE,        LISP0740
     1                  NRBAFL, NRBAFR                                       LISP0742
      LOGICAL  LDTYPE                                                        LISP0770
C                                                                            LISP0780
C                                                                            LISP0820
C           READ PROGRAM CONTROLS AND GENERAL DATA                           LISP1000
C           * * * * * * * * * * * * * * * * * * * *                          LISP1020
      WRITE(6,5)                                                             LISP1022
    5 FORMAT(1H1 ///// ///// 43X 24HANALYTICAL   DESCRIPTION ///             LISP1024
     1 38X 34HINJECTOR   SPRAY   CHARACTERISTICS   ///                       LISP1026
     2 40X 29HBIPROPELLANT  LIQUID  SYSTEMS   ///  ///                       LISP1028
     3 47X 16HCOMPUTER   MODEL  /// 26X 41HPROGRAM NAME   L I S P   JULYLISP1030
     4 72 REVISION                  /// 26X 43HDEVELOPED BY   W S HINES LISP1031
     5 AND  W D CHADWICK / 41X 42HADVANCED PROGRAMS (D/589-197),  ROCKETLISP1032
     6DYNE / 41X 31HNORTH  AMERICAN  ROCKWELL  CORP ///                      LISP1034
     7 [illegible] BY   U S AIR FORCE ROCKET PROPULSION LABORATORY/LISP1035
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     $ 41X 25HEDWARDS AIR FORCE BASE, CA / 41X 32HUNDER CONTRACT  F04611LISP1036
     9-8F-C-0043 )                                                      LISP1037
      M = 2                                                             LISP1038
      REWIND M                                                          LISP1039
      INERR = 0                                                         LISP1044
      NCOM = 0                                                          LISP1045
        IF(IEB.GT.1)  GO TO 180                                         LISP1050
   10 READ(5,15) AMAT                                                   LISP1060
   15 FORMAT(18A4)                                                      LISP1080
   20 FORMAT(8E12.8)                                                    LISP1100
   25 FORMAT(1316)                                                      LISP1120
   27 FORMAT(I12,5E12.8)                                                LISP1122
      WRITE(6,30) AMAT                                                  LISP1140
   30 FORMAT(1H1 19X 18A4/20X,18A4//45X19HI N P U T   D A T A  //)      LISP1160
        CALL TIME                                                       LISP1170
      READ(5,25) NEL, NRML, NTHML, NRWALL, NTHR, NTHL,                  LISP1180
     1           JSYM, NRBAFR, NRBAFL, NLSPEC, NCRT, IPUN              LISP1200
     2         , IPUNR, IPUNL, KFCRT, KOCRT, KTCRT, KFFCRT             LISP1202
      IF(NRWALL.LT.1.OR.NRWALL.GT.NRML) NRWALL = NRML                   LISP1220
      IF(JSYM.GT.1) NRBAFL=NRBAFR                                       LISP1240
      NTHR = MAXO(NTHR,1)                                               LISP1260
      NTHL = MINO(NTHL,NTHML)                                           LISP1280
      NDT = NTHL-NTHR                                                   LISP1300
      IF(NTHML-NTHL.GE.NDT .OR. NTHR.GT.NDT) INERR = INERR+1            LISP1320
      IF(IPUNR.GE.IPUNL) IPUN = 0                                       LISP1330
      WRITE(6,35)NEL, NRML, NTHML, NRWALL, NTHR, NTHL,                  LISP1340
     1           JSYM, NRBAFR, NRBAFL, NLSPEC, NCRT, IPUN              LISP1360
     2         , IPUNR, IPUNL, KFCRT, KOCRT, KTCRT, KFFCRT             LISP1370
   35 FORMAT(                                                           LISP1380
     14X7HNEL    = I4,9H  NRML  = I4,9H  NTHML = I4,9H  NRWALL= I4,     LISP1400
     22X7HNTHR   = I4,9H  NTHL  = I4,9H  JSYM  = I4,9H  NRBAFR= I4/50X  LISP1420
     3  9HNRBAFL= I4,9H  NLSPEC= I4,9H  NCRT  = I4,9H  IPUN  = I4/     LISP1440
     44X7HIPUNR = I4,9H  IPUNL = I4,9H  KFCRT = I4,9H  KOCRT = I4,      LISP1450
     59H  KTCRT = I4,9H  KFFCRT= I4)                                    LISP1452
      NMESH = NRML*NTHML                                                LISP1460
      IF(NMESH.GT.400 .OR. NEL.GT.60 .OR. NLSPEC.GT.10 .OR. NCRT.GT.NRMLLISP1480
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     1 ) INERR = INERR+1                                                    LISP1500
       IF(NCRT.LE.0) GO TO 38                                               LISP1520
       READ(5,25)  (IRCRT(I),I=1,NCRT)                                      LISP1540
       WRITE(6,36) (IRCRT(I),I=1,NCRT)                                      LISP1560
    36 FORMAT(4X 7HIRCRT = I4,7I13/ (2X 8I13) )                             LISP1580
    38 CONTINUE                                                             LISP1600
       READ(5,20)   DZOM,   DTHETM, THETAR, ZOM,    ZOM2,   ZOM3          LISP1700
     1            , CDBAR                                                  LISP1702
       WRITE(6,40)  DZOM,   DTHETM, THETAR, ZOM,    ZOM2,   ZOM3          LISP1710
     1            , CDBAR                                                  LISP1712
    40 FORMAT( 5HO DZOM  = 1PE10.3, 5H DTHETM= E10.3, 8H THETAR= E10.3,     LISP1720
     1          8H ZOM   =   E10.3, 8H ZOM2  = E10.3, 8H ZOM3  = E10.3/    LISP1722
     2        8H CDBAR =   E10.3)                                           LISP1724
          DRADM = 0.5*DZOM/FLOAT(NRWALL)                                    LISP1740
          EPS = 0.                                                          LISP1750
C                                                                           LISP1800
C          ELEMENT   SPECIFICATIONS                                         LISP1810
       LDTYPE = .FALSE.                                                     LISP1814
       DO 60 I=1,NLSPEC                                                     LISP1820
       READ(5,25)  NTYPE(I), NPROP1(I), NPROP2(I), IDBAR(I)                 LISP1830
         NT = NTYPE(I)                                                      LISP1840
       IF(NT.LE.3 .AND. IDBAR(I).EQ.0)  LDTYPE = .TRUE.                     LISP1842
       READ(5,20) DIA1(I),DIA2(I),CDDIA1(I),CDDIA2(I),ZE(I),GAME(I),        LISP1850
     1            BETA(I),GAMMA(I)                                         LISP1860
          DBAR1(I) = 0.                                                     LISP1870
          DBAR2(I) = 0.                                                     LISP1880
       WRITE(6,50)  I, NT, NPROP1(I), NPROP2(I), IDBAR(I),                  LISP1890
     1 DIA1(I),   DIA2(I),   CDDIA1(I), CDDIA2(I), ZE(I),     GAME(I),      LISP1900
     2 BETA(I),   GAMMA(I)                                                  LISP1910
    50 FORMAT( 4X 37HELEMENT SPECIFICATIONS,  GROUP NUMBER  I4  /           LISP1920
     1 4X7HNTYPE = I4,9H  NPROP1= I4,9H  NPROP2= I4,9H  IDBAR = I4          LISP1930
     2/2X7HDIA1  = 1PE10.3, 8H DIA2  = E10.3, 8H CDDIA1= E10.3              LISP1940
     3, 8H CDDIA2=   E10.3, 8H ZE    = E10.3, 8H GAME  = E10.3              LISP1950
     4/2X7HBETA  =   E10.3, 8H GAMMA = E10.3)                               LISP1960
          IF(NT.NE.3) GO TO 54                                              LISP1970
       READ(5,20) GAMFAN(I), SPFAN(I), SPEL(I)                              LISP1980
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      WRITE(6,52) GAMEAN(I), SPEAN(I), SPEL(I)                          LISP1990
   52 FORMAT(2X /8HGAMEAN= 1PE10.3, 8H SPEAN = E10.3, 8H SPEL  = E10.3)  LISP2000
   54   IF(NT.LT.6 .AND. IDBAR(I).EQ.0)  GO TO 60                       LISP2010
      READ(5,20) DBAR1(I), DBAR2(I)                                     LISP2020
      WRITE(6,56) DBAR1(I), DBAR2(I)                                    LISP2030
   56 FORMAT(2X 7HDBAR1 = 1PE10.3, 8H DBAR2 = E10.3)                    LISP2040
        IF(NT.NE.8) GO TO 60                                            LISP2050
      READ(5,20)                                                        LISP2060
     1 SC11(I),   SC21(I),   SC31(I),   SC41(I),   SC51(I),   SC61(I)   LISP2070
     2,SC12(I),   SC22(I),   SC32(I),   SC42(I),   SC52(I),   SC62(I)   LISP2080
     3,SA1(I),    SB1(I),    SA2(I),    SB2(I)                          LISP2090
      WRITE(6,58)                                                       LISP2100
     1 SC11(I),   SC21(I),   SC31(I),   SC41(I),   SC51(I),   SC61(I)   LISP2110
     2,SC12(I),   SC22(I),   SC32(I),   SC42(I),   SC52(I),   SC62(I)   LISP2120
     3,SA1(I),    SB1(I),    SA2(I),    SB2(I)                          LISP2130
   58 FORMAT(                                                           LISP2140
     1 2X7HSC11  = 1PE10.3, 8H SC21  = E10.3, 8H SC31  = E10.3          LISP2150
     2, 8H SC41  =   E10.3, 8H SC51  = E10.3, 8H SC61  = E10.3          LISP2160
     3/2X7HSC12  =   E10.3, 8H SC22  = E10.3, 8H SC32  = E10.3          LISP2170
     4, 8H SC42  =   E10.3, 8H SC52  = E10.3, 8H SC62  = E10.3          LISP2180
     5/2X7HSA1   =   E10.3, 8H SB1   = E10.3, 8H SA2   = E10.3          LISP2190
     6, 8H SB2   =   E10.3)                                             LISP2200
        IF(4.*SC21(I).LT.SC11(I)**2)   INERR = INERR+1                  LISP2210
        IF(4.*SC22(I).LT.SC12(I)**2)   INERR = INERR+1                  LISP2220
        IF(4.*SC41(I).LT.SC31(I)**2)   INERR = INERR+1                  LISP2230
        IF(4.*SC42(I).LT.SC32(I)**2)   INERR = INERR+1                  LISP2340
        IF(4.*SC61(I).LT.SC51(I)**2)   INERR = INERR+1                  LISP2350
        IF(4.*SC62(I).LT.SC52(I)**2)   INERR = INERR+1                  LISP2360
   60 CONTINUE                                                          LISP2370
      IF(LDTYPE .AND. JLISP.NE.2)  INERR = INERR + 1                    LISP2380
C        ELEMENT   LOCATION   &   ORIENTATION                           LISP2400
      WRITE(6,62)                                                       LISP2410
   62 FORMAT(// 25X 38HELEMENT   LOCATION   AND   ORIENTATION //)       LISP2420
      THER = (NTHR-1)*DTHETM + THETAR                                   LISP2430
      THEL = (NTHL-1)*DTHETM + THETAR                                   LISP2440
      DO 70 L=1,NEL                                                     LISP2450
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      READ(5,27) LSPEC(L), RADE(L), THETAE(L), ALFA(L)                  LISP2460
      WRITE(6,64) L, LSPEC(L), RADE(L), THETAE(L), ALFA(L)              LISP2470
   64 FORMAT(4X  8HELEM NO. I3, 5X 7HLSPEC = I3, 3X 6HRADE = F8.3,      LISP2480
     1 3X 6HTHETAE = F8.2, 3X 8HALFA   = F8.2 )                         LISP2490
        IF(LSPEC(L).LE.NLSPEC) GO TO 65                                 LISP2492
        WRITE(6,67)                                                     LISP2494
        INERR = INERR+1                                                 LISP2496
   65 CONTINUE                                                          LISP2498
        IF(NTHR.EQ.1 .AND. NTHL.EQ.NTHML)  GO TO 70                     LISP2500
      IF(THETAE(L).GT.THER .AND. THETAE(L).LT.THEL) GO TO 70            LISP2510
      WRITE(6,66)                                                       LISP2520
   66 FORMAT(52H INJ ELEM MUST BE INSIDE MESH BOUNDARY NTHR AND NTHR)   LISP2530
   67  FORMAT(5X 48HELEMENT SPECIFICATION NUMBER GREATER THAN NLSPEC )   LISP2532
      INERR = INERR+1                                                   LISP2540
   70 CONTINUE                                                          LISP2550
C                                                                       LISP2560
      KCRT = 0                                                          LISP2700
      IF(KFCRT.NE.0 .OR. KOCRT.NE.0 .OR. KTCRT.NE.0 .OR. KFFCRT.NE.0)   LISP2710
     X    KCRT = 1                                                     LISP2712
      IF(KCRT.EQ.0)  GO TO 90                                           LISP2720
      READ(5,20) W1F,    W2F,    W1O,    W2O,    W1T,    W2T,         LISP2730
     1           W1FF,   W2FF                                           LISP2740
      WRITE(6,74)W1F,    W2F,    W1O,    W2O,    W1T,    W2T,         LISP2750
     1           W1FF,   W2FF                                           LISP2760
   74 FORMAT( ///                                                       LISP2770
     1 8H W1F   = 1PE10.3,8H W2F   =  E10.3,8H W1O   =  E10.3           LISP2780
     2,8H W2O   =  E10.3,8H W1T   =  E10.3,8H W2T   =  E10.3            LISP2790
     3/8H W1FF  =  E10.3,8H W2FF  =  E10.3 )                            LISP2800
C                                                                       LISP2878
   90 IF(DRADM.LE.0. .OR. DTHETM.LE.0.) INERR = INERR+1                 LISP2880
      IF((NTHML-1)*DTHETM.GT.360.01)    INERR = INERR+1                 LISP2900
      IF(INERR.LE.0) GO TO 180                                          LISP2920
C                                                                       LISP2940
  170 WRITE(6,175) INERR                                                LISP2960
  175 FORMAT(///I6,                                                     LISP2980
     X           43H  I N P U T   E R R O R S  -  CASE  DELETED  )      LISP2982
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      GO TO 8500                                                        LISP3000
C                                                                       LISP3002
  180 DPINJ1 = PMF-PIE                                                  LISP3010
      DPINJ2 = PMO-PIE                                                  LISP3012
      DNSAT1 = DNSAX1 + SDNSA1*(PIE-PX)                                 LISP3020
      DNSAT2 = DNSAX2 + SDNSA2*(PIE-PX)                                 LISP3022
        IF(.NOT.LDTYPE)  GO TO 186                                      LISP3030
        JK = 0                                                          LISP3032
        CALL  LOCFAC(JK,XMRI,IMR,NMR, JX,FX)                            LISP3034
        TG = TTG(JX,1) + FX*(TTG(JX+1,1)-TTG(JX,1))                     LISP3036
        WM = TMW(JX,1) + FX*(TMW(JX+1,1)-TMW(JX,1))                     LISP3038
        RHOG = 0.093204*PIE*WM/TG                                       LISP3040
C           0.093204 = 144/1545                                         LISP3042
C                                                                       LISP3056
  186 RADIUS = 0.                                                       LISP3058
      NTH1 = NTHML-1                                                    LISP3060
      DO 190 J1=1,NMESH,NTHML                                           LISP3080
      RADIUS = RADIUS+DRADM                                             LISP3100
      J2 = J1+NTH1                                                      LISP3120
      DO 190 J=J1,J2                                                    LISP3140
  190 RADM(J) = RADIUS                                                  LISP3160
      THETA = THETAR-DTHETM                                             LISP3180
      DO 200 ITH=1,NTHML                                                LISP3200
      THETA = THETA+DTHETM                                              LISP3220
      DO 200 J=ITH,NMESH,NTHML                                          LISP3240
  200 THETAM(J) = THETA                                                 LISP3260
      FCIRLE = (THEL-THER)/360.                                         LISP3270
C                                                                       LISP3280
  210 SWE1 = FCIRLE*TMFLF                                               LISP3290
      SWE2 = FCIRLE*TMFLO                                               LISP3292
C     CALCULATE PROPELLANT FLOW RATES FOR EACH INJECTOR ELEMENT         LISP3300
        CALL  EFLOW                                                     LISP3310
C                                                                       LISP3320
C     CALCULATE DROPLET SIZES                                           LISP3340
        CALL  DSIZE                                                     LISP3350
C                                                                       LISP3352
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C     CALCULATE COEFFICIENTS FOR SPRAY FLUX EQUATION                    LISP3360
          CALL  SCOEF (DENS1,DENS2)                                     LISP3370
C                                                                       LISP3380
  300 NZON = NZON+1                                                     LISP3390
C                                                                       LISP3400
          CALL  FANIN                                                   LISP3430
C                                                                       LISP3440
C     CALCULATE SPRAY FLUX TO COMBUSTION ZONE MESH POINTS               LISP3460
          CALL  MFLUX                                                   LISP3470
C                                                                       LISP3480
      MESH = (NRWALL-1)*NTHML + NTHL                                    LISP3500
      CALL BNDY(JSYM,NRBAFR,NRBAFL)                                     LISP3520
C                                                                       LISP3540
      WRITE(6,7100) AMAT                                                LISP3560
 7100 FORMAT(1H1 19X 18A4 / 20X 18A4 //                                 LISP3580
     X  21X          49HINDIVIDUAL INJECTOR ELEMENT SPRAY CHARACTERISTILISP3600
     1CS  //                                                           LISP3620
     X 9X  30HINJECTOR  '  RADIAL    ANGULAR  7X                       LISP3622
     X                                          49HFLOW LB/S    FLOW LB/S LISP3624
     2  AV DROP DIA  AV DROP DIA  / 9X                                 LISP3640
     X                                  86HELEMENT   COORDINATE   COORDINATLISP3642
     3S   PROPELLANT1  PROPELLANT2  PROPELLANT1  PROPELLANT2  /)       LISP3660
C                                                                       LISP3662
 7200 FORMAT(I13,F15.3,F13.3,4F13.5)                                    LISP3664
      TIF1 = 0.0                                                        LISP3690
      TIF2 = 0.0                                                        LISP3692
      DO 7220 L=1,NEL                                                   LISP3693
      I = LSPEC(L)                                                      LISP3694
      WRITE(6,7200) (L,RADE(L),THETAE(L),TW1(I),TW2(I),AVD1(I),AVD2(I)) LISP3695
      TIF1 = TIF1 + TW1(I)                                              LISP3696
 7220 TIF2 = TIF2 + TW2(I)                                              LISP3698
      WRITE(6,7230)  TIF1,TIF2                                          LISP3700
 7230 FORMAT(/19X,22H TOTAL INJECTION RATES 2F13.5 )                    LISP3702
C                                                                       LISP3704
      WRITE(6,7300) AMAT, ZOM                                           LISP3740
 7300 FORMAT(1H1 19X 18A4 / 20X 18A4 / 49X5HZOM =  F6.3 //              LISP3760
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     X     27X        42HCOMBUSTION ZONE MESH POINT CHARACTERISTICS  // LISP3760
     X3X                                                              LISP3790
     1 2CHMESH  RADIAL  ANGULAR    PROPEL   WT FLUX   TOT MASS   RADIAL LISP3800
     2  ANGULAR    AXIAL     AV DROP /1X 93HPOINT POSITION  POSITION   LISP3820
     3LANT    LB/IN2/S    L5/S    VELOCITY  VELOCITY  VELOCITY   DIA IN LISP3840
     4,/)                                                             LISP3860
      WRITE(M)   NTHL,NTHR,MESH,NTHML,NRWALL,DRADM,DTHETM,IPUN        LISP3870
      TF1 = 0.0                                                       LISP3872
      TF2 = 0.0                                                       LISP3874
      DO 7415  J1=NTHR,MESH,NTHML                                     LISP3880
       J2 = J1+NTHL-NTHR                                              LISP3900
        DO 7410 J=J1,J2                                               LISP3920
      WRITE(6,7400) (J,RADM(J),THETAM(J),STW1(J),TM1(J),STVR1(J),STVTH1(LISP3940
     1J),STVZ1(J),STDD1(J),STW2(J),TM2(J),STVR2(J),STVTH2(J),STVZ2(J),STLISP3960
     2DD2(J) )                                                        LISP3980
7400 FORMAT(1e,2F10.3,5X,1H1,2F12.7,3F10.2,F10.5/ 31X,1H2,2F12.7,     3LISP4000
     1F10.2,F10.5/)                                                   LISP4020
      TF1 = TF1 + TM1(J)                                              LISP4028
      TF2 = TF2 + TM2(J)                                              LISP4030
7410  CONTINUE                                                        LISP4040
      WRITE (M) (RADM(J),   THETAM(J), STRW1(J),  STRW2(J),  STRDD1(J), LISP4060
     1          STRDD2(J), STVZ1(J),  STVZ2(J), J=J1,J2)             LISP4065
7415 CONTINUE                                                         LISP4080
      WRITE(6,7540)  TF1, TF2                                         LISP4090
7540 FORMAT(14X,29H TOTAL FLOWRATE, PROPELLANT 1 F12.5/3GX,13H PROPELLALISP4092
     1NT 2 F12.5 )                                                    LISP4094
      WRITE(6,7550) AMAT, ZOM                                         LISP4100
7550 FORMAT(1H1 19X 18A4 / 20X 18A4 / 49X5HZOM =  F6.3 //    18X      LISP4120
     1  60HCOMBUSTION ZONE MESH POINT CHARACTERISTICS AFTER EVAPORATION LISP4140
     2//3X56HMESH    RADIAL  ANGULAR  PROPEL     WT FLUX    AV DROP    LISP4160
     3PERCENT / 3X                          67HPOINT  POSITION  POSITION LISP4170
     4LANT      LB/IN2/S   DIA IN     VAPORIZED /)                    LISP4180
       TMCS1 = 0.                                                     LISP4190
       TMCS2 = 0.                                                     LISP4192
       SMV1 = 0.                                                      LISP4194
       SMV2 = 0.                                                      LISP4196
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      DO 7562 J1=NTHR,MESH,NTHML                                        LISP4200
      J2 = J1+NTHL-NTHR                                                 LISP4220
       DO 7562 J=J1,J2                                                  LISP4240
       FVAP1 = 0.                                                       LISP4242
       IF(STW1(J).LT.1.E-12) GO TO 7554                                 LISP4244
       FVAP1 = (STW1(J)-STRW1(J))/STW1(J)                               LISP4246
       TMCS1 = TMCS1+TM1(J)                                             LISP4248
       SMV1 = SMV1 + FVAP1*TM1(J)                                       LISP4250
 7554  FVAP2 = 0.                                                       LISP4252
       IF(STW2(J).LT.1.E-12) GO TO 7556                                 LISP4254
       FVAP2 = (STW2(J)-STRW2(J))/STW2(J)                               LISP4255
       TMCS2 = TMCS2+TM2(J)                                             LISP4256
       SMV2 = SMV2 + FVAP2*TM2(J)                                       LISP4257
 7556  CONTINUE                                                         LISP4258
      WRITE(6,7560)  J, RADM(J),THETAM(J),STRW1(J), STRDD1(J), FVAP1,   LISP4270
     X   STRW2(J), STRDD2(J), FVAP2                                     LISP4272
 7560 FORMAT(I6,2F10.3,5X 1H1 F14.7, F10.5, 2PF11.2,                    LISP4300
     X /31X 1H2 0PF14.7, F10.5, 2PF11.2/)                               LISP4302
 7562 CONTINUE                                                          LISP4310
C                                                                       LISP4312
      XYMR1 = TMCS2/TMCS1                                               LISP4316
      CALL  MIXEFF(TMCS1,TMCS2,NMR,TMR,CST, EM,ECSMX1)                  LISP4318
        IF(ISS.EQ.1)  ECSMIX = ECSMX1                                   LISP4319
      TIF1 = SWE1                                                       LISP4320
      TIF2 = SWE2                                                       LISP4321
      WRITE (N)  TIF1,TIF2,SMV1,SMV2,ZCN                                LISP4322
      END FILE N                                                        LISP4323
      REWIND N                                                          LISP4324
       FVAP1 = SMV1/TMCS1                                               LISP4326
       FVAP2 = SMV2/TMCS2                                               LISP4328
       FVAPT = (SMV1+SMV2)/(TMCS1+TMCS2)                                LISP4330
      WRITE(6,7566) FVAP1,FVAP2,FVAPT                                   LISP4332
 7566 FORMAT( // 5X 24HPERCENT PROP 1 VAPORIZED 2PF7.2,5X 24HPERCENT PROLISP4334
     1P 2 VAPORIZED F7.2, 5X 25HOVERALL PERCENT VAPORIZED F7.2          LISP4336
     X )                                                                LISP4337
C                                                                       LISP4340
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C * * * 2-D INPUT DATA PUNCH CONTROL CARD REMOVED HERE.                    LISP4360
C                                                                          LISP4380
      IF(NCRT.EQ.0) GO TO 8000                                             LISP4400
      IF(NZOM.GT.1) GO TO 7570                                             LISP4410
      CALL PLOTN(NTHML,THETAM, NTHR,NTHL, NRWALL,RADM, NEL,THETAE,RADE,    LISP4420
     1 LSPEC, IERR)                                                        LISP4440
      IF(IERR.EQ.1) GO TO 7570                                             LISP4460
      CALL CRTLEL(72H        SPRAY  MESH  SYSTEM  AND  INJECTOR  IMPINGEMLISP4480
     1ENT  POINTS            ,AMAT,36H                X                    LISP4482
     2,36H                 Y                    )                          LISP4484
 7570 CONTINUE                                                             LISP4500
      IF(NCRT.LE.0) GO TO 8000                                             LISP4510
      DO 7600 I=1,NCRT                                                     LISP4520
      J=IRCRT(I)                                                           LISP4540
      IF(J.LT.1.OR.J.GT.NRML) GO TO 7600                                   LISP4560
      I1 = (J-1)*NTHML+NTHR                                                LISP4580
      NTH = NTHL-NTHR+1                                                    LISP4600
      CALL PLOT2(NTH,THETAM(I1),STRW1(I1),STRW2(I1),RADM(I1),ZOM,IERR)     LISP4620
      IF(IERR.EQ.1) GO TO 7600                                             LISP4640
      CALL CRTLEL(72H    FUEL  AND  OXIDIZER  SPRAY  FLUXES  AT  CONSTANLISP4660
     1T  RADIUS  SECTION   ,AMAT,36H              THETA (DEG)             LISP4662
     2,36H       SPRAY FLUX (LB/IN2-SEC)          )                       LISP4664
 7600 CONTINUE                                                             LISP4680
 8000 CONTINUE                                                             LISP4690
      IF(KCRT.EQ.1) CALL PLOTC(AMAT)                                       LISP4700
        CALL TIME                                                          LISP4702
        ZOMX = ZOM                                                         LISP4708
      IF(NZOM.GE.3 .OR. IEB.GT.1)  GO TO 8400                              LISP4710
      IF(NZOM.EQ.1) ZOM = ZOM2                                             LISP4720
      IF(NZOM.EQ.2) ZOM = ZOM3                                             LISP4740
      IF(ZOM.GT.0.) GO TO 300                                              LISP4760
 8400   ZOM = ZOMX                                                         LISP4764
 8500 RETURN                                                               LISP4770
      END                                                                  LISP4780
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      SUBROUTINE  EFLOW                                                      EFL00020
      COMMON /ELEM/ NEL, LSPEC(60), RADE(60), THETAE(60), ALFA(60)           EFL00100
      COMMON /ELSPEC/   NLSPEC,                                              EFL00120
     1NTYPE(10), NPROP1(10),NPROP2(10),DIA1(10),  DIA2(10),  CDDIA1(10),EFL00130
     2CDDIA2(10),ZE(10),    GAME(10),  BETA(10),  GAMMA(10), GAMFAN(10),EFL00140
     3SPFAN(10), SPEL(10),  DBAR1(10), DBAR2(10), WOT1(10),  WOT2(10),  EFL00150
     4AC1(10),   AC2(10),   VOT1(10),  VOT2(10),  SWO1(10),  SWO2(10),  EFL00160
     5WOT11(10), WOT12(10), WOT21(10), WOT22(10), TW1(10),   TW2(10),   EFL00170
     6AVD1(10),  AVD2(10),  XOW1L(10), XOW2L(10), XOW1R(10), XOW2R(10), EFL00180
     7SAL1(10),  SAL2(10),  SAR1(10),  SAR2(10),  VR1(10),   VR2(10),   EFL00190
     8VTH1(10),  VTH2(10),  VZ1(10),   VZ2(10),   ALFMOM(10)            EFL00200
      COMMON /LAB1/          DRADM,     DTHETM,    ZOM,       THETAR,    EFL00680
     1DPINJ1,    DPINJ2,    DENS1,     DENS2,     CKP1,      CKP2       EFL00690
      COMMON  /BABB/   SWE1, SWE2, THER, THEL,                           EFL00700
     1                 NRML, NTHML, NRWALL, NTHR, NTHL, MESH, NMESH     EFL00710
                                                                         EFL00720
      DO 800 I=1,NLSPEC                                                  EFL00740
      NT = NTYPE(I)                                                      EFL00760
      GO TO (300,300,400,400,500,550,300,200,700),NT                     EFL00780
C                                                                        EFL00800
  300 AO1(I) = .7854*(DIA1(I)**2)                                        EFL00820
      IF(NPROP1(I).EQ.1) GO TO 303                                       EFL00840
      DENS = DENS2                                                       EFL00860
      DP1  = DPINJ2                                                      EFL00880
      GO TO 305                                                          EFL00900
  303 DENS = DENS1                                                       EFL00920
      DP1 = DPINJ1                                                       EFL00940
  305 WOT2(I) = .6663*CDDIA1(I)*AO1(I)*SQRT(DENS*DP1)                    EFL00960
      VOT1(I) = 144.*WOT2(I)/(AO1(I)*DENS)                               EFL00980
      IF (NPROP1(I).EQ.1) GO TO 310                                      EFL01000
      WOT11(I) = 0.0                                                     EFL01020
      WOT12(I) = WOT1(I)                                                 EFL01040
      GO TO 320                                                          EFL01060
  310 WOT11(I) = WOT1(I)                                                 EFL01080
      WOT12(I) = 0.0                                                     EFL01100
  320 IF (NTYPE(I).EQ.2) GO TO 350                                       EFL01120
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      IF (NTYPE(I).EQ.7) GO TO 800                                    EFLO1140
  321 AO2(I) = .7854*(DIA2(I)**2)                                     EFLO1160
  322 IF(NPROP2(I).EQ.1) GO TO 323                                    EFLO1180
      DENS = DENS2                                                    EFLO1200
      DP2  = DPINJ2                                                   EFLO1220
      GO TO 325                                                       EFLO1240
  323 DENS = DENS1                                                    EFLO1260
      DP2  = DPINJ1                                                   EFLO1280
  325 WOT2(I) = .6663*CDDIA2(I)*AO2(I)*SQRT(DENS*DP2)                 EFLO1300
      VOT2(I) = 144.*WOT2(I)/(AO2(I)*DENS)                            EFLO1320
      IF(NPROP2(I).EQ.1) GO TO 330                                    EFLO1340
      WOT21(I) = 0.0                                                  EFLO1360
      WOT22(I) = WOT2(I)                                              EFLO1380
      GO TO 800                                                       EFLO1400
  330 WOT21(I) = WOT2(I)                                              EFLO1420
      WOT22(I) = 0.0                                                  EFLO1440
      GO TO 800                                                       EFLO1460
  350 WOT21(I) = WOT11(I)                                             EFLO1480
      WOT22(I) = WOT12(I)                                             EFLO1500
      AO2(I) = AO1(I)                                                 EFLO1510
      WOT2(I)  = WOT1(I)                                              EFLO1515
      VOT2(I) = VOT1(I)                                               EFLO1520
      GO TO 800                                                       EFLO1540
  400 AO1(I) = 2.*.7854*(DIA1(I)**2)                                  EFLO1560
      IF(NPROP1(I).EQ.1) GO TO 403                                    EFLO1580
      DENS = DENS2                                                    EFLO1600
      DP1  = DPINJ2                                                   EFLO1620
      GO TO 405                                                       EFLO1640
  403 DENS = DENS1                                                    EFLO1660
      DP1 = DPINJ1                                                    EFLO1680
  405 WOT1(I) = .6663 * CDDIA1(I)*AO1(I)*SQRT(DENS*DP1)               EFLO1700
      VOT1(I) = 144.*WOT1(I)/(AO1(I)*DENS)                            EFLO1720
      IF(NPROP1(I).EQ.1) GO TO 410                                    EFLO1740
      WOT11(I) = 0.0                                                  EFLO1760
      WOT12(I) = WOT1(I)                                              EFLO1780
      GO TO 420                                                       EFLO1800
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410 WGT11(I) = WGT1(I)                                                EFLC1820
    WGT12(I) = 0.0                                                    EFLC1840
420 IF(NTYPE(I).EQ.4) GO TO 450                                       EFLC1860
    AC2(I) = 2.*.7854*(DIA2(I)**2)                                    EFLC1880
    IF(NPROP2(I).EQ.1) GO TO 423                                      EFLC1900
    DENS = DENS2                                                      EFLC1920
    DP2  = DPINJ2                                                     EFLC1940
    GO TO 425                                                         EFLC1960
423 DENS = DENS1                                                      EFLC1980
    DP2 = DPINJ1                                                      EFLC2000
425 WGT2(I) = .6683*CDDIA2(I)*AC2(I)*SQRT(DENS*DP2)                   EFLC2020
    VGT2(I) = 144.*WGT2(I)/(AC2(I)*DENS)                              EFLC2040
    IF(NPROP2(I).EQ.1) GO TO 430                                      EFLC2060
    WGT21(I) = 0.0                                                    EFLC2080
    WGT22(I) = WGT2(I)                                                EFLC2100
    GO TO 500                                                         EFLC2120
430 WGT21(I) = WGT2(I)                                                EFLC2140
    WGT22(I) = 0.0                                                    EFLC2160
    GO TO 500                                                         EFLC2180
450 GO TO 321                                                         EFLC2200
500 AC1(I) = 4.*.7854*(DIA1(I)**2)                                    EFLC2220
    IF(NPROP1(I).EQ.1) GO TO 503                                      EFLC2240
    DENS = DENS2                                                      EFLC2260
    DP1 = DPINJ2                                                      EFLC2280
    GO TO 505                                                         EFLC2300
503 DENS = DENS1                                                      EFLC2320
    DP1 = DPINJ1                                                      EFLC2340
505 WGT1(I) = .6683*CDDIA1(I)*AC1(I)*SQRT(DENS*DP1)                   EFLC2360
    VGT1(I) = 144.*WGT1(I)/(AC1(I)*DENS)                              EFLC2380
    IF(NPROP1(I).EQ.1) GO TO 510                                      EFLC2400
    WGT11(I) = 0.0                                                    EFLC2420
    WGT12(I) = WGT1(I)                                                EFLC2440
    GO TO 321                                                         EFLC2460
510 WGT11(I) = WGT1(I)                                                EFLC2480
    WGT12(I) = 0.0                                                    EFLC2500
    GO TO 321                                                         EFLC2520
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      IF(NPROP1(2).EQ.1) GO TO 553                                      EFLO2540
      DENS = DENS2                                                      EFLO2560
      DP1  = DPINJ2                                                     EFLO2580
      GO TO 555                                                         EFLO2600
  553 DENS = DENS1                                                      EFLO2620
      DP1 = DPINJ1                                                      EFLO2640
  555 WOT1(I) = .6683*CDDIA1(I)*AO1(I)*SQRT(DENS*DP1)                   EFLO2660
      VOT1(I) = 144.*WOT1(I)/(AO1(I)*DENS)                              EFLO2680
      IF (NPROP1(I).EQ.1) GO TO 560                                     EFLO2700
      WOT11(I) = 0.0                                                    EFLO2720
      WOT12(I) = WOT1(I)                                                EFLO2740
      GO TO 570                                                         EFLO2760
  560 WOT11(I) = WOT1(I)                                                EFLO2780
      WOT12(I) = 0.0                                                    EFLO2800
      GO TO 570                                                         EFLO2820
  570 IF(NPROP2(I).EQ.1) GO TO 573                                      EFLO2840
      DENS = DENS2                                                      EFLO2860
      DP2 = DPINJ2                                                      EFLO2880
      GO TO 575                                                         EFLO2900
  573 DENS = DENS1                                                      EFLO2920
      DP2  = DPINJ1                                                     EFLO2940
  575 WOT2(I) = .6683*CDDIA2(I)*AO2(I)*SQRT(DENS*DP2)                   EFLO2960
      VOT2(I) = 144.*WOT2(I)/(AO2(I)*DENS)                              EFLO2980
      IF(NPROP2(I).EQ.1) GO TO 580                                      EFLO3000
      WOT21(I) = 0.0                                                    EFLO3020
      WOT22(I) = WOT2(I)                                                EFLO3040
      GO TO 800                                                         EFLO3060
  580 WOT21(I) = WOT2(I)                                                EFLO3080
      WOT22(I) = 0.0                                                    EFLO3100
      GO TO 800                                                         EFLO3120
  700 WOT1(I) = WOT1(I)                                                 EFLO3140
      WOT2(I) = WOT2(I)                                                 EFLO3160
        RETURN                                                          EFLO3170
  800 CONTINUE                                                          EFLO3180
C                                                                       EFLO4000
          = 0.                                                          EFLO4010
```

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      SEF2 = 0.                                                          EFL04020
        DO 900 I=1,NLSPEC                                                EFL04030
        TW1(I) = WGT11(I) + WGT21(I)                                     EFL04040
900     TW2(I) = WGT12(I) + WGT22(I)                                     EFL04050
      T = 0.01                                                           EFL04060
        DO 920 L=1,NEL                                                   EFL04070
        I = LSPEC(L)                                                     EFL04080
        FACT = 1.                                                        EFL04090
        THR = THETAE(L)                                                  EFL04100
        IF(NTHL.LT.NTHML)  GO TO 910                                     EFL04102
        IF(RADE(L).GT.0.)  GO TO 904                                     EFL04110
          FACT = (THEL-THER)/360.                                        EFL04112
          GO TO 910                                                      EFL04114
904     IF(THE.GT.THER+T .AND. THE.LT.THEL-T)  GO TO 910                 EFL04120
        FACT = 0.                                                        EFL04124
        IF(THE.GT.THER-T .AND. THE.LT.THEL+T)  FACT = 0.5                EFL04130
910     SEF1 = SEF1 + FACT*TW1(I)                                        EFL04140
920     SEF2 = SEF2 + FACT*TW2(I)                                        EFL04150
      R1 = SWE1/SEF1                                                     EFL04160
      R2 = SWE2/SEF2                                                     EFL04170
      WRITE(6,924) R1, R2                                                EFL04172
924 FORMAT(39HO  ELEMENT FLOW ADJUSTMENT FACTOR- R1 = F6.4,6H, R2 =      EFL04174
     1       F6.4)                                                       EFL04176
        DO 930 I=1,NLSPEC                                                EFL04180
          RA = R1                                                        EFL04182
          IF(NPROP1(I).EQ.2)  RA = R2                                    EFL04184
          RB = R2                                                        EFL04186
          IF(NPROP2(I).EQ.1)  RB = R1                                    EFL04188
        WGT11(I) = R1*WGT11(I)                                           EFL04190
        WGT21(I) = R1*WGT21(I)                                           EFL04200
        TW1  (I) = R1*TW1  (I)                                           EFL04210
        WGT1 (I) = RA*WGT1 (I)                                           EFL04220
        VOT1 (I) = RA*VOT1 (I)                                           EFL04230
        WGT12(I) = R2*WGT12(I)                                           EFL04240
        WGT22(I) = R2*WGT22(I)                                           EFL04250
        TW2  (I) = R2*TW2  (I)                                           EFL04260
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      WOT2 (I) = RB*WOT2 (I)                                                EFLO4270
  930 VOT2 (I) = RB*VOT2 (I)                                                EFLO4280
      RETURN                                                                EFLO9980
      END                                                                   EFLO9990



      SUBROUTINE  SCOEF (DENS1,DENS2)                                       COEF0020
      COMMON /ELEM/ NEL, LSPEC(60), RADE(60), THETAE(60), ALFA(60)          COEF0100
      COMMON /ELSPEC/   NLSPEC,                                             COEF0120
     1NTYPE(10), NPROP1(10),NPROP2(10),DIA1(10),  DIA2(10),  CODIA1(10),COEF0130
     2CODIA2(10),ZE(10),    GAME(10),  BETA(10),  GAMFAN(10),GAMFAN(10),COEF0140
     3SPFAN(10), SPEL(10),  DBAR1(10), DBAR2(10), WOT1(10),  WOT2(10),  COEF0150
     4WO1(10),   WO2(10),   VOT1(10),  VOT2(10),  SWO1(10),  SWO2(10),  COEF0160
     5WOT11(10), WOT12(10), WOT21(10), WOT22(10), TW1(10),   TW2(10),   COEF0170
     6AVD1(10),  AVD2(10),  XOW1L(10), XOW2L(10), XOW1R(10), XOW2R(10), COEF0180
     7SAL1(10),  SAL2(10),  SAR1(10),  SAR2(10),  VR1(10),   VR2(10),   COEF0190
     8VTH1(10),  VTH2(10),  VZ1(10),   VZ2(10),   ALFMOM(10)            COEF0200
      COMMON /SHAPEC/       SA1(10),   SB1(10),   SA2(10),   SB2(10),   COEF0220
     1SC11(10),  SC21(10),  SC31(10),  SC41(10),  SC51(10),  SC61(10),  COEF0230
     2SC12(10),  SC22(10),  SC32(10),  SC42(10),  SC52(10),  SC62(10)   COEF0240
C                                                                         COEF0670
      ALF(WVR,GAM) = 57.3*ARSIN(SIND(180.-GAM)/SQRT(1.+WVR**2-2.*WVR      COEF0680
     1           *COSD(180.-GAM))) - GAM/2.                               COEF0682
      DO 4000 I=1,NLSPEC                                                  COEF0740
      ALFMOM(I) = 0.                                                      COEF0750
      NT = NTYPE(I)                                                       COEF0760
      GO TO (2100,2100,2300,2400,2400,2600,2700,3000,2900),NT             COEF0780
 2100 XDIA1 = DIA1(I)                                                     COEF0800
      XDIA2 = DIA2(I)                                                     COEF0820
      XGAME = GAME(I)                                                     COEF0840
      WU1 = WOT1(I)*VOT1(I)                                               COEF0850
      WU2 = WOT2(I)*VOT2(I)                                               COEF0860
      ALFMOM(I) = ALF(WU1/WU2,XGAME)                                      COEF0870
          WRITE(6,2101) ALFMOM(I)                                         COEF0874
 2101     FORMAT(113X,E8.3)                                               COEF0876
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      IF(NPROP1(I).EQ.1) GO TO 2103                                    COEF0940
      XDENS1 = DENS2                                                   COEF0960
      GO TO 2105                                                       COEF0980
 2103 XDENS1 = DENS1                                                   COEF1000
 2105 IF(NPROP2(I).EQ.1) GO TO 2108                                    COEF1020
      XDENS2 = DENS2                                                   COEF1040
      GO TO 2110                                                       COEF1060
 2108 XDENS2 = DENS1                                                   COEF1080
 2110 SA1(I) = FSA(XDIA1,XDIA2,XGAME,XDENS1,SC41(I))                   COEF1100
      SA2(I) = FSA(XDIA2,XDIA1,XGAME,XDENS2,SC42(I))                   COEF1120
      CALL FSB(1, XDIA1,XDIA2, WU1,WU2, XGAME)                         COEF1200
 2150 IF(NTYPE(I).NE.2) GO TO 3000                                     COEF1702
      SC11(I) =0.0                                                     COEF1704
      SC12(I) =0.0                                                     COEF1706
      SC51(I) = 0.0                                                    COEF1708
      SC52(I) = 0.0                                                    COEF1710
      GO TO 3000                                                       COEF1712
 2300 SC11(I) = 0.0                                                    COEF1716
      SC12(I) = 0.0                                                    COEF1718
      SC21(I) = 0.0                                                    COEF1720
      SC22(I) = 0.0                                                    COEF1722
      SC51(I) = 0.0                                                    COEF1724
      SC52(I) = 0.0                                                    COEF1726
      SC61(I) = 0.0                                                    COEF1728
      SC62(I) = 0.0                                                    COEF1730
      SA1(I) = 11.4                                                    COEF1732
      SB1(I) = 31.                                                     COEF1734
      SC31(I) = 2.1                                                    COEF1738
      SC41(I) = SC31(I)**2/4.                                          COEF1740
      SA2(I) = 11.3                                                    COEF1741
      SB2(I) = 21.0                                                    COEF1742
      SC32(I) = 0.5                                                    COEF1744
      SC42(I) = SC32(I)**2/4.                                          COEF1746
      GO TO 3000                                                       COEF1752
 2400 SC11(I) = 0.0                                                    COEF1780
      SC12(I) = 0.0                                                    COEF1800
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      SC31(I) = 0.0                                                    COEF1820
      SC32(I) = 0.0                                                    COEF1840
      SC51(I) = 0.0                                                    COEF1860
      SC52(I) = 0.0                                                    COEF1880
      XDIA1 = DIA1(I)                                                  COEF1900
      XDIA2 = DIA2(I)                                                  COEF1920
      XWVR1 = WOT1(I)*VOT1(I)/(WOT2(I)*VOT2(I))                        COEF1940
      ALFMOM(I) = ALF(WOT1(I)*VOT1(I)/(WOT2(I)*VOT2(I)),GAME(I))       COEF1950
      IF(NTYPE(I).EQ.5) GO TO 2500                                     COEF1960
      XSA1 = FTDSA(XDIA1,XDIA2,XWVR1,XSC41)                            COEF1980
      SA1(I) = XSA1                                                    COEF2000
      SC41(I) = XSC41                                                  COEF2020
      XSA2 = FTSSA(XDIA1,XDIA2,XWVR1,XSC42)                            COEF2040
      SA2(I) = XSA2                                                    COEF2060
      SC42(I) = XSC42                                                  COEF2080
      XSB1 = FTDSB(XDIA1,XDIA2,XWVR1,XSC21)                            COEF2100
      SB1(I) = XSB1                                                    COEF2120
      SC21(I) = XSC21                                                  COEF2140
      SC61(I) = XSC21                                                  COEF2160
      XSB2 = FTSSB(XDIA1,XDIA2,XWVR1,XSC22)                            COEF2180
      SB2(I) = XSB2                                                    COEF2200
      SC22(I) = XSC22                                                  COEF2220
      SC62(I) = XSC22                                                  COEF2240
      GO TO 3000                                                       COEF2260
 2500 XSA2 = FPDSA(XDIA1,XDIA2,XWVR1,XSC41)                            COEF2280
      SA1(I) = XSA1                                                    COEF2300
      SC41(I) = XSC41                                                  COEF2320
      XSA2 = FPSSA(XDIA1,XDIA2,XWVR1,XSC42)                            COEF2340
      SA2(I) = XSA2                                                    COEF2360
      SC42(I) = XSC42                                                  COEF2380
      SB1(I)  = SA1(I)                                                 COEF2400
      SC21(I) = SC41(I)                                                COEF2420
      SC61(I) = SC41(I)                                                COEF2440
      SB2(I)  = SA2(I)                                                 COEF2460
      SC22(I) = SC42(I)                                                COEF2480
      SC62(I) = SC42(I)                                                COEF2500
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      GO TO 3000                                                        COEF2520
 2600 CONTINUE                                                          COEF2540
 2700 CONTINUE                                                          COEF2560
 2900 CONTINUE                                                          COEF2940
 3000 SWO1(I) = 0.3183*WOT1(I)*SQRT(SA1(I)*SB1(I))/(1. + .5*SC21(I)/SB1(COEF2960
     1I) + .5*SC41(I)*(1. + .5*SC61(I)/SB1(I))/SA1(I))                  COEF2980
 3005 SWO2(I) = 0.3183*WOT2(I)*SQRT(SA2(I)*SB2(I))/(1. + .5*SC22(I)/SB2(COEF3000
     1I) + .5*SC42(I)*(1. + .5*SC62(I)/SB2(I))/SA2(I))                  COEF3020
 4000 CONTINUE                                                          COEF3200
      WRITE(6,4100) (I,SC11(I),SC21(I),SC31(I),SC41(I),SC51(I),SC61(I), COEF3300
     1 SA1(I),SB1(I),  SC12(I),SC22(I),SC32(I),SC42(I),SC52(I),SC62(I), COEF3310
     2 SA2(I),SB2(I), I=1,NLSPEC)                                       COEF3320
 4100 FORMAT(1H1 39X 31HSPRAY DISTRIBUTION COEFFICIENTS // 6X 10HSPEC  OCOEF3330
     1RIF 6X 2HC1 9X 2HC2 9X 2HC3 9X 2HC4 9X 2HC5 9X 2HC6 9X 1HA 10X 1HBCOEF3340
     2 // (I9, 5X 1H1 8F11.3 / 14X 1H2 8F11.3 /) )                     COEF3350
      RETURN                                                            COEF9980
      END                                                               COEF9990
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      SUBROUTINE DSIZE                                                  DSIZ0020
      COMMON /ELEM/ NEL, LSPEC(60), RADE(60), THETAE(60), ALFA(60)      DSIZ0100
      COMMON /ELSPEC/   NLSPEC,                                         DSIZ0120
     1NTYPE(10), NPROP1(10),NPROP2(10),DIA1(10),  DIA2(10),  CDDIA1(10),DSIZ0130
     2CDDIA2(10),ZE(10),    GAME(10),  BETA(10),  GAMMA(10), GAMFAN(10),DSIZ0140
     3SPFAN(10), SPEL(10),  DBAR1(10), DBAR2(10), WOT1(10),  WOT2(10),  DSIZ0150
     4AO1(10),   AO2(10),   VOT1(10),  VOT2(10),  SWO1(10),  SWO2(10),  DSIZ0160
     5WOT11(10), WOT12(10), WOT21(10), WOT22(10), TW1(10),   TW2(10),   DSIZ0170
     6AVD1(10),  AVD2(10),  XOW1L(10), XOW2L(10), XOW1R(10), XOW2R(10), DSIZ0180
     7SAL1(10),  SAL2(10),  SAR1(10),  SAR2(10),  VR1(10),   VR2(10),   DSIZ0190
     8VTH1(10),  VTH2(10),  VZ1(10),   VZ2(10),   ALFMOM(10)            DSIZ0200
      COMMON  /LAB1/  LAB1D1(6), DENS1, DENS2                           DSIZ0210
      COMMON  /LAB2/  VISC1, VISC2, RHOG, EPS, IDBAR(10), STEN1, STEN2, DSIZ0220
     1                CDBAR                                            DSIZ0222
C                                                                       DSIZ0230
      DO 1500 I=1,NLSPEC                                                DSIZ0240
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      NT = NTYPE(I)                                                          DSIZ0260
      IF(IDBAR(I).NE.0)  GO TO 1400                                          DSIZ0270
      IF(NT.GT.5)  GO TO 1400                                                DSIZ0280
      GO TO (1100,1150,1150,1250,1250),NT                                    DSIZ0300
 1100 IF(DIA1(I).GT.DIA2(I))  GO TO 1120                                     DSIZ0320
      DIAHW1 = 1.14/VOT1(I)**0.76*DIA1(I)**0.293*(DIA2(I)/DIA1(I))**.023     DSIZ0330
     1         *((DENS1*VOT1(I))/(DENS2*VOT2(I)))**0.165                     DSIZ0340
      DIAHW2 = 1.07/VOT2(I)**0.57*DIA2(I)**0.65*(DIA1(I)/DIA2(I))**.17       DSIZ0350
     1         *((DENS2*VOT2(I))/(DENS1*VOT1(I)))**0.25                      DSIZ0360
      GO TO 1130                                                             DSIZ0370
 1120 DIAHW2 = 1.14/VOT2(I)**0.76*DIA2(I)**0.293*(DIA1(I)/DIA2(I))**.023     DSIZ0380
     1         *((DENS2*VOT2(I))/(DENS1*VOT1(I)))**0.165                     DSIZ0390
      DIAHW1 = 1.07/VOT1(I)**0.57*DIA1(I)**0.65*(DIA2(I)/DIA1(I))**.17       DSIZ0400
     1         *((DENS1*VOT1(I))/(DENS2*VOT2(I)))**0.25                      DSIZ0410
 1130 CGAM =  1.44-0.00733*GAMMA(I)                                          DSIZ0414
      DBAR1(I)=DIAHW1*(STEN1/(DENS1*.356))**0.4 * CDBAR*CGAM                 DSIZ0420
C          0.356 = 17.(DYNES/CM)/47.7(LBM/FT3)                              DSIZ0430
      DBAR2(I)=DIAHW2*(STEN2/(DENS2*.356))**0.4 * CDBAR*CGAM                 DSIZ0440
      GO TO 1400                                                             DSIZ0450
 1150 IF(NPROP1(I).EQ.1)  PR = (VISC1*STEN1/DENS1)                           DSIZ0460
      IF(NPROP1(I).EQ.2)  PR = (VISC2*STEN2/DENS2)                           DSIZ0470
      CPR = (PR/RHOG)**0.25                                                  DSIZ0480
      DBAR1(I) = 1.524/( 2.64*SQRT(VOT1(I)/DIA1(I)) + 0.215/CPR*             DSIZ0490
     1           5.*(EPS-1.)/(EPS+3.)*ABS(480./EPS - VOT1(I)))               DSIZ0500
      IF(NPROP1(I).NE.NPROP2(I))  GO TO 1175                                 DSIZ0510
      DBAR2(I) = DBAR1(I)                                                    DSIZ0520
      GO TO 1400                                                             DSIZ0530
 1175 IF(NPROP2(I).EQ.1)  PR = VISC1*STEN1/DENS1                             DSIZ0540
      IF(NPROP2(I).EQ.2)  PR = VISC2*STEN2/DENS2                             DSIZ0550
      CPR = (PR/RHOG)**0.25                                                  DSIZ0560
      DBAR2(I) = 1.524/( 2.64*SQRT(VOT2(I)/DIA2(I)) + 0.215/CPR*             DSIZ0570
     1           5.*(EPS-1.)/(EPS+3.)*ABS(480./EPS - VOT2(I)))               DSIZ0580
      GO TO 1400                                                             DSIZ0590
 1250 D301 = 0.82*(DIA1(I)**.1036)*(DIA2(I)**.125)/((VOT1(I)**.086)*         DSIZ0600
     1           (VOT2(I)**.891))                                           DSIZ0610
      D302 = 1.65*(DIA2(I)**.68)/((VOT2(I)**.56)*(VOT1(I)**.568)*            DSIZ0620
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```
     1            (DIA1(I)**.555))                                          DSIZ0630
      AJA = 0.03                                                           DSIZ0640
      ABD = 310.                                                           DSIZ0650
      GO TO 1270                                                           DSIZ0660
 1270 DBAR1(I) = 1./(AJA*(1./D301) + ABD)                                  DSIZ0670
     1   *CDBAR                                                            DSIZ0672
      DBAR2(I) = 1./(AJA*(1./D302) + ABD)                                  DSIZ0680
     1   *CDBAR                                                            DSIZ0682
 1400 CONTINUE                                                             DSIZ0690
C                                                                          DSIZ0700
      IF(NPROP2(I).EQ.1) GO TO 1450                                        DSIZ0720
        AVD1(I) = DBAR1(I)                                                 DSIZ0730
        AVD2(I) = DBAR2(I)                                                 DSIZ0740
      GO TO 1500                                                           DSIZ0750
 1450   AVD1(I) = DBAR2(I)                                                 DSIZ0760
        AVD2(I) = DBAR1(I)                                                 DSIZ0770
 1500 CONTINUE                                                             DSIZ0800
C                                                                          DSIZ0810
      RETURN                                                               DSIZ9980
      END                                                                  DSIZ9990
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      SUBROUTINE  FANIN                                                    FANI0020
      COMMON /ELEM/ NEL, LSPEC(60), RADE(60), THETAE(60), ALFA(60)         FANI0100
      COMMON /FLSPEC/   NLSPEC,                                            FANI0120
     1NTYPE(10), NPROP1(10),NPROP2(10),DIA1(10),  DIA2(10),  CDDIA1(10),FANI0130
     2CDDIA2(10),ZE(10),    GAME(10),  BETA(10),  GAMMA(10), GAMFAN(10),FANI0140
     3SPFAN(10), SPEL(10),  DBAR1(10), DBAR2(10), WGT1(10),  WGT2(10),  FANI0150
     4AD1(10),   AD2(10),   VOT1(10),  VOT2(10),  SWD1(10),  SWD2(10),  FANI0160
     5WCT11(10), WCT12(10), WCT21(10), WCT22(10), TW1(10),   TW2(10),   FANI0170
     6AVD1(10),  AVD2(10),  XOW1L(10), XOW2L(10), XOW1R(10), XOW2R(10), FANI0180
     7SAL1(10),  SAL2(10),  SAR1(10),  SAR2(10),  VR1(10),   VR2(10),   FANI0190
     8VTH1(10),  VTH2(10),  VZ1(10),   VZ2(10),   ALFMOM(10)            FANI0200
      COMMON /SHAPEC/       SA1(10),   SB1(10),   SA2(10),   SB2(10)     FANI0220
C                                                                          FANI0718
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      DO 4000  I = 1,NEL                                                    FANI0720
 3900 SAR1(I)=SA1(I)                                                        FANI4900
      SAR2(I)=SA2(I)                                                        FANI4920
      SAL1(I)=SA1(I)                                                        FANI4940
      SAL2(I)=SA2(I)                                                        FANI4960
 4000 CONTINUE                                                              FANI4980
C                                                                           FANIN040
C * * DUMMY SUBROUTINE, PROVIDES NO INTERFERENCE BETWEEN SPRAY FANS.        FANIN060
C                                                                           FANIN080
      RETURN                                                                FANI9980
      END                                                                   FANI9990


      SUBROUTINE  MFLUX                                                     MFLX0020
      COMMON /ELEM/ NEL, LSPEC(60), RADE(60), THETAE(60), ALFA(60)          MFLX0100
      COMMON /ELSPEC/   NLSPEC,                                             MFLX0120
     1NTYPE(10), NPROP1(10),NPROP2(10),DIA1(10),  DIA2(10),  CDDIA1(10),MFLX0130
     2CDDIA2(10),ZE(10),    GAME(10),  BETA(10),  GAMMA(10), GAMFAN(10),MFLX0140
     3SPFAN(10), SPEL(10),  DBAR1(10), DBAR2(10), WOT1(10),  WOT2(10),  MFLX0150
     4AO1(10),   AO2(10),   VOT1(10),  VOT2(10),  SWO1(10),  SWO2(10),  MFLX0160
     5WOT11(10), WOT12(10), WOT21(10), WOT22(10), TW1(10),   TW2(10),   MFLX0170
     6AVO1(10),  AVO2(10),  XOW1L(10), XOW2L(10), XOW1R(10), XOW2R(10), MFLX0180
     7SAL1(10),  SAL2(10),  SAR1(10),  SAR2(10),  VR1(10),   VR2(10),   MFLX0190
     8VTH1(10),  VTH2(10),  VZ1(10),   VZ2(10),   ALFMOM(10)            MFLX0200
      COMMON /SHAPEC/       SA1(10),   SB1(10),   SA2(10),   SB2(10),   MFLX0220
     1SC11(10),  SC21(10),  SC31(10),  SC41(10),  SC51(10),  SC61(10),  MFLX0230
     2SC12(10),  SC22(10),  SC32(10),  SC42(10),  SC52(10),  SC62(10)   MFLX0240
      COMMON  /LABML/                                                     MFLX0400
     1  RADM(400), THETAM(400), STW1(400), STW2(400), STVR1(400)         MFLX0410
     2 ,STVR2(400), STVTH1(400), STVTH2(400), STVZ1(400), STVZ2(400)     MFLX0420
     7 ,STDD1(400), STDD2(400), TM1(400), STRW1(400), STRW2(400)         MFLX0440
     8 ,STRDD1(400), STRDD2(400), TM2(400)                               MFLX0460
     9 ,SVTH1A(400), SVTH2A(400)                                         MFLX0480
      COMMON /LAB1/         DRADM,     DTHETM,    ZOM,       THETAR,    MFLX0680
     1DPINJ1,    DPINJ2,    DENS1,     DENS2,     CKP1,      CKP2       MFLX0690
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     2,DNSAT1,   DNSAT2                                                    MFLX0700
      COMMON  /LAB3/   SWE1, SWE2, THER, THEL,                             MFLX0710
     1                 NRML, NTHML, NRWALL, NTHR, NTHL, MESH, NMESH        MFLX0711
      LOGICAL  TBNDY2                                                      MFLX0712
C                                                                          MFLX0720
      TBNDY2 = .TRUE.                                                      MFLX0728
      IF(NTHR.EQ.1 .AND. NTHL.EQ.NTHML)  TBNDY2 = .FALSE.                  MFLX0730
      FAREA = DRADM*DTHETM/57.2958                                         MFLX0732
      DENR31 = (DENS1/DNSAT1)**0.3333                                      MFLX0734
      DENR32 = (DENS2/DNSAT2)**0.3333                                      MFLX0738
      TMCS1 = 0.0                                                          MFLX0740
      TMCS2 = 0.0                                                          MFLX0760
        GAMMAX = 0.0                                                       MFLX0768
        DO 4000 I=1,NLSPEC                                                 MFLX0770
 4000   GAMMAX = AMAX1(GAMMAX,GAME(I))                                      MFLX0772
        ZODMIN = AMAX1(0.3, SIND(90.-GAMMAX))                              MFLX0774
      DO 5000  J=1,NMESH                                                   MFLX0780
C                                                                          MFLX0800
      SW1 = 0.                                                             MFLX0820
      SW2 = 0.                                                             MFLX0840
      SVR1 = 0.                                                            MFLX0860
      SVR2 = 0.                                                            MFLX0880
      SVTH1 = 0.                                                           MFLX0900
      SVTH2 = 0.                                                           MFLX0920
      SVZ1 = 0.                                                            MFLX0940
      SVZ2 = 0.                                                            MFLX0960
      SDD1 = 0.                                                            MFLX0980
      SDD2 = 0.                                                            MFLX1000
      SRW1 = 0.                                                            MFLX1020
      SRW2 = 0.                                                            MFLX1040
      SRDD1 = 0.                                                           MFLX1060
      SRDD2 = 0.                                                           MFLX1080
      RM = RADM(J)                                                         MFLX1090
      THM = THETAM(J)                                                      MFLX1092
C                                                                          MFLX1100
      DO 4500  L=1,NEL                                                     MFLX1120
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      I = LSPEC(L)                                                          MFLX1130
      IF(NTYPE(I).EQ.9) GO TO 4400                                          MFLX1140
      RE = RADE(L)                                                          MFLX1180
      THE = THETAE(L)                                                       MFLX1190
      DZ = ZOM - ZE(I)                                                      MFLX1192
C       (X,Y,Z) INJECTOR ELEMENT COORDINATES OF MESH POINT (RM,THM,ZOM)     MFLX1200
C         CYLINDRICAL TO RECTANGULAR  &  ORIGIN TRANSLATION TO ELEMENT      MFLX1202
          Y1 = RM*COSD(THM) - RE*COSD(THE)                                  MFLX1210
          Y2 = RM*SIND(THM) - RE*SIND(THE)                                  MFLX1220
          Y3 = DZ                                                           MFLX1230
C         ROTATION ABOUT Y3                                                 MFLX1240
          PHI = THE - 90. + ALFA(L)                                         MFLX1242
          CPHI = COSD(PHI)                                                  MFLX1244
          SPHI = SIND(PHI)                                                  MFLX1246
          U1 = Y1*CPHI + Y2*SPHI                                            MFLX1250
          U2 =-Y1*SPHI + Y2*CPHI                                            MFLX1252
          U3 = Y3                                                           MFLX1254
C         ROTATION ABOUT U2                                                 MFLX1260
          CBETA = COSD(BETA(I))                                             MFLX1262
          SBETA = SIND(BETA(I))                                             MFLX1264
          V1 = U1*CBETA - U3*SBETA                                          MFLX1266
          V2 = U2                                                           MFLX1268
          V3 = U1*SBETA + U3*CBETA                                          MFLX1270
C         ROTATION ABOUT V1                                                 MFLX1272
          ALF = GAMMA(I)  + ALFMOM(I)                                       MFLX1274
          CALF = COSD(ALF)                                                  MFLX1276
          SALF = SIND(ALF)                                                  MFLX1278
          X = V1                                                            MFLX1280
          Y = V2*CALF + V3*SALF                                             MFLX1290
          Z =-V2*SALF + V3*CALF                                             MFLX1300
      D = SQRT(Y1**2 + Y2**2 + Y3**2)                                       MFLX1310
        IF(Z/D.LT.ZCOMIN) GO TO 4500                                        MFLX1314
      VZ1(I) = VCT1(I) * DZ / D                                             MFLX1320
      VRTH = SQRT(AMAX1(VCT1(I)**2-VZ1(I)**2, 0.) )                         MFLX1340
      A = RE*SIND(THM-THE)                                                  MFLX1360
      B = RM-RE*COSD(THM-THE)                                               MFLX1380
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      C = SQRT(A**2+B**2)                                                MFLX1400
      IF(C.EQ.0.) C=1.0                                                  MFLX1420
      VR1(I) = VRTH*B/C                                                  MFLX1440
      VTH1(I)= VRTH*A/C                                                  MFLX1460
      VZ2(I) = VOT2(I)*DZ/D                                              MFLX1500
      VRTH = SQRT(AMAX1(VOT2(I)**2 - VZ2(I)**2, 0.) )                    MFLX1510
      VR2(I) = VRTH*B/C                                                  MFLX1520
      VTH2(I) = VRTH*A/C                                                 MFLX1540
      X=X/Z                                                              MFLX1700
      Y=Y/Z                                                              MFLX1720
      IF(X.GE.0.) GO TO 4150                                             MFLX1740
      SSA1 = SAL1(I)                                                     MFLX1760
      SSA2 = SAL2(I)                                                     MFLX1780
      GO TO 4200                                                         MFLX1800
 4150 SSA1 = SAR1(I)                                                     MFLX1820
      SSA2 = SAR2(I)                                                     MFLX1840
 4200   SSWC1 = SWC1(I)                                                  MFLX1860
        SSWC2 = SWC2(I)                                                  MFLX1880
      WC1J = SSWC1 * ( (1.+SC11(I)*Y+SC21(I)*Y*Y) +                      MFLX1940
     1 (SC31(I)*Y+SC41(I)*X*X) * (1.+SC51(I)*Y+SC61(I)*Y*Y) )            MFLX1960
     2                * EXP(-SSA1*X*X-SB1(I)*Y*Y) / Z**2                MFLX1980
      WC2J = SSWC2 * ( (1.+SC12(I)*Y+SC22(I)*Y*Y) +                      MFLX2000
     1 (SC32(I)*X+SC42(I)*X*X) * (1.+SC52(I)*Y+SC62(I)*Y*Y) )            MFLX2020
     2                * EXP(-SSA2*X*X-SB2(I)*Y*Y) / Z**2                MFLX2040
      IF(NTYPS(I).NE.2) GO TO 4220                                       MFLX2045
      WC1J = 2.0*WC1J                                                    MFLX2049
      WC2J =  0.0                                                        MFLX2051
 4220 CONTINUE                                                           MFLX2053
      IF(NPROP1(I).EQ.2) GO TO 4300                                      MFLX2060
      SW1 = SW1 + WC1J                                                   MFLX2080
      SW2 = SW2 + WC2J                                                   MFLX2100
      WVR1 = WC1J*VR1(I)                                                 MFLX2120
      WVR2 = WC2J*VR2(I)                                                 MFLX2140
      SVR1 = SVR1 + WVR1                                                 MFLX2160
      SVR2 = SVR2 + WVR2                                                 MFLX2180
      WVTH1 = WC1J*VTH1(I)                                               MFLX2200
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      WVTH2 = WC2J*VTH2(I)                                              MFLX2220
      SVTH1 = SVTH1 + WVTH1                                             MFLX2240
      SVTH2 = SVTH2 + WVTH2                                             MFLX2260
      WVZ1 = WC1J*VZ1(I)                                                MFLX2280
      WVZ2 = WC2J*VZ2(I)                                                MFLX2300
      SVZ1 = SVZ1 + WVZ1                                                MFLX2320
      SVZ2 = SVZ2 + WVZ2                                                MFLX2340
      WDD1 = WC1J*DBAR1(I)                                              MFLX2360
      WDD2 = WC2J*DBAR2(I)                                              MFLX2380
      SDD1 = SDD1 + WDD1                                                MFLX2400
      SDD2 = SDD2 + WDD2                                                MFLX2420
C          FOR  CRIF 1, PROP 1                                          MFLX2430
      IF(WC1J.LE.0.) GO TO 4250                                         MFLX2440
      A = CKP1*DZ/(12.*VZ1(I)*DBAR1(I)**2)                              MFLX2460
      IF(A.GE.1.) GO TO 4250                                            MFLX2480
      RWC1J = WC1J*(1.0 - A)**1.5                                       MFLX2500
      RWD1J = DBAR1(I)*((RWC1J/WC1J)**.33)*RWC1J                        MFLX2520
      SRW1 = SRW1 + RWC1J                                               MFLX2540
      SRDD1 = SRDD1 + RWD1J                                             MFLX2560
C          FOR  CRIF 2, PROP 2                                          MFLX2570
 4250 CONTINUE                                                          MFLX2580
      IF(WC2J.LE.0.) GO TO 4280                                         MFLX2600
      A = CKP2*DZ/(12.*VZ2(I)*DBAR2(I)**2)                              MFLX2620
      IF(A.GE.1.) GO TO 4280                                            MFLX2640
      RWC2J = WC2J*(1.0 - A)**1.5                                       MFLX2660
      RWD2J = DBAR2(I)* ((RWC2J/WC2J)**.33)*RWC2J                       MFLX2680
      SRW2 = SRW2 + RWC2J                                               MFLX2700
      SRDD2 = SRDD2 + RWD2J                                             MFLX2720
 4280 CONTINUE                                                          MFLX2740
      GO TO 4500                                                        MFLX2760
C                                                                       MFLX2780
 4300 SW1 = SW1 + WC2J                                                  MFLX2800
      SW2 = SW2 + WC1J                                                  MFLX2820
      WV21 = WC2J*VZ2(I)                                                MFLX2840
      WV12 = WC1J*VZ1(I)                                                MFLX2860
      SV21 = SV21 + WV21                                                MFLX2880
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      SVR2 = SVR2 + WVR2                                                MFLX2900
      WVTH1 = WC2J*VTH2(I)                                              MFLX2920
      WVTH2 = WC1J*VTH1(I)                                              MFLX2940
      SVTH1 = SVTH1 + WVTH1                                             MFLX2960
      SVTH2 = SVTH2 + WVTH2                                             MFLX2980
      WVZ1 = WC2J*VZ2(I)                                                MFLX3000
      WVZ2 = WC1J*VZ1(I)                                                MFLX3020
      SVZ1 = SVZ1 + WVZ1                                                MFLX3040
      SVZ2 = SVZ2 + WVZ2                                                MFLX3060
      WDD1 = WC2J*DBAR2(I)                                              MFLX3080
      WDD2 = WC1J*DBAR1(I)                                              MFLX3100
      SDD1 = SDD1 + WDD1                                                MFLX3120
      SDD2 = SDD2 + WDD2                                                MFLX3140
C          FOR  CRIF 1, PROP 2                                          MFLX3150
      IF(WC1J.LE.0.) GO TO 4350                                         MFLX3160
      A = CKP2*DZ/(12.*VZ1(I)*DBAR1(I)**2)                              MFLX3180
      IF(A.GE.1.) GO TO 4350                                            MFLX3200
      RWC1J = WC1J*(1.0 - A)**1.5                                       MFLX3220
      RWDD1J = DBAR1(I)*((RWC1J/WC1J)**.33)*RWC1J                       MFLX3240
      SPW2 = SPW2 + RWC1J                                               MFLX3260
      SPDD2 = SPDD2 + RWDD1J                                            MFLX3280
C          FOR  CRIF 2, PROP 1                                          MFLX3290
 4350 IF(WC2J.LE.0.) GO TO 4380                                         MFLX3300
      A = CKP1*DZ/(12.*VZ2(I)*DBAR2(I)**2)                              MFLX3320
      IF(A.GE.1.) GO TO 4380                                            MFLX3340
      RWC2J = WC2J*(1.0 - A)**1.5                                       MFLX3360
      RWDD2J = DBAR2(I)*((RWC2J/WC2J)**.33)*RWC2J                       MFLX3380
      SPW1 = SPW1 + RWC2J                                               MFLX3400
      SPDD1 = SPDD1 + RWDD2J                                            MFLX3420
 4380 CONTINUE                                                          MFLX3440
      GO TO 4500                                                        MFLX3460
 4400 CONTINUE                                                          MFLX3480
 4500 CONTINUE                                                          MFLX3500
C                                                                       MFLX3510
C          E N D   I   D O   L O O P                                    MFLX3512
C                                                                       MFLX3514
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      STW1(J) = SW1                                                    MFLX3520
      STW2(J) = SW2                                                    MFLX3540
        IF(SW1.EQ.0.) SW1 = 1.                                         MFLX3550
        IF(SW2.EQ.0.) SW2 = 1.                                         MFLX3552
      SVTH1A(J) = SVTH1                                                MFLX3560
      SVTH2A(J) = SVTH2                                                MFLX3580
      STVR1(J) = SVR1/SW1                                              MFLX3600
      STVR2(J) = SVR2/SW2                                              MFLX3620
      STVTH1(J) = SVTH1/SW1                                            MFLX3640
      STVTH2(J) = SVTH2/SW2                                            MFLX3660
      STVZ1(J) = SVZ1/SW1                                              MFLX3680
      STVZ2(J) = SVZ2/SW2                                              MFLX3700
      STDD1(J) = SDD1/SW1                                              MFLX3720
      STDD2(J) = SDD2/SW2                                              MFLX3740
      STRW1(J) = SRW1                                                  MFLX3760
      STRW2(J) = SRW2                                                  MFLX3780
        IF(SRW1.EQ.0.) SRW1 = 1.                                       MFLX3790
        IF(SRW2.EQ.0.) SRW2 = 1.                                       MFLX3792
      STRDD1(J) = DENR31*SRDD1/SRW1                                    MFLX3800
      STRDD2(J) = DENR32*SRDD2/SRW2                                    MFLX3820
      DAREA = RADM(J)*FAREA                                            MFLX3830
      IF(J.LE.NTHML)  DAREA = 1.125*DAREA                              MFLX3840
      IF(TENDY2)  GO TO 4900                                           MFLX3842
      IF(THM.EQ.THETAM(1) .OR. THM.EQ.THETAM(NTHML))  DAREA = 0.5*DAREA MFLX3850
 4900 CONTINUE                                                         MFLX3858
      TM1(J) = STW1(J)*DAREA                                           MFLX3860
      TM2(J) = STW2(J)*DAREA                                           MFLX3880
      TMCS1 = TMCS1+ TM1(J)                                            MFLX3900
 5000 TMCS2 = TMCS2 + TM2(J)                                           MFLX3920
C                                                                      MFLX3930
C       E N D   J   D O   L O O P                                      MFLX3932
C                                                                      MFLX3934
      RCONT1 =  SWE1/TMCS1                                             MFLX4185
      RCONT2 =  SWE2/TMCS2                                             MFLX4190
      DO 6100  J= 1,NMESH                                              MFLX4195
      STRW1(J) = RCONT1*STRW1(J)                                       MFLX4200
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      STRW2(J) = RCONT2*STRW2(J)                                        MFLX4210
      STW1(J) = STW1(J)*RCONT1                                          MFLX4213
      STW2(J)= RCONT2*STW2(J)                                           MFLX4216
      TM1(J) = RCONT1*TM1(J)                                            MFLX4218
      TM2(J) = RCONT2*TM2(J)                                            MFLX4219
  6100 CONTINUE                                                         MFLX4220
      RETURN                                                            MFLX9960
      END                                                               MFLX9990


      SUBROUTINE BNDY(JSYM,NRBR,NRBL)                                   BNDY0010
C                                                                       BNDY0020
      COMMON  /LAMB/   SWE1, SWE2, THER, THEL,                          BNDY0024
     1                 NR, NT, NRW, NTR, NTL, MESH, NMESH               BNDY0026
      COMMON  /LAMBL/                                                   BNDY0030
     1  RAD(400), THETA(400), STW1(400), STW2(400), STVR1(400)          BNDY0032
     2 ,STVR2(400), STVTH1(400), STVTH2(400), STVZ1(400), STVZ2(400)    BNDY0034
     3 ,STD01(400), STD02(400), TM1(400), STRW1(400), STRW2(400)        BNDY0036
     4 ,STRD01(400), STRD02(400), TM2(400), SVTH1A(400), SVTH2A(400)    BNDY0038
C                                                                       BNDY0040
C     JSYM=TYPE SYMMETRY-  1 FOR MIRROR IMAGE,   2 FOR REPEATING IMAGE  BNDY0041
C     NRBR,NRBL- LENGTH IN RADIAL STEPS OF BAFFLES ALONG RIGHT (CW)     BNDY0042
C       AND LEFT (CCW) BOUNDARIES                                       BNDY0043
C     NR=NUMBER OF RADIAL STEPS,   NT=THETA STEPS                       BNDY0044
C     NRW=RADIAL STEPS TO WALL,    NTR=THETA STEP RIGHT HAND (CW) BNDY  BNDY0045
C     NTL=THETA STEP LEFT HAND (CCW) BNDY                               BNDY0046
C                                                                       BNDY0050
C     FILL IN FLOW VALUES FROM OUTSIDE OF RADIAL WALL BNDY              BNDY0058
      NDR = NR-NRW                                                      BNDY0060
      IF(NDR.LT.1) GO TO 100                                            BNDY0070
      J1 = (NRW-1)*NT+1                                                 BNDY0080
      J2 = J1+NT-1                                                      BNDY0090
        DO  90 JIN=J1,J2                                                BNDY0100
        J3 = JIN+NT                                                     BNDY0110
        J4 = JIN+NDR*NT                                                 BNDY0120
```

```
            DO  90 JOUT=JA,JB,NT                                          BNDY0130
   90       CALL  SUMM(JIN,JOUT)                                          BNDY0140
C                                                                        BNDY0150
C       FOLD  IN  FLOW  VALUES  FROM  OUTSIDE  OF  RIGHT (CW)  BNDY      BNDY0158
  100 N = NTR-1                                                          BNDY0160
      IF(N.LT.1) GO TO 200                                               BNDY0170
      IF(NRBR.LT.1) GO TO 150                                            BNDY0180
C        INNER, RADIAL  BAFFLE  ZONE                                     BNDY0188
      J2 = (NRBR-1)*NT + NTR                                             BNDY0190
        DO 140 JIN=NTR,J2,NT                                             BNDY0200
        JA = JIN-N                                                       BNDY0210
        JB = JIN-1                                                       BNDY0220
          DO 140 JOUT=JA,JB                                              BNDY0230
  140     CALL  SUMM(JIN,JOUT)                                           BNDY0240
  150 IF(NRBR.GE.NRW) GO TO 200                                          BNDY0250
C        OUTSIDE  BAFFLE  ZONE                                           BNDY0258
      I1 = NRBR+1                                                        BNDY0260
      IT2 = NTR                                                          BNDY0262
      IF(JSYM.GT.1) IT2=N                                                BNDY0264
        DO 190 IR=I1,NRW                                                 BNDY0270
          DO 190 IT=1,IT2                                                BNDY0280
          IF(JSYM.LE.1) ITIN=NTR+NTR-IT                                  BNDY0290
          IF(JSYM.GT.1) ITIN=NTL-NTR+IT                                  BNDY0300
          J = (IR-1)*NT                                                  BNDY0310
          JIN = J+ITIN                                                   BNDY0320
          JOUT = J+IT                                                    BNDY0330
C         ADJUSTMENT OF MEAN DROP VELOCITY COMPONENTS AT RH BNDY         BNDY0331
          CALL SUMV(JSYM,JIN,JOUT)                                       BNDY0332
  190     CALL  SUMM(JIN,JOUT)                                           BNDY0340
C                                                                        BNDY0350
C       FOLD  IN  FLOW  VALUES  FROM  OUTSIDE  OF  LEFT (CCW)  BNDY      BNDY0358
  200 N = NT-NTL                                                         BNDY0360
      IF(N.LT.1) GO TO 300                                               BNDY0370
      IF(NRBL.LT.1) GO TO 250                                            BNDY0380
C        INNER, RADIAL  BAFFLE  ZONE                                     BNDY0388
      J2 = NRBL*NT                                                       BNDY0390
```

```
      DO 240 JIN=NTL,J2,NT                                              BNDY0400
      JA = JIN+1                                                        BNDY0410
      JB = JIN+N                                                        BNDY0420
        DO 240 JOUT=JA,JB                                               BNDY0430
240     CALL  SUMM(JIN,JOUT)                                            BNDY0440
250   IF(NRBL.GE.NRW) GO TO 300                                         BNDY0450
C       OUTSIDE  OF  BAFFLE  ZONE                                       BNDY0458
      I1 = NRBL+1                                                       BNDY0460
        DO 290 IR=I1,NRW                                                BNDY0470
      IT1 = NTL                                                         BNDY0480
      IF(JSYM.GT.1) IT1=NTL+1                                           BNDY0482
        DO 290 IT=IT1,NT                                                BNDY0490
        IF(JSYM.LE.1) ITIN=NTL+NTL-IT                                   BNDY0500
        IF(JSYM.GT.1) ITIN=IT-NTL+NTR                                   BNDY0510
        J = (IR-1)*NT                                                   BNDY0511
        JIN = J+ITIN                                                    BNDY0512
        JOUT = J+IT                                                     BNDY0513
C       ADJUSTMENT OF MEAN DROP VELOCITY COMPONENTS AT LH BNDY          BNDY0515
        CALL SUMV(JSYM,JIN,JOUT)                                        BNDY0516
290     CALL  SUMM(JIN,JOUT)                                            BNDY0520
C                                                                       BNDY0530
300   CONTINUE                                                          BNDY0540
      IF(JSYM.GT.1.AND.NRBR.LT.NRW) CALL SUM2(NRBR)                     BNDY0542
C       TO ADJ FLOW VALUES AT RH AND LH BNDYS FOR REPEATING IMAGE SYM   BNDY0543
C                                                                       BNDY0544
C       ZERO OUT RADIAL COMPONENT OF DROP VELOCITY AT WALL              BNDY0546
      N = (NRW-1)*NT                                                    BNDY0550
       DO 320 J=NTR,NTL                                                 BNDY0560
       K = N+J                                                          BNDY0570
       STV21(K) = 0.                                                    BNDY0580
320    STV22(K) = 0.                                                    BNDY0590
C                                                                       BNDY0600
C       ZERO OUT THETA COMPONENT OF DROP VELOCITY AT THETA BNDY, JSYM=1  BNDY0608
C         AND ALONG BAFFLE IF JSYM=0 OR2                                BNDY0609
      J2 = NT*NRW                                                       BNDY0610
      KB = NT*(NRBR-1)+NTR                                              BNDY0612
```

```
      LB = NT*(NRBL-1)+NTL                                              BNDY0614
       DO 340 J=1,J2,NT                                                 BNDY0620
       K = J+NTR-1                                                      BNDY0630
       L = J+NTL-1                                                      BNDY0640
       IF(JSYM.NE.1 .AND. K.GT.KB) GO TO 330                            BNDY0646
       STVTH1(K) = 0.                                                   BNDY0650
       STVTH2(K) = 0.                                                   BNDY0660
  330  IF(JSYM.NE.1 .AND. L.GT.LB) GO TO 340                            BNDY0666
       STVTH1(L) = 0.                                                   BNDY0670
       STVTH2(L) = 0.                                                   BNDY0680
  340  CONTINUE                                                         BNDY0682
C                                                                      BNDY0690
  350 CONTINUE                                                         BNDY0700
C         ADJUST FLUX AT CHAMBER WALL TO COMPRESS DOWN TO 1/2 DELTA AREABNDY0710
      J1 = (NRW-1)*NT + NTR                                            BNDY0730
      J2 = (NRW-1)*NT + NTL                                            BNDY0740
      JI = 1                                                           BNDY0750
      IB = 1                                                           BNDY0760
      FNW = 4.*NRW                                                     BNDY0762
      FW = 2.*FNW/(FNW - 1.)                                           BNDY0764
C                                                                      BNDY0768
  360   DO 370 JB=J1,J2,JI                                             BNDY0770
        STW1(JB)  = STW1(JB)*FW                                        BNDY0780
        STW2(JB)  = STW2(JB)*FW                                        BNDY0790
        STRW1(JB) = STRW1(JB)*FW                                       BNDY0800
  370   STRW2(JB) = STRW2(JB)*FW                                       BNDY0810
C         ADJUST FLOWRATES AT CENTER & RADIAL BOUNDARIES FOR DELTA AREASBNDY0812
      J1 = NTR                                                         BNDY0813
      GO TO 360                                                        BNDY0814
  372   DO 376 JB=J1,J2,JI                                             BNDY0816
        TM1(JB) = F*TM1(JB)                                            BNDY0818
  376   TM2(JB) = F*TM2(JB)                                            BNDY0819
      GO TO (380,390,400),IB                                           BNDY0820
C                                                                      BNDY0822
  380 IF(NTR.EQ.1 .AND. NTL.EQ.NT) GO TO 400                           BNDY0830
C         RIGHT (CW) BNDY                                              BNDY0836
```

```
      IB = 2                                                          BNDY0840
      F = 0.5                                                         BNDY0850
      J2 = NT*NRW                                                     BNDY0860
      J1 = NT                                                         BNDY0870
      GO TO 372                                                       BNDY0880
C                                                                     BNDY0882
  390 IB = 3                                                          BNDY0890
C         LEFT (CCW) BNDY                                           BNDY0896
      J1 = NTL                                                        BNDY0900
      GO TO 372                                                       BNDY0910
C                                                                     BNDY0912
  400 CONTINUE                                                        BNDY0920
C                                                                     BNDY0930
      RETURN                                                          BNDY1200
      END                                                             BNDY1210


      SUBROUTINE  SUMM(J,K)                                           SUM00010
      COMMON  /LAB3/   SWE1, SWE2, THER, THEL,                        SUM00014
     1                 NR, NT, NRW, NTR, NTL, MESH, NMESH             SUM00016
      COMMON  /LABML/  X1(800), A1(400), A2(400),                     SUM00020
     1 VR1(400), VR2(400), VT1(400), VT2(400), X2(1600),A3(400), A4(400)SUM00022
     2 ,A5(400), A6(400), A7(400), A8(400)                            SUM00024
C                                                                     SUM00028
C         CALC  AREA  AT J                                          SUM00030
          AJ1 = A3(J)/A1(J)                                           SUM00032
          AJ2 = A8(J)/A2(J)                                           SUM00034
C         CALC & SAVE INITIAL VALUES OF TOTAL MASS MINUS VAP AT J & K SUM00040
       TRM1J=A3(J)*A4(J)/A1(J)                                        SUM00042
       TRM1K=A3(K)*A4(K)/A1(K)                                        SUM00044
       TRM2J=A8(J)*A5(J)/A2(J)                                        SUM00046
       TRM2K=A8(K)*A5(K)/A2(K)                                        SUM00048
C          TM1 & 2   MASS, NO VAP                                     SUM00050
      A3(J) = A3(J)+A3(K)                                             SUM00052
      A8(J) = A8(J)+A8(K)                                             SUM00054
```

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C          STW1 & 2   MASS FLUX, NO VAP                                    SUM00060
      A1(J) = A3(J)/AJ1                                                    SUM00062
      A2(J) = A8(J)/AJ2                                                    SUM00064
C          STRW1 & 2  MASS FLUX REDUCED BY VAPORIZATION                    SUM00070
      A4(J) = (TRM1J+TRM1K)/AJ1                                            SUM00072
      A5(J) = (TRM2J+TRM2K)/AJ2                                            SUM00074
C          STRDD1 & 2   AV DROP DIAMETER REDUCED BY VAP                    SUM00080
      A6(J) = (A6(J)*TRM1J + A6(K)*TRM1K) / (TRM1J+TRM1K)                  SUM00082
      A7(J) = (A7(J)*TRM2J + A7(K)*TRM2K) / (TRM2J+TRM2K)                  SUM00084
      RETURN                                                               SUM00110
      END                                                                  SUM00120


      SUBROUTINE                                                           SUM00190
     X     SUM2(NRB)                                                       SUM00200
      COMMON  /LAB3/   SWE1, SWE2, THER, THEL,                             SUM00201
     1                 NR, NT, NRW, NTR, NTL, MESH, NMESH                  SUM00202
      COMMON  /LABML/  X1(800), A1(400), A2(400),                          SUM00203
     1 VR1(400), VR2(400), VT1(400), VT2(400), X2(1600),A3(400), A4(400)   SUM00204
     2 ,A5(400), A6(400), A7(400), A8(400)                                 SUM00206
      I1 = NRB+1                                                           SUM00210
      F = 0.5                                                              SUM00212
      DO 50 IR=I1,NRW                                                      SUM00220
      J = (IR-1)*NT                                                        SUM00230
      K = J+NTR                                                            SUM00240
      L = J+NTL                                                            SUM00250
        A3(L) = F*(A3(L)+A3(K))                                            SUM00300
        A3(K) = A3(L)                                                      SUM00310
        A8(L) = F*(A8(L)+A8(K))                                            SUM00318
        A8(K) = A8(L)                                                      SUM00320
        A1(L) = F*(A1(L)+A1(K))                                            SUM00338
        A1(K) = A1(L)                                                      SUM00340
        A2(L) = F*(A2(L)+A2(K))                                            SUM00348
        A2(K) = A2(L)                                                      SUM00350
                                    *A4(K)) /(A4(L)+A4(K))                 SUM00352
```

```
      A7(L) = (A7(L)*A5(L)+A7(K)*A5(K))/(A5(L)+A5(K))                    SUM00354
      A4(L) = F*(A4(L)+A4(K))                                            SUM00358
      A4(K) = A4(L)                                                      SUM00360
      A5(L) = F*(A5(L)+A5(K))                                            SUM00368
      A5(K) = A5(L)                                                      SUM00370
      A6(K) = A6(L)                                                      SUM00380
      A7(K) = A7(L)                                                      SUM00390
   50 CONTINUE                                                           SUM00500
      RETURN                                                             SUM00505
      END                                                                SUM00510


      SUBROUTINE                                                         SUM00590
     X     SUMV(JSYM,J,K)                                                SUM00600
      COMMON /LAB3/   SWE1, SWE2, THER, THEL,                            SUM00601
     1                NR, NT, NRW, NTR, NTL, MESH, NMESH                 SUM00602
      COMMON  /LABML/  X1(800), A1(400), A2(400),                        SUM00603
     1 VR1(400), VR2(400), VT1(400), VT2(400), X2(1600),A3(400), A4(400)SUM00604
     2 ,A5(400), A6(400), A7(400), A8(400)                               SUM00606
      S = 1.                                                             SUM00610
      IF(JSYM.EQ.1) S=-1.                                                SUM00620
      VT1(J) = (A1(J)*VT1(J)+S*A1(K)*VT1(K)) / (A1(J)+A1(K))             SUM00630
      VT2(J) = (A2(J)*VT2(J)+S*A2(K)*VT2(K)) / (A2(J)+A2(K))             SUM00640
      VR1(J) = (A1(J)*VR1(J)+A1(K)*VR1(K)) / (A1(J)+A1(K))               SUM00650
      VR2(J) = (A2(J)*VR2(J)+A2(K)*VR2(K)) / (A2(J)+A2(K))               SUM00660
      RETURN                                                             SUM00900
      END                                                                SUM00910
```

```
      FUNCTION  FTSSA(D1,D2,RMOM,C4)                                    FTSA0010
C                                                                       FTSA0020
C       CALCULATES A AND C4 FOR CENTER ORIFICE OF TRIPLET ELEMENT       FTSA0030
C                 TYPE 4 ELEMENT                                        FTSA0040
      DIMENSION TM(11), TD(2), TA(11,2),TC4(11,2)                       FTSA0050
      DATA TM,TD/0.3,0.4,0.6,0.7,1.0,1.5,2.0,3.,4.,5.,6.,.067,.13/      FTSA0060
      DATA TA/35.,27.,18.,15.,12.,7.5,5.3,3.5,2.6,2.1,1.7,15.,11.,7.5,6.FTSA0070
     X6,4.8,3.3,2.5,1.8,1.4,1.,1./                                      FTSA0080
      DATA TC4/40.,38.,34.,32.,28.,25.,22.,17.,15.,13.,12.,22.,20.,17.,1FTSA0090
     X6.,14.,12.,10.,9.,8.,6.,6./                                       FTSA0100
C                                                                       FTSA0110
      D = AMAX1(D1,.067)                                                FTSA0120
      D = AMIN1(D,.130)                                                 FTSA0130
      CALL ITRP2(RMOM,TM,11,2,D,TD,2,2,TA,11,FTSSA)                     FTSA0140
      CALL ITRP2(RMOM,TM,11,2,D,TD,2,2,TC4,11,C4)                       FTSA0150
      RETURN                                                            FTSA0160
      END                                                               FTSA0170
                                                                        FTSA0180


      FUNCTION FTSSB(D1,D2,RMOM,C2)                                     FTSB0010
C                                                                       FTSB0020
C       CALCULATES B AND C2 FOR CENTER  ORIFICE OF TRIPLET ELEMENT      FTSB0030
C                 TYPE 4 ELEMENT                                        FTSB0040
      DIMENSION TM(11),TD(2), TB(11,2)                                  FTSB0050
      DATA TM,TD/0.3,0.4,0.6,0.7,1.0,1.5,2.0,3.,4.,5.,6.,.067,.13/      FTSB0060
      DATA TB/150.,150.,120.,80.,45.,23.,14.,10.,7.,5.,5.,130.,130.,70.,FTSB0070
     X55.,32.,18.,12.,8.,5.,5.,5./                                      FTSB0080
C                                                                       FTSB0090
      D = AMAX1(D1,.067)                                                FTSB0100
      D = AMIN1(D,.130)                                                 FTSB0110
      CALL ITRP2(RMOM,TM,11,2,D,TD,2,2,TB,11,FTSSB)                     FTSB0120
      C2 = 0.0                                                          FTSB0130
      RETURN                                                            FTSB0140
      END                                                               FTSB0150
```

```
      FUNCTION  FTDSA(D1,D2,RMOM,C4)                                    FTDA0010
C                                                                       FTDA0020
C       CALCULATES A AND C4 FOR DOUBLE ORIFICE OF TRIPLET ELEMENT       FTDA0030
C             TYPE 4 ELEMENT                                            FTDA0040
      DIMENSION TM(11), TD(2), TA(11,2)                                 FTDA0050
      DATA TM,TD/0.3,0.4,0.5,0.6,0.8,1.0,2.0,3.,4.,6.,8.,.043,.085/     FTDA0060
      DATA TA/14.,11.,8.3,7.2,6.,5.5,4.5,4.,3.7,3.4,3.3,13.0,9.5,7.3,6.2FTDA0070
     X,5.3,4.8,4.0,3.7,3.5,3.3,3.2/                                     FTDA0080
C                                                                       FTDA0090
      D = AMAX1(D1,.043)                                                FTDA0100
      D = AMIN1(D,.085)                                                 FTDA0110
      CALL ITRP2(RMOM,TM,11,2,D,TD,2,2,TA,11,FTDSA)                     FTDA0120
      C4 = 0.0                                                          FTDA0130
      RETURN                                                            FTDA0140
      END                                                               FTDA0150


      FUNCTION  FTDSB(D1,D2,RMOM,C2)                                    FTDB0010
C                                                                       FTDB0020
C       CALCULATES B AND C2 FOR DOUBLE ORIFICE OF TRIPLET ELEMENT       FTDB0030
C             TYPE 4 ELEMENT                                            FTDB0040
      DIMENSION TM(11), TD(2), TB(11,2)                                 FTDB0050
      DATA TM,TD/0.3,0.4,0.5,0.6,0.8,1.0,2.0,3.,4.,6.,8.,.043,.085/     FTDB0060
      DATA TB/180.,180.,150.,140.,100.,80.,35.,23.,17.,11.,8.,100.,100.,FTDB0070
     X60.,55.,33.,25.,15.,13.,12.,10.,7./                               FTDB0080
C                                                                       FTDB0090
      D = AMAX1(D1,.043)                                                FTDB0100
      D = AMIN1(D,.085)                                                 FTDB0110
      CALL ITRP2(RMOM,TM,11,2,D,TD,2,2,TB,11,FTDSB)                     FTDB0120
      C2 = 0.0                                                          FTDB0130
      RETURN                                                            FTDB0140
      END                                                               FTDB0150
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      FUNCTION FPDSA(A,B,C,D)                                          00000100
      RETURN                                                           00000110
      END                                                              00000120


      FUNCTION FPSSA(A,B,C,D)                                          00000130
      RETURN                                                           00000140
      END                                                              00000150


      FUNCTION   FSA (D1,D2, GAM,DEN, C4)                              FSA00010
C                                                                      FSA00020
C       CALCULATES  A & K4  FOR LIKE AND UNLIKE DOUBLETS               FSA00030
C          TYPE 1&2 ELEMENTS                                           FSA00040
      DIMENSION  TD(4), TG(3), TA(4,3), TRD(10), TRD1(9), TRA(10),     FSA00050
     X TRC4(9)                                                         FSA00060
C                                                                      FSA00070
      DATA TD,TG/ .020,.040,.052,.079, 50.,60.,70./                    FSA00080
      DATA TA/ 22.,14.1,11.2,9., 14.2,9.3,7.4,6.8, 11.2,8.3,5.4,5.8/   FSA00090
      DATA TRD / 0.1,0.6,0.8,1.0,1.2,  1.4,1.6,1.8,2.0,10./            FSA00100
      DATA TRA / 0.8,.85,.90,1.0,1.09, 1.14,1.16,1.18,1.2,1.25/        FSA00110
      DATA TRD1/ 1.0, 1.1, 1.2, 1.3, 1.4, 1.6, 1.8, 2.0, 10./          FSA00120
      DATA TRC4/ 1.0,1.38,1.55,1.68,1.78,1.94,2.12,2.28,8.27/          FSA00130
C                                                                      FSA00140
      D = AMIN1(D1,0.10)                                               FSA00150
      G = AMAX1(GAM,40.)                                               FSA00160
      G = AMIN1(G,80.)                                                 FSA00170
C                                                                      FSA00180
      CALL ITRP2(D,TD,4,2, G,TG,3,2, TA,4, FSA)                        FSA00190
      FSA = FSA * (DEN/62.4)**0.21                                     FSA00195
      C4 = FSA                                                         FSA00200
      RD = D2/D1                                                       FSA00210
      IF(RD.EQ.1.) GO TO 100                                           FSA00220
      FSA = FSA*YCF(RD,TRD,TRA,10,2)                                   FSA00230
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      IF(RD.LT.1.) RD=1./RD                                                    FSA00240
      C4 = C4*YCF(RD,TRC1,TRC4,9,2)                                            FSA00250
C                                                                              FSA00260
  100 RETURN                                                                   FSA00500
      END                                                                      FSA00510


      SUBROUTINE   FSB (J, D1,D2, WU1,WU2, GAM)                                FSB00010
C                                                                              FSB00020
C      CALCULATES  S AND C1,2,3,5&6  SPRAY SHAPE COEFFICIENTS                  FSB00030
C        FOR TYPE  1 AND 2  ELEMENTS                                           FSB00040
C                                                                              FSB00050
      DIMENSION  TPM(5), TRD(5), TG(10), TB1(5,5), TB2(5,5), TBF(10),          FSB00060
     X           IR(6)                                                         FSB00062
      COMMON /SHAPEC/       SA1(10),   SB1(10),   SA2(10),   SB2(10),        FSB00070
     1SC11(10),  SC21(10),  SC31(10),  SC41(10),  SC51(10),  SC61(10),        FSB00072
     2SC12(10),  SC22(10),  SC32(10),  SC42(10),  SC52(10),  SC62(10)         FSB00074
      DATA  TPM/ 1.0, 1.2, 1.4, 1.6, 1.8/                                      FSB00080
      DATA  TRD/ 1.0, 1.2, 1.36,1.6, 1.8/                                      FSB00090
      DATA  TG/  45., 47.5, 50., 52.5, 55.,  57.5, 60., 62.5, 65., 70./        FSB00100
      DATA  TB1/ 35.0,34.7,33.8,32.1,29.2,  21.0,26.1,29.5,30.0,29.0,          FSB00110
     1           13.2,21.3,26.5,28.3,28.0,   7.4,14.5,20.5,24.0,25.2,         FSB00120
     2            4.7,10.4,15.8,19.8,21.6/                                    FSB00130
      DATA  TB2/ 35.0,36.7,37.8,36.5,39.0,  23.0,27.5,34.6,39.0,40.3,          FSB00140
     1           19.1,23.5,31.2,36.8,38.0,  15.3,19.2,25.3,30.7,34.0,          FSB00150
     2           13.3,16.2,19.5,23.5,28.4/                                     FSB00160
      DATA  TBF/ 2.22,1.86,1.60,1.38,1.22,  1.11,1.00,0.92,0.84,0.69/          FSB00170
C                                                                              FSB00180
      IERR = 0                                                                 FSB00190
      DO 10 I=1,6                                                              FSB00200
   10 IR(I) = 0                                                                FSB00210
      GAM1 = AMAX1(40.,AMIN1(80.,GAM))                                         FSB00212
      IF(GAM.LT.40. .OR. GAM.GT.80.)                    IR(1) = 1              FSB00220
      IF(D1.LT.0.03 .OR. D2.LT.0.03 .OR. D1.GT.0.09 .OR. D2.GT.0.09)           FSB00230
     X                                                  IR(2) = 1              FSB00240
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```
      IF(WU1.LT.WU2 .AND. D1.GT.D2)                    IR(3) = 1          FSB00250
      IF(WU1.GT.WU2 .AND. D1.LT.D2)                    IR(4) = 1          FSB00260
      IF(D1.LE.D2)  RD = D2/D1                                            FSB00270
      IF(D1.GT.D2)  RD = D1/D2                                            FSB00280
      IF(WU1.LE.WU2)  RM = WU2/WU1                                        FSB00290
      IF(WU1.GT.WU2)  RM = WU1/WU2                                        FSB00300
      IF(ABS(RM/RD-1.0).GT.0.2)                        IR(5) = 1          FSB00310
       DO 20 I=1,5                                                        FSB00320
       IF(IR(I).NE.0) GO TO 30                                            FSB00330
   20 CONTINUE                                                            FSB00340
      GO TO 50                                                            FSB00350
C                                                                         FSB00360
   30 ISKP =1                                                             FSB00370
      WRITE(6,40) GAM,D1,D2,WU1,WU2,(IR(I),I=1,5)                         FSB00380
   40 FORMAT(1H1//3BX34HE AND C1  SPRAY SHAPE COEFFICIENTS /// 45X        FSB00390
     1 19HI  N  V  A  L  I  D /// 18X  70HIMPINGEMENT ANGLE,  ORIFICE DIFSB00400
     2AMETER  AND/OR  MOMENTUM  RELATIONSHIPS ///36X 37HBEYOND  EMPIRIFSB00410
     3ICAL  CORRELATION  RANGE /////    41X      26HREFER TO SUBPROGRFSB00420
     4AM  FSB  ///19X 23HGAM, D1, D2, WU1, WU2 - 3F8.4, 1P2E12.4 //      FSB00430
     5 37X 7HIR(I) = 5I4 )                                               FSB00440
C                                                                         FSB00450
   50 CALL  ITRP2(RM,TRM,5,2, RD,TRD,5,2, TB1,5, B160)                    FSB00460
      CALL  ITRP2(RM,TRM,5,2, RD,TRD,5,2, TB2,5, B260)                    FSB00470
      BF = YOF(GAM1,TG,TBF,10,2)                                          FSB00480
        IF(D1.GT.D2) GO TO 60                                             FSB00490
      B1 = BF*B160                                                        FSB00500
      B2 = BF*B260                                                        FSB00510
        GO TO 70                                                          FSB00520
   60 B1 = BF*B360                                                        FSB00530
      B2 = BF*B160                                                        FSB00540
   70 TANG2 = TAN(GAM1/(2.*57.2958))                                      FSB00550
      BMIN = 1./(12.56*TANG2**2)                                          FSB00552
      IF(B1.GE.BMIN .AND. B2.GE.BMIN) GO TO 74                            FSB00554
       IR(6) = 1                                                          FSB00556
       B1 = AMAX1(BMIN,B1)                                                FSB00557
       B2 = AMAX1(BMIN,B2)                                                FSB00558
```

```
   74 YM = TANG2*(WU1-WU2)/(WU1+WU2)                                          FSB00560
      WUD1 = WU1/D1                                                           FSB00570
      WUD2 = WU2/D2                                                           FSB00580
      YCM = TANG2*(WUD1-WUD2)/(WUD1+WUD2)                                     FSB00590
      Y1B = TANG2                                                             FSB00610
      Y2B =-TANG2                                                             FSB00620
      XY1A = 0.96                                                             FSB00630
      XY2A = 0.96                                                             FSB00640
      IF(WUD1.LT.WUD2 .AND. WU1.LT.WU2)   XY1A = 0.96+0.06*(RD-1.0)           FSB00650
      IF(WUD1.GE.WUD2 .AND. WU1.GE.WU2)   XY2A = 0.96+0.06*(RD-1.0)           FSB00660
      Y1A = Y1B - XY1A*(Y1B-YCM)                                              FSB00670
      Y2A = Y2B + XY2A*(YCM-Y2B)                                              FSB00680
      SC11(J) = (1.-SQRT(1.-2.*B1*(Y1A-YM)**2)) / (0.5*(Y1A-YM))              FSB00690
      SC12(J) = (1.-SQRT(1.-2.*B2*(Y2A-YM)**2)) / (0.5*(Y2A-YM))              FSB00700
      SB1(J) = B1                                                             FSB00710
      SB2(J) = B2                                                             FSB00712
C                                                                             FSB00720
      IF(IER9.NE.0 .OR. IR(6).NE.0)    WRITE(6,60) B1,SC11(J),B2,SC12(J)FSB00730
   30 FORMAT(/// 41X  4HB1 = 1PE12.4,  5X 5HC11 = E12.4                      FSB00740
     1        // 41X  4HB2 =   E12.4,  5X 5HC12 = E12.4)                     FSB00750
C                                                                             FSB00760
C                                                                             FSB00770
      SC21(J) = SC11(J)**2/4.                                                 FSB00780
      SC22(J) = SC12(J)**2/4.                                                 FSB00790
      SC31(J) = 0.                                                            FSB00800
      SC32(J) = 0.                                                            FSB00810
      TERM = PM/RD - 1.                                                       FSB00820
      XYTA = 0.96 + 0.05*TERM - 0.5*TERM**2                                   FSB00830
      DYT1 = Y1B - XYTA*(Y1B-YM) - YM                                         FSB00840
      DYT2 = Y2B - XYTA*(Y2B-YM) - YM                                         FSB00850
      R1 = SC42(J)/(2.*SA1(J))                                                FSB00860
      T1 = 1.-2.*B1*DYT1**2/R1*(1.+SC11(J)**2/(8.*B1)+R1                      FSB00870
     1                          -SC11(J)/(2.*B1*DYT1))                        FSB00872
      SC41(J) = (1.-SQRT(AMAX1(0.,T1)))/(0.5*DYT1)                            FSB00880
      R1 = SC42(J)/(2.*SA2(J))                                                FSB00890
      T2 = 1.-2.*B2*DYT2**2/R1*(1.+SC12(J)**2/(8.*B2)+R1                      FSB00900
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     1                              -SC12(J)/(2.*B2*DYT2))                    FSB00902
      SC52(J) = (1.-SQRT(AMAX1(0.,T2)))/(0.5*DYT2)                            FSB00910
      IF(T1.LT.0. .OR. T2.LT.0.)  WRITE(6,90)  T1, T2                         FSB00912
   90 FORMAT(47H0  COEFFICIENT SC5, CALC IN FSB, IS QUESTIONABE //            FSB00914
     1  7H    T1 = 1PE14.6, 5X  4HT2 = E14.6 ///)                            FSB00916
      SC61(J) = SC51(J)**2/4.                                                 FSB00920
      SC62(J) = SC52(J)**2/4.                                                 FSB00930
C                                                                             FSB00940
      RETURN                                                                  FSB00980
      END                                                                     FSB00990


      SUBROUTINE  PLOTC(AMAT)                                                 PLOTC010
C                                                                             PLOTC020
C       PLOTS  CONTOURS  FOR   L I S P                                        PLOTC030
C                                                                             PLOTC040
      COMMON  /LAB3/    SWE1, SWE2, THER, THEL,                             PLOTC044
     1                  NRML, NTHML, NRWALL, NTHR, NTHL, MESH, NMESH        PLOTC046
      COMMON  /LA3ML/                                                         PLOTC050
     1 RADM(400), THETAM(400), STW1(400), STW2(400)                           PLOTC060
      COMMON /SEGM/ NSEG, NTH, THT(39), NR, RT(20), RC, WT(39,20), JSYM,     PLOTC070
     X CTH(36), STH(36)                                                       PLOTC080
      COMMON /CPLOT/ KFCRT,KCCRT,KTCRT,KFFCRT,W1F,W2F,W1C,W2C,W1T,W2T,        PLOTC090
     X W1FF,W2FF, XMRI                                                        PLOTC092
      DIMENS     AMAT(36)                                                     PLOTC094
C                                                                             PLOTC098
      IERR = 0                                                                PLOTC100
      NTH = NTHL-NTHR                                                         PLOTC110
      THSEG = THETAM(NTHL)-THETAM(NTHR)                                       PLOTC120
      DTHETM = THETAM(2)-THETAM(1)                                            PLOTC122
      DRADM = RADM(1)                                                         PLOTC130
      NSEG = 361./THSEG                                                       PLOTC140
      NPASS = 2                                                               PLOTC150
      IF(NSEG.EQ.1 .OR. JSYM.EQ.2) NPASS = 1                                  PLOTC160
      NSEG = NSEG/NPASS                                                       PLOTC170
```

```
      NTH = NTH*NPASS+1                                                    PLOTC172
      THSEG = FLOAT(NPASS)*THSEG                                           PLOTC180
      IF(ABS(FLOAT(NSEG)*THSEG-360).LT.1.)  GO TO 20                       PLOTC190
        WRITE(6,10)                                                        PLOTC200
   10   FORMAT(1H1 35X 37HE R R O R   ENCOUNTERED IN  SUB PLOTC  ///)      PLOTC210
        IERR = 1                                                           PLOTC220
        GO TO 150                                                          PLOTC230
   20 NR = NRWALL                                                          PLOTC240
        DO 30 IR=1,NR                                                      PLOTC250
   30   RT(IR) = FLOAT(IR)*DRADM                                           PLOTC260
      RC = RT(NR)                                                          PLOTC262
        DO 40 ISEG=1,NSEG                                                  PLOTC270
        TH = -FLOAT(ISEG-1)*THSEG                                          PLOTC272
        CTH(ISEG) = COSD(TH)                                               PLOTC274
   40   STH(ISEG) = SIND(TH)                                               PLOTC276
      THT(1) = THETAM(NTHR)                                                PLOTC280
        DO 50 IT=2,NTH                                                     PLOTC290
   50   THT(IT) = THT(IT-1)+DTHETM                                         PLOTC300
C                                                                          PLOTC310
      IF(KFCRT.EQ.0) GO TO 60                                              PLOTC320
        KTYPE = 1                                                          PLOTC330
        GO TO 100                                                          PLOTC340
   60 IF(KCCRT.EQ.0) GO TO 70                                              PLOTC350
        KTYPE = 2                                                          PLOTC360
        GO TO 100                                                          PLOTC370
   70 IF(KTCRT.EQ.0) GO TO 80                                              PLOTC380
        KTYPE = 3                                                          PLOTC390
        GO TO 100                                                          PLOTC400
   80 IF(KFFCRT.EQ.0) GO TO 250                                            PLOTC410
        KTYPE = 4                                                          PLOTC420
  100 IR = 0                                                               PLOTC430
        DO 200 J1=NTHR,MESH,NTHML                                          PLOTC440
        IR = IR + 1                                                        PLOTC450
        J2 = J1 + NTHL - NTHR                                              PLOTC460
        IT = 0                                                             PLOTC470
          DO 200 J=J1,J2                                                   PLOTC480
```

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            IT = IT + 1                                                    PLOTC490
            GO TO  (110,120,130,140),KTYPE                                 PLOTC500
  110       WJ = STW1(J)                                                   PLOTC510
              GO TO 150                                                    PLOTC520
  120       WJ = STW2(J)                                                   PLOTC530
              GO TO 150                                                    PLOTC540
  130       WJ = STW1(J) + STW2(J)                                         PLOTC550
              GO TO 150                                                    PLOTC560
  140       WJ = XMRI*STW1(J)                                              PLOTC570
            WJ = WJ/(WJ+STW2(J))                                           PLOTC580
  150       WT(IT,IP) = WJ                                                 PLOTC590
              IF(NPASS.EQ.1 .OR. J.EQ.J2) GO TO 200                        PLOTC600
            JT = NTP - (J-J1)                                              PLOTC610
            WT(JT,IP) = WJ                                                 PLOTC620
  200     CONTINUE                                                         PLOTC630
          GO TO (210,220,230,240),KTYPE                                    PLOTC640
  210   CALL CONTUR(KFCRT,W1F,W2F,AMAT,                                    PLOTC650
         X 36H        FUEL FLUX CONTOUR PLOT          )                   PLOTC660
            GO TO 60                                                       PLOTC670
  220   CALL CONTUR(KOCRT,W1O,W2O,AMAT,                                    PLOTC680
         X 36H     OXIDIZER FLUX CONTOUR PLOT         )                   PLOTC690
            GO TO 70                                                       PLOTC700
  230   CALL CONTUR(KTCRT,W1T,W2T,AMAT,                                    PLOTC710
         Y 36H TOTAL PROPELLANT FLUX CONTOUR PLOT )                        PLOTC720
            GO TO 80                                                       PLOTC730
  240   CALL CONTUR(KFFCRT,W1FF,W2FF,AMAT,                                 PLOTC740
         X36HCONTOUR PLOT OF (MRI*WF)/(MRI*WF+WO))                         PLOTC750
C                                                                          PLOTC760
  250   RETURN                                                           PLOTC900
        END                                                              PLOTC910
```

```
      SUBROUTINE PLOT2(N,X,Y1,Y2,RAD,ZOM,IERR)                          PLOT2010
      DIMENSION X(1),Y1(1),Y2(1)                                        PLOT2020
      CALL MXMN(1,Y1,N,Y1MX,Y1MN)                                       PLOT2070
      CALL MXMN(1,Y2,N,Y2MX,Y2MN)                                       PLOT2080
      YMX = AMAX1(Y1MX,Y2MX)                                            PLOT2090
      YMN = AMIN1(Y1MN,Y2MN)                                            PLOT2100
      CALL  LGRID(0, X(1),X(N),YMN,YMX, 24,0,24,42, IERR)               PLOT2110
      IF(IERR.EQ.1) RETURN                                              PLOT2111
      CALL LINEG(N,X,Y1,1,1,3)                                          PLOT2112
      CALL LINEG(N,X,Y2,1,1,3)                                          PLOT2114
      NI=4                                                              PLOT2120
      IF(N.LT.8) NI=1                                                   PLOT2122
      IF(N.GT.40) NI=8                                                  PLOT2124
      NI= MAX0(1,NI/2)                                                  PLOT2130
      NL=N-NI                                                           PLOT2140
      CALL APLOTV(NL,X(NI),Y1(NI),NI,NI,1,22,IR)                        PLOT2150
      CALL APLOTV(NL,X(NI),Y2(NI),NI,NI,1,38,IR)                        PLOT2160
      CALL PRINTV( 7, 7HRADIUS=,10,1017)                                PLOT2170
      CALL LABLV(RAD,74,1017,6,1,2)                                     PLOT2180
      CALL PRINTV(5,5HZOM =,10,1002)                                    PLOT2182
      CALL LABLV(ZOM,58,1002,6,1,2)                                     PLOT2184
      RETURN                                                            PLOT2190
      END                                                               PLOT2200


      SUBROUTINE  CONTUR ( NCLI, WMN, WMX, AMAT, TITLE)                 CONTR010
C       CONTOUR PLOTTING FOR POLAR COORDINATES                          CONTR030
C     WRITTEN  NOV 1970   W CHADWICK                                    CONTR040
C                                                                       CONTR050
      DIMENSION TITLE(9),AMAT(36)                                       CONTR060
      COMMON /SEGM/  NSEG, NTH,THT(39), NR,RT(20),RC, WT(39,20), JSYM,  CONTR070
     X CTH(36), STH(36)                                                 CONTR080
      COMMON /CNTRE/ X(4),Y(4),W(4), NCL,WCNTR(35), RPU,RXC,RYC, JDIAG  CONTR090
     X           , KXC, KYC                                             CONTR092
      COMMON /LAB1/  DUM1, DUM2, ZOM                                    CONTR100
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```
      CALL CAMPAV(9)                                                    CONTR120
      CALL FRAMEV(0)                                                    CONTR130
      CALL PRINTV(5,5HZCM =,10,1002)                                    CONTR132
      CALL LABELV(ZCM,58,1002,6,1,2)                                    CONTR134
      CALL PITFCV(142,1014,1023, 90,2,36,1,TITLE,IERR)                  CONTR140
      IX = 230                                                          CONTR142
        DO 10 I=1,18                                                    CONTR144
        IX = IX + 32                                                    CONTR145
        CALL PRINTV(4,AMAT(I),IX,960)                                   CONTR146
10      CALL PRINTV(4,AMAT(I+18),IX,974)                                CONTR148
      CALL CLEVLS(NCL,WMN,WMX)                                          CONTR150
      CALL PRINTV(14,14HCONTOUR LEVELS,906,930)                         CONTR160
      CALL APRNTV(0,-14,NCL,35H123456789ABCDEFGHIJKLMNOPQRSTUVWXYZ,     CONTR170
     1 906,912)                                                         CONTR180
      ND = 2                                                            CONTR190
      XMAX = WCNTR(NCL)                                                 CONTR194
      IF(XMAX.GT.100.) ND=4                                             CONTR200
      IF(XMAX.GT.10000.) ND=6                                           CONTR210
      IY = 926                                                          CONTR220
        DO 20 I=1,NCL                                                   CONTR230
        IY = IY-14                                                      CONTR240
20      CALL LABELV(WCNTR(I),930,IY,8,1,ND)                             CONTR250
      XYC = 452                                                         CONTR260
      XYC = 452                                                         CONTR270
      RXC = RXC                                                         CONTR272
      RYC = RYC                                                         CONTR274
      XPU = 450./RC                                                     CONTR280
      C2 = COSD(THT(1))                                                 CONTR290
      S2 = SIND(THT(1))                                                 CONTR300
      NTH1 = NTH-1                                                      CONTR310
      JTH = 1                                                           CONTR312
        DO 50 IT=1,NTH1                                                 CONTR320
        JTH = -JTH                                                      CONTR322
        C1 = C2                                                         CONTR330
        S1 = S2                                                         CONTR340
        C2 = COSD(THT(IT+1))                                            CONTR350
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```
      S2 = SIND(THT(IT+1))                                                  CONTR360
      JDIAG = JTH                                                           CONTR362
        DO 50  IR=1,NR                                                      CONTR370
         IF(IR.EQ.NR) GO TO 30                                              CONTR374
        JDIAG = -JDIAG                                                      CONTR376
        R = RT(IR)                                                          CONTR380
        X(1) = R*C1                                                         CONTR390
        Y(1) = R*S1                                                         CONTR400
         RX = X(1)*RPU                                                      CONTR402
         RY = Y(1)*RPU                                                      CONTR404
         CALL PLOTV(INT(RX+RXC),INT(RY+RYC),42)                             CONTR406
         IF(NSEG.LE.1) GO TO 26                                             CONTR408
          DO 24 ISEG=2,NSEG                                                 CONTR410
          C = CTH(ISEG)                                                     CONTR412
          S = STH(ISEG)                                                     CONTR414
   24      CALL PLOTV(INT(RX*C+RY*S+RXC),INT(-RX*S+RY*C+RYC),42)             CONTR416
   26   X(4) = R*C2                                                         CONTR418
        Y(4) = R*S2                                                         CONTR420
        R = RT(IR+1)                                                        CONTR430
        X(2) = R*C1                                                         CONTR440
        Y(2) = R*S1                                                         CONTR450
        X(3) = R*C2                                                         CONTR460
        Y(3) = R*S2                                                         CONTR470
        W(1) = WT(IT,IR)                                                    CONTR490
        W(2) = WT(IT,IR+1)                                                  CONTR500
        W(3) = WT(IT+1,IR+1)                                                CONTR510
        W(4) = WT(IT+1,IR)                                                  CONTR520
C                                                                           CONTR526
        CALL   CONTRE                                                       CONTR530
        GO TO 50                                                            CONTR540
C                                                                           CONTR542
   30     KX2 = KXC + INT(X(2)*RPU)                                        CONTR550
          KY2 = KYC + INT(Y(2)*RPU)                                        CONTR560
          KX3 = KXC + INT(X(3)*RPU)                                        CONTR570
          KY3 = KYC + INT(Y(3)*RPU)                                        CONTR580
           DO 40 I=1,2                                                     CONTR590
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   40         CALL CONTRP(0,KX2,KY2,XX3,KY3)                          CONTR600
             IF(IT.EQ.1) CALL CONTRP(0,KXC,KYC,KX2,KY2)               CONTR610
   50    CONTINUE                                                     CONTR620
C                                                                     CONTR630
  100 RETURN                                                          CONTR910
      END                                                             CONTR920


      SUBROUTINE  CLEVLS(NCLI,WMN,WMX)                                CLEVL010
C      SETS  CONTOUR  LEVELS                                          CLEVL020
C       IF WMX.LT.WMN,  WMAX IS MAX W                                 CLEVL030
C       IF WMX.EQ.WMN,  WMAX & WMIN ARE MAX & MIN W                   CLEVL040
C       IF NCLI IS NEG.  SCALE IS CALC WITH NCL APPROX = -NPLI        CLEVL050
C                                                                     CLEVL060
      COMMON /SEGM/ NSEG, NTH, THT(39), NR, RT(20), RC, WT(39,20), JSYM,CLEVL070
     X CTH(36), STH(36)                                               CLEVL080
      COMMON /CNTRS/ X(4),Y(4),W(4), NCL,WCNTR(35), RPU,RXC,RYC       CLEVL090
C                                                                     CLEVL100
      WMIN = WMN                                                      CLEVL110
      WMAX = WMX                                                      CLEVL120
        IF(WMX.GT.WMN) GO TO 20                                       CLEVL130
      WMAX = WT(1,1)                                                  CLEVL140
      WMIN = WMAX                                                     CLEVL150
        DO 10 IR=1,NR                                                 CLEVL160
          DO 10 IT=1,NTH                                              CLEVL170
          WMAX = AMAX1(WT(IT,IR),WMAX)                                CLEVL180
   10     WMIN = AMIN1(WT(IT,IR),WMIN)                                CLEVL190
      IF(WMAX.LT.WMN) WMIN = WMN                                      CLEVL200
   20       = MAXO(NCLI,4)                                           CLEVL210
            (NCLI.GT.0) GO TO 40                                      CLEVL220
          = MAXO(-NCLI+1,0)                                           CLEVL230
      CALL SCALE(WMIN,WMAX,NCL,W1,W2,DW,IERR)                         CLEVL240
        IF(IERR.NE.0) GO TO 40                                        CLEVL250
      IF(W1+0.5*DW.LT.WMIN) W1 = W1+DW                                CLEVL260
      IF(W2-0.5*DW.GT.WMAX) W2 = W2-DW                                CLEVL270
```

```
      WMIN = W1                                                          CLEVL280
   30   NCL = (W2-W1)/DW + 0.1                                          CLEVL290
      WMAX = W2                                                          CLEVL292
        IF(NCL.LE.35) GO TO 50                                           CLEVL300
        DW = 2.*DW                                                       CLEVL310
        GO TO 30                                                         CLEVL320
   40 DW = (WMAX-WMIN)/FLOAT(NCL)                                        CLEVL330
   50 WCNTR(1) = WMIN + 0.5*DW                                           CLEVL340
        DO 60 KL=2,NCL                                                   CLEVL350
   60   WCNTR(KL) = WCNTR(KL-1) + DW                                     CLEVL360
C                                                                        CLEVL370
      RETURN                                                             CLEVL810
      END                                                                CLEVL820


      SUBROUTINE  CONTRE                                                 CNTE0010
C       CONTOUR PLOTTING ROUTINE FOR 4-POINT ELEMENT                     CNTE0020
C        TECHNIQUES FROM SUB VISUAL USED                                 CNTE0030
C         WRITTEN NOV 1970   W CHADWICK                                  CNTE0040
      DIMENSION KY(35,3),KX(35,3),KR(35,3),NK(3)                         CNTE0050
      COMMON /CNTRE/ X(4),Y(4),W(4), NCL,WCNTR(35), RPU,RXC,RYC, JDIAG   CNTE0060
     X             , KXC, KYC                                          CNTE0062
C                                                                        CNTE0080
      IA = 1                                                             CNTE0090
      IB = 2                                                             CNTE0100
C       DO FOR EACH TRIANGLE                                             CNTE0110
        DO 110 JTRI = 1,2                                                CNTE0120
C         DO FOR EACH SIDE OF TRIANGE - SIDE 3 IS COMMON SIDE            CNTE0128
          DO 40 LT = 1,3                                                 CNTE0130
          IF(JTRI.EQ.2) GO TO 10                                         CNTE0140
          IF(JDIAG.LT.0) GO TO 6                                         CNTE0144
           IF(LT.EQ.2) IB = 4                                            CNTE0150
           IF(LT.EQ.3) IA = 2                                            CNTE0160
           GO TO 20                                                      CNTE0170
    6     IF(LT.EQ.2) IA = 3                                             CNTE0172
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      IF(LT.EQ.3) IB = 1                                                CNTE0174
      GO TO 20                                                          CNTE0176
   10 IF(LT.EQ.3) GO TO 44                                              CNTE0180
      IF(JDIAG.LT.01 GO TO 16                                           CNTE0182
      IF(LT.EQ.1) IA = 3                                                CNTE0190
      IF(LT.EQ.2) IB = 2                                                CNTE0200
      GO TO 20                                                          CNTE0202
   16 IF(LT.EQ.1) IB = 4                                                CNTE0204
      IF(LT.EQ.2) IB = 1                                                CNTE0206
C                                                                       CNTE0208
   20 NN =                                                              CNTE0210
      DW = W(IB)-W(IA)                                                  CNTE0220
      IF(DW.EQ.0.0) GO TO 40                                            CNTE0230
      WMIN = AMIN1(W(IA),W(IB))                                         CNTE0240
      WMAX = AMAX1(W(IA),W(IB))                                         CNTE0250
      IF(WMAX.LT.WCNT(1)) GO TO 40                                      CNTE0254
      DO 30 LC=1,NCL                                                    CNTE0260
      CL = WCNT(LC)                                                     CNTE0270
      IF(CL.LT.WMIN) GO TO 30                                           CNTE0280
      IF(CL.LT.WMAX) GO TO 40                                           CNTE0290
      NN = NN+1                                                         CNTE0300
      SL = (CL-W(IA))/DW                                                CNTE0310
      XX(NN,LT) = (X(IB)*(X(IB)-X(IA))*SL)*RPU + RXC                    CNTE0320
      XY(NN,LT) = (Y(IA)*(Y(IB)-Y(IA))*SL)*RPU + RYC                    CNTE0330
      ZZ(NN,LT) = CL                                                    CNTE0340
   30 CONTINUE                                                          CNTE0350
   40 NN(LT) = NN                                                       CNTE0360
C                                                                       CNTE0370
   44 CONTINUE                                                          CNTE0374
C     DO FOR SIDE 1 AND 2 OF TRIANGLE                                   CNTE0376
      DO 100 K=1,2                                                      CNTE0380
      NK = NN(K)                                                        CNTE0390
      IF(NK.EQ.0) GO TO 100                                             CNTE0400
C       DO FOR EACH CONTOUR LEVEL ON SIDE                               CNTE0406
      DO 90 KL=1,NK                                                     CNTE0410
      KPX = XX(KL,K)                                                    CNTE0420
```

```
      NL = 2                                                            CNTE0430
      IF(K1.EQ.2) NL=3                                                  CNTE0440
C       COMPARE CONTOUR LEVELS - SIDE 1 WITH 2 & 3, SIDE 2 WITH 3       CNTE0446
       DO 80 KM=NL,3                                                    CNTE0450
       NKB = NK(KM)                                                     CNTE0460
       IF(NKB.LE.0) GO TO 80                                            CNTE0470
        DO 70 KN=1,NKB                                                  CNTE0480
         IF(KRX.NE.KR(KN,KM)) GO TO 70                                  CNTE0490
        CALL CONTRP(KRX,KX(KL,K1),KY(KL,K1),KX(KN,KM),KY(KN,KM))        CNTE0500
   70   CONTINUE                                                        CNTE0560
   80  CONTINUE                                                         CNTE0570
   90 CONTINUE                                                          CNTE0580
  100 CONTINUE                                                          CNTE0590
  110 CONTINUE                                                          CNTE0600
      RETURN                                                            CNTE0610
      END                                                               CNTE0620


      SUBROUTINE  CONTRP(K,KX1,KY1,KX2,KY2)                             CNTRP010
C                                                                       CNTRP020
C       PLOT ANY LABEL CONTOUR LINE SEGMENTS  IN EACH REPEATING PIE SEG CNTRP030
C                                                                       CNTRP040
      DIMENSION LABEL(35), CLBL(35)                                     CNTRP050
      COMMON /CNTRP/ X(4),Y(4),W(4), NCL,WCNTR(35), RPU,RXC,RYC         CNTRP060
     * , JDIAG,    KXC, KYC                                             CNTRP062
      COMMON /SYSM/ NSEQ, NTH,THT(39), NR,RT(20),RC, WT(39,20), JSYM,   CNTRP070
     * CTH(39), STH(38)                                                 CNTRP080
      DATA LABEL/6,9,2,5,8,1,4,7,10,3,6,9,2,5,8,1,4,7,10,3,6,9,2,5,8,1,4,CNTRP090
     1 7,10,3,6,9,2,5,8/                                                CNTRP100
      DATA CLBL/1HDH1   2   3   4   5   6   7   8   9   A   B   C   D   CNTRP110
     1   F   G   H   I   J   K   L   M   N   O   P   Q   R   S   T   U CNTRP120
     2  V   W   X   Y   Z   /                                           CNTRP130
C                                                                       CNTRP140
      CALL LINEV(KX1,KY1,KX2,KY2)                                       CNTRP150
      ILABEL = 0                                                        CNTRP160
```

```
      IF(K.LE.0) GO TO 12                                               CNTRP162
      IF(LABL(K).LT.10) GO TO 10                                        CNTRP170
      IFLABL = 1                                                        CNTRP180
      CALL PRINTV(1,CLBL(K),KX1,KY1)                                    CNTRP190
      LABL(K) = 0                                                       CNTRP200
   10 LABL(K) = LABL(K) + 1                                             CNTRP210
   12 IF(NSEG.LE.1) GO TO 50                                            CNTRP220
      X1 = KX1-KXC                                                      CNTRP230
      Y1 = KY1-KYC                                                      CNTRP240
      X2 = KX2-KXC                                                      CNTRP250
      Y2 = KY2-KYC                                                      CNTRP260
        DO 20 ISEG=2,NSEG                                               CNTRP270
        C = CTH(ISEG)                                                   CNTRP280
        S = STH(ISEG)                                                   CNTRP290
        KXA = KXC + INT( X1*C + Y1*S)                                   CNTRP300
        KYA = KYC + INT(-X1*S + Y1*C)                                   CNTRP310
        KXB = KXC + INT( X2*C + Y2*S)                                   CNTRP320
        KYB = KYC + INT(-X2*S + Y2*C)                                   CNTRP330
        CALL LINEV(KXA,KYA,KXB,KYB)                                     CNTRP340
        IF(ILK.LE.0.1) CALL PRINTV(1,CLBL(K),KXA,KYA)                   CNTRP350
   20   CONTINUE                                                        CNTRP360
C                                                                       CNTRP800
   50 RETURN                                                            CNTRP810
      END                                                               CNTRP820


      SUBROUTINE PLOTS(NTH,TH,NTHR,NTHL,NR,R, NE,THE,RE,NTYPE,IERR)     PLN00010
      DIMENSION TH(1),R(1)                                              PLN00020
     1, THE(1),RE(1),NTYPE(1),JCHAR(10)                                 PLN00022
     2 ,X(400), Y(400)                                                  PLN00024
      DATA JCHAR/1, ,15,16,17,18,19,20,22,23/                           PLN00026
C                                                                       PLN00028
      TMAX=NTH*NR                                                       PLN00030
      NT = NTHL-NTHR+1                                                  PLN00032
      TMAX=R(TMAX)                                                      PLN00040
```

```
      XMIN = 0.                                                          PLN00044
      THMAX = TH(NTHL)-TH(NTHR)                                          PLN00050
      IF(THMAX.LT.90.01) GO TO 10                                        PLN00060
      IF(THMAX.GE.150.)  XMIN = -RMAX                                    PLN00062
      IF(THMAX.LT.150.)  XMIN = RMAX*COSD(THMAX)                         PLN00084
   10 CONTINUE                                                           PLN00090
      XMIN = AMIN1(XMIN,-RMAX/3.)                                        PLN00094
C                                                                        PLN00098
      CALL  GCRID(1,XMIN,RMAX,XMIN,RMAX,24,0,24,30, IERR)                PLN00100
      IF(IERR.EQ.1) RETURN                                               PLN00102
C                                                                        PLN00108
C                                                                        PLN00109
      DO 50 J=NTHR,NTHL                                                  PLN00110
      THX = TH(J)-TH(NTHR)                                               PLN00112
      CTH = COSD(THX)                                                    PLN00120
      STH = SIND(THX)                                                    PLN00130
C                                                                        PLN00138
      DO 50 I=J,IMAX,NTH                                                 PLN00140
      X(I) = R(I)*CTH                                                    PLN00150
      Y(I) = R(I)*STH                                                    PLN00160
   50 CONTINUE                                                           PLN00170
C                                                                        PLN00172
        NDI = (NR-1)*NTH                                                 PLN00180
        DO 70 ITH=NTHR,NTHL                                              PLN00190
   70   CALL LINEG(2,X(ITH),Y(ITH),NDI,NDI,3)                            PLN00200
C                                                                        PLN00210
      DO 80 J=NTHR,IMAX,NTH                                              PLN00220
   80 CALL LINEG(NT,X(J),Y(J),1,1,3)                                     PLN00230
C                                                                        PLN00240
      DO 100 I=1,NE                                                      PLN00250
      THX = THE(I)-TH(NTHR)                                              PLN00252
      X1 = RE(I)*COSD(THX)                                               PLN00260
      Y1 = RE(I)*SIND(THX)                                               PLN00270
      IF(X1.LT.XMIN .OR. Y1.LT.XMIN) GO TO 100                           PLN00272
      K  = NTYPE(I)                                                      PLN00280
      NC = JCHAR(K)                                                      PLN00290
```

```
      CALL PLINTV(X1,Y1,NC)                                              PLN00300
  100 CONTINUE                                                           PLN00310
C                                                                        PLN00490
      RETURN                                                             PLN00500
      END                                                                PLN00510


      SUBROUTINE MIXEFF(FT,OT,NCSTR,TMR,CST, EM,ECSMIX)                  MIXEF010
      DIMENSION  TMR(1), CST(1)                                          MIXEF020
      COMMON  /LABNL/  DUM1(4800), WF(400), DUM2(1600), WO(400)          MIXEF030
      COMMON  /LA33/   SWE1, SWE2, THER, THEL,                           MIXEF040
     1                 NRML, NTHML, NRWALL, NTHR, NTHL, MESH, NMESH     MIXEF042
C                                                                        MIXEF050
C          FSUBM                                                         MIXEF060
      TT = FT + OT                                                       MIXEF070
      RAT = OT/TT                                                        MIXEF080
      SUM1 = 0.                                                          MIXEF090
      SUM2 = 0.                                                          MIXEF100
        DO 30 J1=NTHR,MESH,NTHML                                         MIXEF110
        J2 = J1+NTHL-NTHR                                                MIXEF120
          DO 30 J=J1,J2                                                  MIXEF130
          R = WO(J)                                                      MIXEF140
          IF(WO(J).GT.1.E-50)  R = R/(R+WF(J))                           MIXEF142
          IF(R-RAT) 10,30,20                                             MIXEF150
   10     TERM = (WO(J)+WF(J))*(1.-R/RAT)/TT                             MIXEF160
          SUM1 = SUM1 + TERM                                             MIXEF170
            GO TO 30                                                     MIXEF180
   20     TERM = (WO(J)+WF(J))*(RAT-R)/(TT*(RAT-1.))                     MIXEF190
          SUM2 = SUM2 + TERM                                             MIXEF200
   30     CONTINUE                                                       MIXEF210
      EM = 100.*(1.-(SUM1+SUM2))                                         MIXEF220
      WRITE(6,40) EM                                                     MIXEF230
   40 FORMAT(///15X 36H PUPE MIXING EFFICIENCY FACTOR, EM = F9.4)        MIXEF240
C                                                                        MIXEF250
C          CSTAR  MIXING  EFFICIENCY                                     MIXEF260
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```
      IF(NCSTR.LT.3) GO TO 100                                          MIXEF270
      SUM = 0.                                                          MIXEF280
      TMR1 = TMR(1)                                                     MIXEF290
      TMRN = TMR(NCSTR)                                                 MIXEF300
        DO 50 J1=NTHR,MESH,NTHML                                        MIXEF310
        J2 = J1+NTHL-NTHR                                               MIXEF320
          DO 50 J=J1,J2                                                 MIXEF330
          XMR = WO(J)/AMAX1(WF(J),1.E-50)                               MIXEF340
          XMR = AMIN1(XMR,TMRN)                                         MIXEF350
          XMR = AMAX1(XMR,TMR1)                                         MIXEF360
   50     SUM = SUM + (WO(J)+WF(J)) * YOF(XMR,TMR,CST,NCSTR,2)          MIXEF370
C                                                                       MIXEF380
      ECSMIX = SUM/(TT*YOF(OT/FT,TMR,CST,NCSTR,4))                      MIXEF390
      WRITE(6,60) ECSMIX                                                MIXEF400
   60 FORMAT(///15X 26H CSTAR MIXING EFFICIENCY = 2PF9.4 )              MIXEF410
C                                                                       MIXEF420
  100 RETURN                                                            MIXEF800
      END                                                               MIXEF810
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      SUBROUTINE  PMSTC(ISTX)                                                STC00100
C                                                                            STC00140
C * * * CONTROL PROGRAM FOR COMBUSTION IN STREAM TUBES.                      STC00160
C                                                                            STC00180
C                                                                            STC00200
      COMMON  /HEAD/ AMAT(72), CDATE(2), ILISP, ISTC, ITRANS, ITDK, IPM      STC00220
      COMMON  /COMPM/ JTAPE, NREC, ICRTSD, VOLC, AT, LCHAM, DCHAM,           STC00230
     1         AMCHAM, MOCHAM, ESPIMP,ECSTAR,ECF, THRUST,SPIMP,              STC00232
     2         CSTAR, CF, OXFR, HTLOSS, CR, ECSMIX, ECSENR, ZIMPF,           STC00234
     3         ZIMPC, FCSHR, RPCIN                                           STC00236
      COMMON  /TBL/TMR(18), TTC(18,3), TVIS(18,3),TGAM(18,3),TMW(18,3),      STC00380
     1          CSTR(18),TEPS(6),   TMACH(3),  TCF(18,6)                   STC00400
     2        , TOXFRP(18), XMRM                                            STC00410
      COMMON  /AGI/APRCF(12,2), CCSAR(300), Z(300),                          STC00420
     X          AREA1(19),   AREA2(19),  DELARS(20)                         STC00440
     X,         RBAR1(19),   REAR2(19),  SINCR(19)                          STC00460
     X,         SUMSTA,       RDSL1(19),  RDSL2(19)                         STC00480
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCDG(19),   SGAM(19),             STC00500
     X          SMWG(19),    SVOS(19),    VISG(19),   RHOG1(19),            STC00520
     X          RMCG2(19),  VELG1(19),  VELG2(19),  TCG1(19),              STC00540
     X          TCG2(19),    VSON(19),    STOT(19),   SMACH(19)             STC00560
      COMMON  /VAP/EVAP1(19), EVAPC(19),  SUMFC(19),  SUMOC(19)              STC00640
      COMMON  /P/ PC(300),    PCI(300),   PPC(20),    U2(300)                STC00660
      COMMON  /PS/P1(19),   P2(19),   DPDR(19), DRDS(19), DZDS(19)           STC00680
      COMMON  /SVV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,         STC00720
     1           RHOLF,HTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,           STC00740
     2          WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,           STC00760
     3           NSSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,           STC00780
     4             PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,           STC00800
     5             NTS,    NC, CCSAI, YMFLF, TMFLO,  CMRI, TCSTR,           STC00820
     6             IPR,  IZPR,    ND,   NPQ,  SNCR,    IZ,   III,           STC00840
     7          ETA1,  ETA2,   SCS, ZINCR,  IKPF,   IKPO,  LAXI            STC00860
     8        , ISEQ, NASEG, MSTI, NEPS, PAMB, AEXIT, ECFVAC,               STC00880
     9          NMACH, ECSTR1, PNS,   PIE,   RVAPF, RVAPO                   STC00890
      COMMON /COMT/ GA, RR, RT, ZI, ZPVSR, IZBC, PZ(20), RZ(20), PSTARI,STC00940
     1          RATVAP, CD                                                  STC00942
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      COMMON  /STK1/ ROSL(19), PIL, ZIL(40), RIL(40), THIL(40)          STC00960
     1              , VIL(19), XMBIL(19), ZDSL(19), NPE                 STC00962
      DATA   R / 1545./                                                 STC00980
C                                                                       STC01000
C       S T C   USES SECONDARY DATA STORAGE UNITS IN  ITERB (3),        STC01010
C           CPM1 (4), CPM2 (4),  TDKSET (2)  AND  STCRT(2)              STC01012
C                                                                       STC01020
      M = 3                                                             STC01040
      REWIND M                                                          STC01060
      IST = ISTX                                                        STC01080
      MSTI = 0                                                          STC01100
      IF(IST.EQ.1) CALL  CINPUT                                         STC01120
      CALL TIMF                                                         STC01140
C                                                                       STC01160
  420 CALL  CINIT                                                       STC01180
      IF(IST.EQ.MSTI  CALL  CPM1                                        STC01190
      EPS = AEXIT/CCSAR(NP)                                             STC01200
      NPI = 2                                                           STC01220
      NPE = NP                                                          STC01240
      IF(IST.GT.1 .AND. LAXI.GT.0)  NPE = MIND(300,NP+25)               STC01260
  425 MSTI = MSTI + 1                                                   STC01280
      IF(NPI.GT.2)  CALL ITERB(2,M)                                     STC01300
      NPI = NPI                                                         STC01320
      ICPM = 0                                                          STC01324
      IF(NPI.EQ.2 .AND. IST.EQ.MSTI  ICPM = 1                           STC01326
      SSTAMN = 10000.                                                   STC01330
C                                                                       STC01340
C                                                                       STC01360
C*    *    *    *    *    *    *    *    *    *    *    *    *    *    *STC01380
C                MAIN  PART  OF  PROGRAM                                STC01400
C*    *    *    *    *    *    *    *    *    *    *    *    *    *    *STC01420
C                                                                       STC01440
C * * * MAIN DO-LOOP MARCHES FROM Z=ZSTART TO NOZZLE THROAT IN          STC01460
C                    EQUAL INCREMENTS OF ZINCR(IN.).                    STC01480
C                                                                       STC01500
      DO 1000  IZ=NPI,NPE                                               STC01520
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      IF(Z(IZ).LE.ZPVSR)  NPI = IZ + 1                                  STC01540
C                                                                       STC01560
C * * * * APPROXIMATIONS ARE MADE OF THECHANGES IN GASDYNAMIC VARIABLES. STC01580
C                                                                       STC01600
      IF(IZ.GE.NP) GO TO 430                                            STC01620
      DPZSST = PC(IZ)-PC(IZ-1)                                          STC01640
      DU2 =  U2(IZ) - U2(IZ-1)                                          STC01660
  430 PC(IZ) = PC(IZ-1) + DPZSST                                        STC01680
      CCR = CCSAR(IZ)/CCSAR(IZ-1)                                       STC01700
      P = PC(IZ)                                                        STC01720
C                                                                       STC01740
      DO 440  NT=1,NTS                                                  STC01760
      IF(LAXI.GT.0 .AND. IST.GT.1)  P = PI(NT) + DPZSST                 STC01780
      PZ(NT) = P                                                        STC01800
      RHOSZ(NT) = P*SMMG(NT)/(12.9R*TCG1(NT))                           STC01820
      VELG2(NT) =  VELG2(NT) + DU2                                      STC01840
      AREAZ(NT) =  AREA1(NT) * CCR                                      STC01860
  440 CONTINUE                                                          STC01880
C                                                                       STC01900
      III = 1                                                           STC01920
  450 IF(IST.EQ.1 .OR. LAXI.EQ.0)  GO TO 500                            STC01940
      CALL RCOORD                                                       STC01960
C                                                                       STC01980
C     MEAN PRESSURE FOR EACH STEAM TUBE CALCULATED AS FUNCTION OF       STC02000
C       CENTERLINE PRES & RADIAL PRES GRADIENT FROM TRANS ISOBARS       STC02020
      CALL  PVSSY(IZ,NTS,NP,III)                                        STC02040
C                                                                       STC02060
  500 CALL  CSPRAY                                                      STC02080
C                                                                       STC02100
      CALL CGDYN(NPI)                                                   STC02120
C                                                                       STC02140
      IF(IZ.LE.2 .AND. III.LE.2*(ICRC+1))  GO TO 460                    STC02150
      IF(III.LE.ICRC+1) GO TO 460                                       STC02160
      IF(IST.EQ.1) GO TO 600                                            STC02180
C                          MULTIPLE  STREAM  TUBE                       STC02196
        SSTAR = AMIN1(SSTAMR,SUMSTA)                                    STC02200
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      IF(LAXI.EQ.0.) GO TO 530                                          STC02220
      IF(ZIIZ+1).GT.ZPVSR .AND. NPI.EQ.IZ+1 .AND. NPI.EQ.2)             STC02240
     X          CALL  ITERB(1,M)                                        STC02250
        ISTCRT = 1                                                      STC02260
        IF(ISTCRT.EQ.1) CALL STCRT(1,IZ,NST)                            STC02280
  530  CONTINUE                                                         STC02300
       GO TO 760                                                        STC02320
C                                                                       STC02340
C                          SINGLE  STREAM  TUBE                         STC02350
  600  IF(IZ.EQ.IZBC)  RBC = RHOG2(1)                                   STC02352
       IF(IZ.LE.3 .OR. IZ.GE.(NP-3) .OR. IZ.EQ.IZBC)  GO TO 640         STC02354
       IF(IZ.LT.IZPR)  GO TO 990                                        STC02356
       IZPR = IZPR + IPR                                                STC02358
  640    CALL  CPRINT(1)                                               STC02360
       IF(IZ.LT.NP)  GO TO 990                                          STC02370
C                                                                       STC02380
C        AT  THROAT  PLANE                                              STC02400
       GA = ALOG(PC(NP)/PC(IZBC)) / ALOG(RHOG2(1)/RBC)                  STC02420
       CONRAT =  AREA2(1) / CCTAR(NP)                                   STC02500
       OXFRGP = SUMOC(1)/(SUMOC(1)+XMRM*SUMFC(1))                       STC02510
         F = (1.-HTLOSS)*ECSMIX/CO                                      STC02520
       RVARF = SUMFC(1)/(TMFLF*F)                                       STC02530
       RVARO = SUMOC(1)/(TMFLO*F)                                       STC02532
       RATVAR = CASEL(1)/(F*(TMFLF+TMFLO))                              STC02540
       CSTARG = YOF(OXFRGP,TOXFRP,CSTR,NMR,2)                           STC02550
       ECSMR  = CSTARG/TCSTR                                            STC02552
       ECSTAR = ECSMIX*RATVAR*ECSMR*(1.-HTLOSS)                         STC02554
         CSTAR = ECSTAR*TCSTR                                           STC02560
       PMR = CSTARG*(SUMFC(1)+SUMOC(1))/(32.174*AREA2(1))               STC02562
       ETA1 = 100.*ECSTAR                                               STC02570
       NC = NC+1                                                        STC02580
       CALL  CONTRAN                                                    STC02582
       CALL  ENGBAL(2,IERCC)                                            STC02590
       PC1(1) = PC(1)                                                   STC02592
       IF(ISERCC.EQ.2)  GO TO 740                                       STC02594
       TEST =   ABS(1.0 - CONRAT)                                       STC02600
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      IF(TEST-CRTCL) 710,710,740                                          STC02620
  710 IST = NST                                                           STC02640
      IF(NST.EQ.1) GO TO 1050                                             STC02660
  712 NTS = NST                                                           STC02680
      DO 715 I=2,NP                                                       STC02700
  715 PC1(I) = PC(I)                                                      STC02720
      GO TO 1050                                                          STC02740
  740 IF(NC.GE.NSST1) NPC = 1                                             STC02760
      IF(NPC.GT.0) GO TO 1700                                             STC02770
      GO TO 420                                                           STC02780
C                          MULTIPLE  STREAM  TUBE                       STC02830
  760 IF(IZ.LE.3 .OR. IZ.EQ.IZBC .OR. ZABS(NP-IZ).LE.3 .OR. IZ.EQ.NPE)    STC02840
     X    GO TO 800                                                      STC02842
      IF(Z(IZ+1).GT.ZPVSR .AND. NPI.EQ.IZ+1) GO TO 800                    STC02860
      IF(IZ.LT.IZPR) GO TO 990                                            STC02880
      IZPR = IZPR + IPR                                                   STC02900
C                                                                         STC02920
  800 CALL CPRINT(NST)                                                    STC02940
C                                                                         STC02960
      IF(IZ.NE.NP) GO TO 830                                              STC03010
C                          THROAT   CALCULATIONS                          STC03012
      SUMFG = 0.                                                          STC03014
      SUMOG = 0.                                                          STC03016
      SUMCS = 0.                                                          STC03018
        DO 820 NT=1,NST                                                   STC03022
        SUMFG = SUMFG + SUMFC(NT)                                         STC03024
        SUMOG = SUMOG + SUMOC(NT)                                         STC03026
        CXFRP = SMRG(NT)/(SMRG(NT)+XMRM)                                  STC03028
  820   SUMCS = SUMCS + GASFL(NT)*YDF(CXFRP,TOXFRP,CSTR,NMR,2)            STC03030
      CXFRGP = SUMOG/(SUMOG+XMRM*SUMFG)                                   STC03032
      CSTARG = YDF(CXFRGP,TOXFRP,CSTR,NMR,2)                              STC03034
      FCSMR = CSTARG/TCSTR                                                STC03036
      FCSMIX = SUMCS/(CSTARG*(SUMFG+SUMOG))                               STC03038
        F = 1./(1.-HTL0SS)                                                STC03043
      RVAPF = F*SUMFG/TMFLF                                               STC03044
      RVAPO = F*SUMOG/TMFLO                                               STC03045
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      RATVAP = FR(SUMFG*SUMOG)/(TMFLF*TMFLO)                            STC03046
      ECSTAR = ECSMIX*RATVAP*ECSMR*(1.-HTLOSS)                          STC03047
        CSTAR = ECSTAR*TCSTR                                            STC03048
  830 IF(IZ.LT.NPE) GO TO 990                                           STC03050
        IF(ISTCRT.EQ.1) CALL STCRT(2,IZ,NST)                            STC03060
         ARAT = SSTAMN/CCSAR(NP)                                        STC03080
         PSTARI = ARAT*PSTARI                                           STC03090
         WRITE(6,890) SSTAMN, ARAT, WGCHAM                              STC03100
  890    FORMAT(50H1   MINIMUM CROSS-SECTIONAL AREA OF STREAM TUBES =   STC03120
     1          F15.7/ 4X 43HCALCULATED TO SPECIFIED THROAT AREA RATIO =STC03140
     2          F10.7 / 4X 37HWEIGHT OF GAS IN COMBUSTION CHAMBER =     STC03150
     3          1PE14.5)                                                STC03152
      PNS = PIE/RPCIN                                                   STC03162
        CALL  ENSBAL(4,IEBCC)                                           STC03170
        IF(IEBCC.EQ.2)  GO TO 894                                       STC03176
      IF(ABS(ARAT-1.).LE.CRTOL)  GO TO 1050                             STC03180
  894 CONTINUE                                                          STC03200
      IF(MSTI.LT.NMSTI .AND. ABS(ARAT-1.).GT.3.*CRTOL)  GO TO 420       STC03220
      IF(MSTI.LT.NMSTI)  GO TO 425                                      STC03240
      WRITE(6,900)  CRTOL,NMSTI                                         STC03260
  900 FORMAT(//49H   TERMINATION DUE TO FAILURE TO CONVERGE WITHIN      STC03280
     1          2PF5.3,12H PERCENT IN  I2,12H ITERATIONS. )             STC03300
      GO TO 1050                                                        STC03320
C                                                                       STC03340
  990 CALL CHANGE(2,NTS,NGT)                                            STC03620
      IF(ICPM.EQ.1)  CALL  CPM1                                         STC03630
C                                                                       STC03640
 1000 CONTINUE                                                          STC03660
C                                                                       STC03680
C                                                                       STC03700
 1050 CALL TIME                                                         STC03720
      CALL  ITRP2(OXFRGP,TOXFRP,NMR,2, EPS,TEPS,NEPS,2, TCF,18, CFTHVG) STC03722
      OXFRP = TMFLO/(TMFLO+SMRM*TMFLF)                                  STC03724
      CALL  ITRP2(OXFRP,TOXFRP,NMR,2, EPS,TEPS,NEPS,2, TCF,18, CFTHV)   STC03725
      CF = ECFVAC*CFTHVG - PAMB*EPS/PNS                                 STC03726
      THRUST = CCSAR(NP)*PNS*CF                                         STC03728
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      SPIMP = CSTAR*CF/32.174                                                STC03730
        ECF = CF/(CFTHV - PAMB*EPS/PNS)                                      STC03734
        ESPIMP = ECF*ECSTAR                                                  STC03736
      WRITE(6,1100) PNS, THRUST, CSTAR, ECSTAR, CF, ECF, SPIMP, ESPIMP       STC03740
 1100 FORMAT(1H1//40X20HPERFORMANCE  SUMMARY //33X 44H(WITH VACUUM C-SUBSTC03742
     1-F EFFICIENCY AS AN INPUT) /// 24X 48HNOZZLE MEAN STAGNATION PRESSSTC03744
     2URE, P-SUB-NS (PSIA)  2X F12.1// 24X 15HTHRUST, F (LBF) 35X F12.1 STC03746
     3 // 24X 40HCHARACTERISTIC VELOCITY, C-STAR (FT/SEC) 10X F12.1 /   STC03748
     4 30X 18HEFFICIENCY (RATIO)26XF12.3 // 24X 27HTHRUST COEFFICIENT, CSTC03750
     5-SUB-F 23X F12.4 / 30X 18HEFFICIENCY (RATIO) 26X F12.3  // 24X     STC03752
     6 39HSPECIFIC IMPULSE, I-SUB-S (LBF/LBM-SEC) 11X F12.1 / 30X        STC03754
     7 18HEFFICIENCY (RATIO) 26X F12.3 )                                 STC03756
C                                                                        STC03757
        WRITE(6,1110)                                                    STC03770
 1110   FORMAT(1H1)                                                      STC03772
      IF(ISTX.GT.1 .AND. LAXI.NE.0)  CALL  TDKSET                        STC03800
      RETURN                                                             STC03810
C                                                                        STC03820
 1700 WRITE(6,1720) NPQ                                                  STC03840
 1720 FORMAT(//10X,28H** TERMINATION DUE TO ERROR(,I1,3H)--)             STC03860
 1740 WRITE(6,1750)                                                      STC03880
 1750 FORMAT(15X,45HSINGLE STREAM TUBE ANALYSIS DID NOT CONVERGE. )      STC03900
C                                                                        STC03920
 2000 CALL EXIT                                                          STC03940
      STOP                                                               STC03960
      END                                                                STC03980



      SUBROUTINE  C.&PUT                                                 CINP0050
C                                                                        CINP0060
      COMMON  /HEAD/   AMAT(72), CDATE(2), ILISP, ISTC, ITRANS, ITDK     CINP0100
      COMMON  /ERCOM/ ERCD1(5), IEBX                                     CINP0108
      COMMON  /SAVE/XAR(19),    XGF(19),    XMR(19),    XWS(12,19),      CINP0110
     *              XVS(12,19), XDS(12,19)                               CINP0115
      COMMON  /GRP/GRMOD(12,19),  GVELD1(12,19), GVELD2(12,19),          CINP0120
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     X             GDIAD1(12,19), GDIAD2(12,19), GNDD1(12,19),          CINP0140
     X             GNDD2(12,19),  GNDDT1(12,19), GNDDT2(12,19),         CINP0160
     X             GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),          CINP0180
     X             GDIAM(12,19)                                         CINP0200
      COMMON  /TCL/TMR(18), TTC(18,3), TVIS(18,3),TGAM(18,3),TMW(18,3), CINP0220
     1             CSTR(18),TEPS(6),   TMACH(3),  TCF(18,6)             CINP0240
     2           , TOXERR(18), XMRM                                     CINP0260
      COMMON  /AC2/APROF(12,2), CCSAR(300), Z(300),                     CINP0280
     X             AREA1(19),   AREA2(19),  DELARS(20)                  CINP0300
     X,            RRAR1(19),   RRAR2(19),  SINCR(19)                   CINP0320
     X,             DUM(39), VOL, VOL1, AS, ZATO, WG                    CINP0340
      COMMON  /GAS/GASPL(19),  SMRG(19),   TCDG(19),   SGAM(19),        CINP0360
     X             SMWG(19),   SVDS(19),   VISG(19),   RHOGI(19),       CINP0380
     X             RHOG2(19),  VELG1(19),  VELG2(19),  TCGI(19),        CINP0400
     X            TCG2(19),    VSON(19)                                CINP0420
      COMMON  /P/ PC(300),    PC1(300),   PPC(20),    U2(300)           CINP0440
      COMMON  /COMPM/ CPMD1(21), ZIMPF, ZIMPO                           CINP0460
      COMMON  /PDS/ SMM(19),   SR(19),     STM(19)                      CINP0480
      COMMON  /SVV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,    CINP0500
     1            RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,     CINP0520
     2           WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,     CINP0540
     3            NSSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,     CINP0560
     4              PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,     CINP0580
     5              NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,     CINP0600
     6              IPR,  IZPR,    ND,   NPO,  SNCR,   II,   III,     CINP0620
     7             ETA1,  ETA2,   SCS, ZINCR, IKPF,  IKPO,  LAXI      CINP0640
     8           , ISEC, WASEC, MSTI, NEPS, PAMB, AEXIT, ECFVAC,      CINP0660
     9             NMACH, ECSTR1, PNS,   PIE,   RVAPF, RVAPO          CINP0680
      COMMON  /PRCON/ IPRSST, IPRMST                                    CINP0700
      COMMON  /COMT/   CA, RR                                           CINP0720
      COMMON  /ISCR/ NOZ N, NSTPZ                                       CINP0740
      DATA  PROPF,PROPO / 4HFUEL  , 4HOXID  /                           CINP0760
C * * FORMATS FOR INPUT DATA.                                          CINP0780
    5 FORMAT (18A4)                                                     CINP0800
    8 FORMAT(1H )                                                       CINP0820
   10 FORMAT (6I12)                                                     CINP0840
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   17 FORMAT (8E12.6)                                                    CINP0800
C                                                                        CINP0820
      CALL TIME                                                          CINP0840
C                                                                        CINP0860
C * * DATA INPUT. * * * * *                                            CINP0880
C                                                                        CINP0900
C * * ISEQ=1 FOR STR. TUBE INITIALIZATION BY PUNCHED-CARD INPUT,         CINP0910
C         =2 FOR INITIALIZATION BY L I S P  SCRATCH TAPE (SUBR. STAPE)   CINP0912
C * * LAXI=0 FOR I-D STR. TUBES (ISEQ=1) OR MIXTURE RATIO SCRAMBLED STR. CINP0920
C           TUBES IN RADIAL ZONES (ISEQ=2)                               CINP0922
C         =1 FOR AXISYMMETRIC STR. TUBES                                 CINP0924
C * * NOZON= NO. OF RADIAL ZONES, NSTPZ= NO. STR. TUBES/ZONE.           CINP0930
      WRITE(6,11901)                                                     CINP0980
        IF(ISEQX.GT.1)  GO TO 25                                         CINP0990
      WRITE(6,1200)                                                      CINP1000
C                                                                        CINP1040
C * * * CONTROL VARIABLES  AND  CHAMBER GEOMETRY                        CINP1060
      READ(5,10)    NOZON,  NSTPZ,  NGT,    NGF,    NP,     NAP,       CINP1070
     1              NSSTI,  NMSTI,  ICRC,   IPRSST, IPRMST             CINP1072
      WRITE(6,20)   NOZON,  NSTPZ,  NGT,    NGF,    NP,     NAP,       CINP1080
     1              NSSTI,  NMSTI,  ICRC,   IPRSST, IPRMST             CINP1082
      ICRC = MING(ICRC,4)                                                CINP1086
   20 FORMAT( 9HO NOZON = I9, 9H, NSTPZ = I9, 9H, NGT   = I9,            CINP1090
     1        9H, NGF   = I9, 9H, NP    = I9, 9H, NAP   = I9/           CINP1092
     2        9H  NSSTI = I9, 9H, NMSTI = I9, 9H, ICRC  = I9,           CINP1094
     3        9H, IPRSST= I9, 9H, IPRMST= I9)                           CINP1096
C                                                                        CINP1200
C * * * COMBUSTOR GEOMETRY DATA. APROF(J,2)=DIAMETER(IN.) IF APROF(1,2) CINP1220
C       IS POSITIVE,  =AREA(IN2.) IF APROF(1,2) IS NEGATIVE.             CINP1240
      READ(5,15) ((APROF(J,L),L=1,2),J=1,NAP)                            CINP1260
           WRITE(6,1215) ((APROF(J,L),L=1,2),J=1,NAP)                    CINP1280
      APROF(1,1) = 26                                                    CINP1282
      READ(5,15)   DEXIT,  PAMB,   ECFVAC, ZSTART, ZIMPF,  ZIMPO,       CINP1290
     1             CRTOL                                                 CINP1292
      WRITE(6,24)  DEXIT,  PAMB,   ECFVAC, ZSTART, ZIMPF,  ZIMPO,       CINP1322
     1             CRTOL                                                 CINP1332
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   24 FORMAT( 9HO DEXIT = 1PE10.3, 8H PAMB  = E10.3, 8H ECFVAC= E10.3,  CINP1310
     1         8H ZSTART=  E10.3, 8H ZIMPF = E10.3, 8H ZIMPD = E10.3/  CINP1312
     2        9H  CRTOL =  E10.3 )                                     CINP1314
C                                                                      CINP2100
      LAXI = 1                                                         CINP2102
      AFXIT = 0.785398*DEXIT**2                                        CINP2110
        NST = NOZON*NSTPZ                                              CINP2112
        IF(NSTYPE.NE.1)  NST = NST + 1                                 CINP2114
        IF(NST.GT.19)  GO TO 1400                                      CINP2116
   25 NPC = 1                                                          CINP2200
      XDPC = 2.0                                                       CINP2220
C                                                                      CINP2240
C  * * INITIAL-PLANE GAS AND SPRAY INPUT DATA.                         CINP2250
        IF(ILISP.EQ.0)  GO TO 30                                       CINP2260
   26 CALL STAPE                                                       CINP2280
      GO TO 37                                                         CINP2300
   30 IF(ICOX.GT.1)  GO TO 37                                          CINP2350
      READ(5,101)    NST,    NASEG                                     CINP2360
      NASEG = MAXO(NASEG,1)                                            CINP2362
      IF(NOZON.EQ.0)  LAXI = 0                                         CINP2364
C                                                                      CINP2490
      DO 35  J=1,NST                                                   CINP2500
      READ(5,15) AREAL(J),GASFL(J),SMRG(J), SNN(J),  SR(J),   STH(J)   CINP2520
      READ(5,15) (GWSPR(I,J),GVELDI(I,J),GDIADI(I,J), I=1,NGT)         CINP2540
   32 IF(NASEG.EQ.1)  GO TO 35                                         CINP2542
        FNAS = NASEG                                                   CINP2544
        AREAL(J) = FNAS * AREAL(J)                                     CINP2548
        GASFL(J) = FNAS * GASFL(J)                                     CINP2550
        SNN(J)   = NASEG* SNN(J)                                       CINP2552
        DO 34 I=1,NST                                                  CINP2554
   34   GWSPR(I,J) = FNAS*GWSPR(I,J)                                   CINP2556
   35 CONTINUE                                                         CINP2560
C                                                                      CINP2600
   37 CONTINUE                                                         CINP2602
            WRITE(6,1265) NST, NGT, NGF, NASEG                         CINP2604
            WRITE(6,1270)                                              CINP2610
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      WRITE(6,1275)  (J,AREAI(J),GASFL(J) SMRG(J), SNN(J),  SR(J),CINP2620
     1                  STM(J),J=1,NST)                          CINP2640
      WRITE(6,1280)                                              CINP2660
      DO 40  J=1,NST                                             CINP2680
      PROP = PROPS                                               CINP2700
        IF(NGF.LE.0)  PROP = PRC 0                               CINP2710
      DO 40  I=1,NGT                                             CINP2720
      WRITE(6,1285)  J, PROP, I, GWSPR(I,J), GVELD1(I,J),        CINP2740
     1                GOIAD1(I,J)                                CINP2760
      IF(I.EQ.NGF)  PROP = PROPO                                 CINP2780
   40 CONTINUE                                                   CINP2800
C                                                                CINP2805
      WRITE(6,1290)                                              CINP2810
C                                                                CINP2815
C * * INITIALIZATION OF CONDITIONS AT Z = ZSTART * * * * *       CINP2820
      NTS = NST                                                  CINP2845
      NC = 0                                                     CINP2850
      NGO = NGT - NGF                                            CINP2855
      DO 45  I=1,NP                                              CINP2880
   45 PSI(I) = PIE                                               CINP2900
      CCSAI = 0.0                                                CINP2920
      DO 50  I=1,NST                                             CINP2940
   50 CCSAI = CCSAI + AREAI(I)                                   CINP2960
C                                                                CINP2980
C * * * GENERATE DUMMY ARRAYS TO SAVE INPUT DATA IF AN AVERAGED SINGLE  CINP3000
C       STREAMTUBE CALCULATION IS TO BE MADE.                    CINP3020
C                                                                CINP3080
      DO 55  J=1,NST                                             CINP3100
      XAR(J) = AREAI(J)                                          CINP3120
      XGF(J) = GASFL(J)                                          CINP3140
      XMR(J) = SMRG(J)                                           CINP3160
      DO 55  I=1,NGT                                             CINP3180
      XWS(I,J) = GWSPR(I,J)                                      CINP3200
      XVS(I,J) = GVELD1(I,J)                                     CINP3220
      XDS(I,J) = GOIAD1(I,J)                                     CINP3240
   55 CONTINUE                                                   CINP3260
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C                                                                       CINP3340
C  * * FORMAT STATEMENTS FOR WRITE OUTPUT STATEMENTS.                   CINP3360
C                                                                       CINP3380
 1190 FORMAT(1H1 /// /// /// 43X 24HANALYTICAL   DESCRIPTION /// 36X 38HCINP3400
     1 MULTIPLE   STREAM   TUBE   COMBUSTION  /// 38X 32H B1PROPELLANT  CINP3420
     2 ROCKET   SYSTEMS /////31X 48HS T C   SECTION  OF   D E R   COMPUTCINP3440
     3ER   PROGRAM  )                                                   CINP3460
 1200 FORMAT(1H1// 4X 21HLISTING OF INPUT DATA   )                      CINP3580
 1215 FORMAT(6X,11HAPROF-ARRAY/(6X,1P6E16.5))                           CINP3680
 1265 FORMAT(6X    4HNST=I3, 8H,   NGT=I3, 8H,   NGF=I3,10H,   NASEC=I3)CINP4020
 1270 FORMAT(1H1,36X,30HSTREAMTUBE INITIALIZATION DATA /)                CINP4040
 1275 FORMAT(/11X,79HSTRM    AREA,       GAS FLOW,     MIXTURE      NO. CINP4060
     1CE       RADIAL      THETA,/11X,79HTUBE     IN2          LB/SEC  CINP4080
     2 RATIO, GAS     NODES       POSITION     RADIANS //               CINP4100
     3(10X,I2,1P6E13.4))                                                CINP4120
 1280 FORMAT(//30X,21HPROPELLANT SPRAY DATA/11X,53HSTRM   DROP SIZE   FLCINP4140
     1OW RATE,    VELOCITY,  DIAMETER,/11X,50HTUBE   GROUP NO.     LB/SECINP4160
     2C       FT/SEC      INCH /)                                       CINP4180
 1285 FORMAT(11X,I2,6X,A4,I3,1P3E13.4)                                  CINP4200
 1290 FORMAT(// 4X 33HEND OF  S T C  INPUT DATA LISTING )               CINP4210
      RETURN                                                            CINP4220
 1400 WRITE(6,1410)                                                     CINP4230
 1410 FORMAT(32H1  * * *  INVALID  INPUT  ENTERED  IN  CINPUT  * * * // CINP4232
     1  10X  48HFUNCTION  AND  NSTPZ  COMBINATION  MAKES  NST.GT.19  )  CINP4234
      CALL  EXIT                                                        CINP4236
      STOP                                                              CINP4238
      END                                                               CINP4240


      SUBROUTINE  STAPE                                                 STAP0100
C                                                                       STAP0150
      COMMON  /GRP/ GRP1(228), GVELD1(12,19), GRP2(228), GDIAD1(12,19), STAP0200
     1              R(20), AR(20,20), HH(20,20), TM(20,20), GRP3(376),  STAP0210
     2              GMSPR(12,19)                                        STAP0220
      COMMON  /CSTAP/ W1(20,20), W2(20,20), D1(20,20), D2(20,20),       STAP0230
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     1                 V1(20,20), V2(20,20)                                STAP0240
      COMMON  /ACZ/D(624), AREA1(19)                                      STAP0300
      COMMON  /GAS/GASFL(19),SMRG(19)                                     STAP0350
      COMMON  /POS/ SMN(19),    SR(19),      STH(19)                      STAP0400
      COMMON  /SVV/E(28),PCI,ZSTART,NST,NGT,NGF,F(22),LAXI,ISEQ,NASEG     STAP0450
      COMMON  /SCR/NIR,NIT,TIF1,TIF2,WGF,WGO,SUMA,FNAS,NGF1               STAP0500
      COMMON  /ISCR/  NOION, NSTPZ                                        STAP0510
      DIMENSION  DDR(6)                                                   STAP0550
      DATA  DDR / 0.45,0.69,0.86,1.12,1.43,1.92 /                         STAP0600
C                                                                         STAP0650
      M = 2                                                               STAP0700
      READ(M)    NTHL,NTHR,MESH,NTHML,NIR,DR,DTHD,IPUN                    STAP0720
C                                                                         STAP0740
      DTH = DTHD/57.2958                                                  STAP0760
      NST = NIR                                                           STAP0780
      NIT = NTHL - NTHR + 1                                               STAP0800
C                                                                         STAP0850
C     AREA ASSOCIATED WITH EACH MESH POINT.                               STAP0900
C                                                                         STAP0950
      NI = NIR - 1                                                        STAP1000
      NJ = NIT - 1                                                        STAP1050
      AR(1,1) = 0.25*DTH*(1.5*DR)**2                                      STAP1100
      AR(1,NIT) = AR(1,1)                                                 STAP1150
      AR(1,2) = 2.*AR(1,1)                                                STAP1200
      AR(NIR,1) = 0.25*DTH*DR*(NIR*DR -0.25*DR)                           STAP1250
      AR(NIR,NIT) = AR(NIR,1)                                             STAP1300
      AR(NIR,2) = 2.*AR(NIR,1)                                            STAP1350
C                                                                         STAP1400
      DO 20  J=3,NJ                                                       STAP1450
      AR(1,J) = AR(1,2)                                                   STAP1500
      AR(NIR,J) = AR(NIR,2)                                               STAP1550
   20 CONTINUE                                                            STAP1600
C                                                                         STAP1650
      R(1) = DR                                                           STAP1700
      DO 40  I=2,NI                                                       STAP1750
      R(I) = R(I-1) + DR                                                  STAP1800
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      AR(I,1) = 0.5*DTH*DR*R(I)                                          STAP1850
      AR(I,NIT) = AR(I,1)                                                STAP1900
      AR(I,2) = 2.*AR(I,1)                                               STAP1950
C                                                                        STAP2000
      DO 30  J=3,NJ                                                      STAP2050
      AR(I,J) = AR(I,2)                                                  STAP2100
   30 CONTINUE                                                           STAP2150
   40 CONTINUE                                                           STAP2200
C                                                                        STAP2250
      SUMW1 = 0.0                                                        STAP2272
      SUMW2 = 0.0                                                        STAP2274
      SUMA = 0.0                                                         STAP2280
      DO 50  I=1,NIR                                                     STAP2300
      READ (M)    (RM(I,J),TM(I,J),W1(I,J),W2(I,J),D1(I,J),D2(I,J),      STAP2350
     1             V1(I,J),V2(I,J),J=1,NIT)                            STAP2400
      DO 50  J=1,NIT                                                     STAP2420
      SUMW1 = SUMW1 + AR(I,J)*W1(I,J)                                    STAP2422
      SUMW2 = SUMW2 + AR(I,J)*W2(I,J)                                    STAP2424
      SUMA = SUMA + AR(I,J)                                              STAP2430
   50 CONTINUE                                                           STAP2450
C                                                                        STAP2500
      READ(M)     TIF1,    TIF2,    WGF,     WGO,     ZOM               STAP2550
      REWIND M                                                           STAP2560
C                                                                        STAP2570
      FF = TIF1/(SUMW1 * WGF)                                            STAP2580
      FO = TIF2/(SUMW2 * WGO)                                            STAP2590
           WRITE(6,52)  SUMW1, WGF, TIF1, FF, SUMW2, WGO, TIF2, FO       STAP2592
      WGF = WGF*FF/SUMA                                                  STAP2600
      WGO = WGO*FO/SUMA                                                  STAP2610
      NASEG = 360.1/(TM(1,NIT) - TM(1,1))                                STAP2620
      FNAS = NASEG                                                       STAP2630
      NGP1 = NGP + 1                                                     STAP2640
   52       FORMAT(1H1 // 5X 27HDATA FROM  STAPE AND SCRMBL  //          STAP2642
     1             7X,6HSUMW1=F10.6,6H, WGF=F10.6,7H, TIF1=F10.6,       STAP2643
     2             5H, FF=F10.6/7X,6HSUMW2=F10.6,6H, WGO=F10.6,7H, TIF2=STAP2644
     3             F10.6,5H, FO=F10.6)                                  STAP2645
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C                                                                       STAP2650
      DO 55  I=1,MIP                                                    STAP2660
      DO 55  J=1,NIT                                                    STAP2670
      W1(I,J) = FF*W1(I,J)*AR(I,J)                                      STAP2680
      W2(I,J) = FO*W2(I,J)*AR(I,J)                                      STAP2690
   55 CONTINUE                                                          STAP2700
C                                                                       STAP2710
      IF(NOZON.EQ.NIP1)  GO TO 57                                       STAP2720
C                                                                       STAP2730
C * * * GENERATE SOME FORM OF MIXTURE RATIO SCRAMBLED STREAM TUBES.     STAP2740
C                                                                       STAP2750
        IF(NGT.NE.21  NGP1 = 7                                          STAP2758
      CALL  SCRMBL                                                      STAP2760
      GO TO 72                                                          STAP2770
C                                                                       STAP2780
C * * * GENERATE AXISYMMETRIC STREAM TUBES BY ANNULAR AVERAGING.        STAP2790
   57 DO 70  I=1,MIP                                                    STAP2800
      SUM1 = 0.0                                                        STAP2810
      SUM2 = 0.0                                                        STAP2850
      SUM3 = 0.0                                                        STAP2900
      SUM4 = 0.0                                                        STAP2950
      SUM5 = 0.0                                                        STAP3000
      SUM6 = 0.0                                                        STAP3050
      SUM7 = 0.0                                                        STAP3060
      DO 60  J=1,NIT                                                    STAP3100
      SUM1 = SUM1 + AR(I,J)                                             STAP3150
      DW1 = W1(I,J)                                                     STAP3200
      DW2 = W2(I,J)                                                     STAP3250
      SUM2 = SUM2 + DW1                                                 STAP3300
      SUM3 = SUM3 + DW2                                                 STAP3350
      SUM4 = SUM4 + DW1*V1(I,J)                                         STAP3400
      SUM5 = SUM5 + DW2*V2(I,J)                                         STAP3450
      SUM6 = SUM6 + DW1/(D1(I,J)**3)                                    STAP3500
      SUM7 = SUM7 + DW2/(D2(I,J)**3)                                    STAP3550
   60 CONTINUE                                                          STAP3600
      AREA1(I) = PNAS*SUM1                                              STAP3650
```

```
      GASFL(I) = (NGF + NGG)*AREA(I)                                    STAP3660
      SMRG(I) = NGG/NGF                                                 STAP3670
      GMSPR(1,I) = FNAS*SUM2                                            STAP3700
      GMSPR(NGF1,I) = FNAS*SUM3                                         STAP3750
      GVELO1(1,I) = SUM4/SUM2                                           STAP3800
      GVELO1(NGF1,I) = SUM5/SUM3                                        STAP3850
      GDIAD1(1,I) = (SUM2/SUM6)**.3333                                  STAP3900
      GDIAD1(NGF1,I) = (SUM3/SUM7)**.3333                               STAP3950
   70 CONTINUE                                                          STAP4000
C                                                                       STAP4050
   72 IF(NGT.EQ.2)  GO TO 120                                           STAP4060
C  * * EACH PROPELLANT'S SPRAY IS DISTRIBUTED AMONG SIX SIZE GROUPS.    STAP4061
C        USING THE ZERO-SPACING LIKE-DOUBLET DATA IN AFRPL-TR-68-147.   STAP4062
C                                                                       STAP4070
      NGT = 12                                                          STAP4080
      NGF = 6                                                           STAP4090
      NGF1 = 7                                                          STAP4100
      DO 110  I=1,NST                                                   STAP4110
      M1 = 1                                                            STAP4120
      M2 = NGF                                                          STAP4130
      DO 110  J=1,2                                                     STAP4140
      IF(J.EQ.1)  GO TO 80                                              STAP4150
      M1 = NGF1                                                         STAP4160
      M2 = NGT                                                          STAP4170
   80 DBAR = GDIAD1(M1,I)                                               STAP4180
      GM = GMSPR(M1,I)                                                  STAP4190
      GV = GVELO1(M1,I)                                                 STAP4200
      N = 0                                                             STAP4210
      DO 100  M=M1,M2                                                   STAP4220
      N = N + 1                                                         STAP4230
      GDIAD1(M,I) = DBAR*DDR(N)                                         STAP4240
      GMSPR(M,I) = GM/6.                                                STAP4250
      GVELO1(M,I) = GV                                                  STAP4260
  100 CONTINUE                                                          STAP4270
  110 CONTINUE                                                          STAP4310
C                                                                       STAP4312
```

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C  * * GENERATE PUNCHED-CARD DECK OF STREAM TUBE INITIALIZATION.          STAP4313
C                                                                         STAP4314
  120 NSEQ = 7000                                                         STAP4320
      DO 150 I=1,NST                                                      STAP4350
      STH(I) = 0.0                                                        STAP4520
      IF(SPUM.EQ.0)  GO TO 150                                            STAP4550
      NSEQ = (NSEQ/10 + 1)*10                                             STAP4600
      PUNCH 130,AREA(I), GASFL(I), SMRG(I), SNN(I), SR(I), STH(I), NSEQ   STAP4650
  130 FORMAT(1P6E12.5,I6)                                                 STAP4700
      DO 140 M=1,MGT,2                                                    STAP4750
      N = M+1                                                             STAP4800
      NSEQ = NSEQ+1                                                       STAP4850
      PUNCH 130, GMSPR(M,I), GVELDI(M,I), GDIAD1(M,I),                    STAP4900
     1           GMSPR(N,I), GVELDI(N,I), GDIAD1(N,I), NSEQ               STAP4950
  140 CONTINUE                                                            STAP5000
  150 CONTINUE                                                            STAP5050
      RETURN                                                              STAP7950
      END                                                                 STAP8000


      SUBROUTINE  SCRMBL                                                  SCRM0020
C                                                                         SCRM0040
C  * * * SUBROUTINE PERFORMS FOUR FUNCTIONS IN CONVERTING  L I S P       SCRM0060
C     OUTPUT INTO STREAM TUBE INPUTS.  (1) DISTRIBUTES GAS PROPORTIONAL   SCRM0080
C     TO LOCAL AREA, WEIGHTED BY LOCAL MIXTURE RATIO.  (2) DISTRIBUTES    SCRM0100
C     MESH POINT FLOWS WITHIN EACH OF 5 ANNULAR ZONES TO MIXTURE-RATIO-   SCRM0120
C     SCRAMBLED STREAM TUBES. (3) LOCATES STR. TUBES IN A ZONE AT         SCRM0140
C     INCREASING RADIUS FOR INCREASING MIXTURE RATIO. (4) FORMS A WALL    SCRM0160
C     STREAM TUBE AT MEAN WALL MIXTURE RATIO (APPROX 10-PCT OF FLOW).     SCRM0170
C                                                                         SCRM0180
      COMMON  /GRP/ GRP1(228), GVELDI(12,19), GRP2(228), GDIAD1(12,19),   SCRM0200
     1              R(20), AR(20,20), GF(20,20), GO(20,20), GRP3(376),    SCRM0210
     2              GMSPR(12,19)                                          SCRM0220
      COMMON  /CSTAP/ M1(20,20), M2(20,20), D1(20,20), D2(20,20),         SCRM0230
     1                V1(20,20), V2(20,20), IC(2,400)                     SCRM0240
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      COMMON  /SAVE/ C(400)                                                  SCRM0250
      COMMON  /ACZ/D(6224), AREA1(19)                                        SCRM0300
      COMMON  /GAS/GASFL(19),SMRG(19)                                        SCRM0320
      COMMON  /PCS/SNN(19), SR(19)                                           SCRM0330
      COMMON  /SVV/E(28),PCI,ESTART,NST,NGT,NGF,F(22),LAXI,ISEQ,NASEG        SCRM0340
      COMMON  /ISCR/ NDZON, NSTPZ                                            SCRM0350
      COMMON  /SCR/NIR,NIT, NFT, NGT,NGF,NGO,SUMA,FNAS,NGF1                  SCRM0360
C                                                                            SCRM0400
C * * * GAS DISTRIBUTION AMONG MESH POINTS.                                  SCRM0414
C                                                                            SCRM0416
      SUMF = 0.                                                              SCRM0420
      SUMG = 0.                                                              SCRM0440
      DO 50  I=1,NIR                                                         SCRM0460
      DO 50  J=1,NIT                                                         SCRM0480
        CSPR = W2(I,J)/W1(I,J)                                               SCRM0500
        CF = (WGF * WGO)/(1. + CSPR)                                         SCRM0520
        GF(I,J) = CF*AR(I,J)                                                 SCRM0540
        GG(I,J) = GF(I,J)*CSPR                                               SCRM0560
        SUMF = SUMF + GF(I,J)                                                SCRM0580
   50   SUMG = SUMG + GG(I,J)                                                SCRM0600
C                                                                            SCRM0620
      FF = SUMA*WGF/SUMF                                                     SCRM0700
      FG = SUMA*WGO/SUMG                                                     SCRM0720
      DO 100  I=1,NIR                                                        SCRM0740
      DO 100  J=1,NIT                                                        SCRM0760
        GF(I,J) = GF(I,J)*FF                                                 SCRM0800
  100   GG(I,J) = GG(I,J)*FG                                                 SCRM0820
C                                                                            SCRM0822
        SUMF = C.                                                            SCRM0830
        SUMG = 0.                                                            SCRM0832
        SUMFS = 0.                                                           SCRM0834
        SUMGS = 0.                                                           SCRM0836
C                                                                            SCRM0840
C * * * SET ASIDE WALL STREAM TUBE FLOW.                                     SCRM0842
      SMAL = 0.                                                              SCRM0844
      CTT  = (NFT * NGT)/12.                                                 SCRM0846
```

```
      DO 130  I=1,NIR                                                    SCRM0848
      K = NIR - I + 1                                                    SCRM0852
      DO 120  J=1,NIT                                                    SCRM0856
  120 SMBL = SMBL + W1(K,J) * W2(K,J) * GF(K,J) * GO(K,J)                SCRM0860
      IF(SMBL.GE.OTT)  GO TO 140                                         SCRM0864
  130 CONTINUE                                                           SCRM0868
C                                                                        SCRM0872
  140 MIP = K - 1                                                        SCRM0874
          PCTT = SMBL/(WFT * WOT)                                        SCRM0876
          WRITE(6,141)  K, SMBL, PCTT, OTT                               SCRM0877
  141     FORMAT(//7X,3H K=I2,8H,  SMBL=F10.6,8H,  PCTT=F10.6,7H,  OTT=SCRM0878
     1           F10.6 //)                                               SCRM0879
      N1 = 1                                                             SCRM0880
      L1 = 1                                                             SCRM0884
      FRAM = (WOT * WFT - SMBL)/(FLOAT(NOZON) - 0.01)                    SCRM0888
      NOZ1 = NOZON + 1                                                   SCRM0890
      SUM = 0.                                                           SCRM0892
C                                                                        SCRM0893
C                                                                        SCRM0894
      DO 350  M=1,NOZ1                                                   SCRM0896
      SL = SUM                                                           SCRM0898
      IF(M.EQ.NOZ1)  MUP = NIR                                           SCRM0900
C                                                                        SCRM0901
C * * * DIVISION OF FLOW INTO RADIAL ZONES.                             SCRM0902
C                                                                        SCRM0903
        DO 160  I=N1,MUP                                                 SCRM0904
        N2 = I                                                           SCRM0908
C                                                                        SCRM0910
        DO 150  J=1,NIT                                                  SCRM0912
  150   SUM = SUM + W1(I,J) * W2(I,J) * GF(I,J) * GO(I,J)                SCRM0916
C                                                                        SCRM0918
      IF(M.LT.NOZ1 .AND. SUM.GE .FRAM*FLOAT(M))  GO TO 170               SCRM0920
  160   CONTINUE                                                         SCRM0924
C                                                                        SCRM0928
C                                                                        SCRM0930
  170 K = 0                                                              SCRM0932
```

```
            WRITE(6,171) N1,N2,SUM                                          SCRM0933
  171       FORMAT(//7X,4H N1=I2,6H  N2=I2,7H,  SUM=F10.6)                  SCRM0934
      WTFR = (SUM - SL)/(FLOAT(NSTPT) - 0.01)                               SCRM0936
C                                                                           SCRM0937
C * * * MESH POINT MIXTURE RATIOS, SORTED INTO ASCENDING ORDER.             SCRM0938
        DO 180  I=N1,N2                                                     SCRM0940
        DO 180  J=1,NIT                                                     SCRM0944
        K = K+1                                                             SCRM0948
        WFL = GF(I,J) * W1(I,J)                                             SCRM0952
        WOL = GO(I,J) * W2(I,J)                                             SCRM0956
  180   C(K) = WOL/WFL                                                      SCRM0960
C                                                                           SCRM0962
      N = K                                                                 SCRM0964
C                                                                           SCRM1000
      CALL  SORTR4(N,C,IC)                                                  SCRM1020
C                                                                           SCRM1040
      LN = 1                                                                SCRM1060
      SUMFL = 0.                                                            SCRM1080
      L2 = L1 + NSTPZ - 1                                                   SCRM1084
      IF(M.EQ.NOZ1)  L2 = L1                                                SCRM1090
C                                                                           SCRM1100
C * * * MIXTURE-RATIO-SCRAMBLING OF ZONE MESH POINTS.                       SCRM1101
C                                                                           SCRM1102
      DO 300  LST=L1,L2                                                     SCRM1120
        SUM1 = 0.                                                           SCRM1140
        SUM2 = 0.                                                           SCRM1160
        SUM3 = 0.                                                           SCRM1180
        SUM4 = 0.                                                           SCRM1200
        SUM5 = 0.                                                           SCRM1220
        SUM6 = 0.                                                           SCRM1240
        SUM7 = 0.                                                           SCRM1260
        SUM8 = 0.                                                           SCRM1280
        SUM9 = 0.                                                           SCRM1300
C                                                                           SCRM1320
      DO 250  L=LN,N                                                        SCRM1340
         K = IC(2,L)                                                        SCRM1380
```

```
          I = (K-1)/NIT + N1                                                    SCRM1400
          J = K - (I-N1)*NIT                                                    SCRM1420
          SUM1 = SUM1 + AR(I,J)                                                 SCRM1440
          DW1 = W1(I,J)                                                         SCRM1460
          DW2 = W2(I,J)                                                         SCRM1480
          SUMFL = SUMFL + DW1 + DW2 + GF(I,J) + GO(I,J)                         SCRM1500
          SUM2 = SUM2 + DW1                                                     SCRM1520
          SUM3 = SUM3 + DW2                                                     SCRM1540
          SUM4 = SUM4 + DW1*V1(I,J)                                             SCRM1560
          SUM5 = SUM5 + DW2*V2(I,J)                                             SCRM1580
          SUM6 = SUM6 + DW1/D1(I,J)**3                                          SCRM1600
          SUM7 = SUM7 + DW2/D2(I,J)**3                                          SCRM1620
          SUM8 = SUM8 + GF(I,J)                                                 SCRM1640
          SUM9 = SUM9 + GO(I,J)                                                 SCRM1660
        IF(L.EQ.N)  GO TO 200                                                   SCRM1680
        IF(LST.EQ.L2 .OR. SUMFL.LT.WTFR*FLOAT(LST-LI+1))  GO TO 250             SCRM1700
C                                                                               SCRM1708
C * * * ASSIGNMENT OF STREAM TUBE VARIABLES.                                   SCRM1710
C                                                                               SCRM1712
  200     AREA1(LST) = SUM1*FNAS                                                SCRM1720
          GASFL(LST) = (SUM8 + SUM9)*FNAS                                       SCRM1740
          SWRC(LST) = SUM9/SUM8                                                 SCRM1760
          SVH(LST) = NASEG*(L-LN+1)                                             SCRM1770
          GWTPR(1,LST) = SUM2*FNAS                                              SCRM1780
          GWTPR(NGP1,LST) = SUM3*FNAS                                           SCRM1800
          GVELD1(1,LST) = SUM4/SUM2                                             SCRM1820
          GVELD1(NGP1,LST) = SUM5/SUM3                                          SCRM1840
          GDIAD1(1,LST) = (SUM2/SUM6)**.3333                                    SCRM1860
          GDIAD1(NGP1,LST) = (SUM3/SUM7)**.3333                                 SCRM1880
          LN = L + 1                                                            SCRM1881
             SUMF = SUMF + SUM8                                                 SCRM1882
             SUMO = SUMO + SUM9                                                 SCRM1884
             SUMFS = SUMFS + SUM2                                               SCRM1886
             SUMOS = SUMOS + SUM3                                               SCRM1888
          GO TO 300                                                             SCRM1890
  250   CONTINUE                                                                SCRM1900
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  300   CONTINUE                                                          SCRM1920
C                                                                         SCRM1922
      N1 = N2 + 1                                                         SCRM1924
      L1 = L2 + 1                                                         SCRM1926
         WRITE(6,311) SUMFS,SUMOS,SUMF,SUMO                               SCRM1927
  350 CONTINUE                                                            SCRM1928
C                                                                         SCRM1930
      NST = L2                                                            SCRM1932
      ASUMI = 0.                                                          SCRM1933
      DO 360  I=1,NST                                                     SCRM1934
      ASUMO = ASUMI + AREA1(I)                                            SCRM1935
      SR(I) = SQRT((ASUMO + ASUMI)/6.28318)                               SCRM1936
  360 ASUMI = ASUMO                                                       SCRM1937
C                                                                         SCRM1940
  311       FORMAT(68H  OUTPUT FLOWRATES FROM  S C R M B L  PER SECTOR/   SCRM1944
     1             5X,13H FUEL SPRAY = F9.5,5X,13H OXID SPRAY = F9.5/    SCRM1946
     2             5X,13H FUEL IN GAS= F9.5,5X,13H OXID IN GAS= F9.5 )   SCRM1948
C                                                                         SCRM1950
      RETURN                                                              SCRM1960
      END                                                                 SCRM1980



      SUBROUTINE SORTR4(N,A,INT)                                          SORT0010
C                                                                         SORT0020
C***** CALLING SEQUENCE                                                   SORT0030
C                                                                         SORT0040
C       N: INTEGER*4 VARIABLE OR CONSTANT EQUAL TO THE NUMBER OF ITEMS    SORT0050
C          TO BE SORTED                                                   SORT0060
C                                                                         SORT0070
C       A: REAL*4 ARRAY OF ITEMS TO BE SORTED                             SORT0080
C                                                                         SORT0090
C     INT: INTEGER*4 ARRAY WHICH UPON RETURN IS ORDERED SUCH THAT THE     SORT0100
C          K'TH ELEMENT IS THE SUBSCRIPT OF THE K'TH SMALLEST ITEM OF     SORT0110
C          THE ARRAY A                                                    SORT0120
C                                                                         SORT0130
```

```
C**** RESTRICTIONS                                                    SORT0140
C                                                                     SORT0150
C     N MUST BE IN THE RANGE:  0<N<32768                              SORT0160
C                                                                     SORT0170
C     NOTE THAT THE ARRAY A IS NOT RE-ORDERED                         SORT0180
C                                                                     SORT0190
      DIMENSION INT(2,N), A(N)                                        SORT0200
      REAL MINIM                                                      SORT0210
      LOGICAL SW                                                      SORT0220
      IF(N .LE. 0 .OR. N .GE. 32768) GOTO 900                         SORT0230
      JWOD=1                                                          SORT0250
      MINIM=A(1)                                                      SORT0260
      DO 40 I=1,N                                                     SORT0270
      INT(1,I)=I                                                      SORT0280
   40 MINIM=AMIN1(MINIM,A(I))                                         SORT0290
 1000 IU=INT(JWOD,1)                                                  SORT0300
      IL=INT(JWOD,N)                                                  SORT0310
      IJ=1                                                            SORT0320
      IK=N                                                            SORT0330
      U=A(IU)                                                         SORT0340
      AL=A(IL)                                                        SORT0350
      X=MINIM                                                         SORT0360
      INDEX=1                                                         SORT0370
      K=0                                                             SORT0380
      L=1                                                             SORT0390
      M=1                                                             SORT0400
      SW=.TRUE.                                                       SORT0410
      JWOL=3-JWOD                                                     SORT0420
      KWOD=3-JWOD                                                     SORT0430
      DO 200 I=1,N                                                    SORT0440
      IF(X .GT. U) GO TO 70                                           SORT0450
      IF(X .GT.AL) GO TO 110                                          SORT0460
      IF(M .GT.AL) GO TO 130                                          SORT0470
      GO TO 125                                                       SORT0480
   70 IF(X .LE.AL) GO TO 130                                          SORT0490
      IF(M .LT. 0) GO TO 95                                           SORT0500
```

```
      M=-1                                                                  SORT0510
      L=INDEX                                                               SORT0520
      INDEX=N-K                                                             SORT0530
      GO TO 100                                                             SORT0540
   95 M=1                                                                   SORT0550
      K=N-INDEX                                                             SORT0560
      INDEX=L                                                               SORT0570
  100 IF(U .GE.ALL) GO TO 130                                               SORT0580
  110 SW=.FALSE.                                                            SORT0590
  120 INT(JMOD,INDEX)=IU                                                    SORT0600
      IF(IJ .EQ. N) GO TO 200                                               SORT0610
      IJ=IJ+1                                                               SORT0620
      IU=INT(KMOD,IJ)                                                       SORT0630
      X=U                                                                   SORT0640
      U=A(IU)                                                               SORT0650
      GO TO 200                                                             SORT0660
  130 SW=.FALSE.                                                            SORT0670
      INT(JMOD,INDEX)=IL                                                    SORT0680
      IK=IK-1                                                               SORT0690
      IL=INT(KMOD,IK)                                                       SORT0700
      X=AL                                                                  SORT0710
      AL=A(IL)                                                              SORT0720
  200 INDEX=INDEX+M                                                         SORT0730
      IF(.NOT. SW) GO TO 1000                                               SORT0740
      DO 260 I=1,N                                                          SORT0750
      INT(2,I)=INT(JMOD,I)                                                  SORT0760
  260 INT(1,I)=0                                                            SORT0770
      RETURN                                                                SORT0780
  900 PRINT 910,N                                                           SORT0790
  910 FORMAT('1ERROR IN SORTR4.  1ST ARG (',I10,' ) IS NOT IN THE RANGE     SORT0800
     1 1 TO 32767')                                                         SORT0810
      STOP 8                                                                SORT0820
      END                                                                   SORT0830
```

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      SUBROUTINE  CINIT                                                      CINI0050
C                                                                            CINI0060
      COMMON  /FPCOM/  FSCDI(5), IERX                                        CINI0100
      COMMON  /SAVE/XAR(19),    XGF(19),    XMR(19),    XWS(12,19),          CINI0110
     X              XVS(12,19), XDS(12,19)                                  CINI0115
      COMMON  /GRP/GRMCD(12,19),  GVELD1(12,19), GVELD2(12,19),              CINI0130
     X             GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),             CINI0140
     X             GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),            CINI0160
     X             GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),             CINI0180
     X             GDIAM(12,19)                                            CINI0200
      COMMON  /TBL/TMR(18), TTC(18,3), TVIS(18,3),TGAM(18,3),TMW(18,3),      CINI0220
     1             CSTR(18),TEPS(6),   TMACH(3),  TCF(18,6)                CINI0240
      COMMON  /ADI/APROF(12,2), CCSAR(300), Z(300),                          CINI0260
     X             AREA1(19),   AREA2(19),  DELARS(20)                     CINI0280
     X,            RBAR1(19),   RBAR2(19),  SINCR(19)                      CINI0290
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCDG(19),   SGAM(19),             CINI0300
     X             SMWG(19),   SVDS(19),   VISG(19),   RHOG1(19),          CINI0320
     X             RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),           CINI0340
     X             TCG2(19),   VSON(19),   STOT(19),   SMACH(19)           CINI0360
      COMMON  /KP/AKF(19),     AKO(19),     TVF(20),     TVO(20),           CINI0380
     X           CPVF(20),    CPVO(20),    TCONVF(20), TCONVO(20),         CINI0400
     X           FTKP(95),    DTKP(95),    FKP(95),     DKP(95)            CINI0420
      COMMON  /VAP/EVAPF(19), EVAPO(19),  SUMFC(19),  SUMOC(19)              CINI0440
      COMMON  /P/ PC(300),     PC1(300),    PPC(20),    U2(300)             CINI0460
      COMMON  /PS/P1(19),   P2(19),   DPDR(19), DRDS(19), DZDS(19)           CINI0470
      COMMON  /SUM/SMFLF(19), SMFLO(19), SDRAG(19), SSPRM(19), STMR(19)      CINI0480
      COMMON  /COMPW/  CPMC1(17), HTLOSS, CR, ECSMIX, ECSENR, ZIMPF,         CINI0500
     1                 ZIMPO, FCSMR, RPCIN                                   CINI0502
      COMMON  /VV/     NP,    NAP,   NMR,    NTK,   TNBF,    TBF,RHONBF,    CINI0510
     1               RHOLF,WTMLLF,WTMLVF,  TNBO,    TBO,RHONBO, RHOLO,     CINI0520
     2              WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,    IST,     CINI0530
     3               NSSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,      CINI0540
     4                 PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,      CINI0550
     5                NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,       CINI0560
     6                IPR,  IZPR,    ND,   NPG,  SNCR,    IZ,   III,       CINI0570
     7               ETA1,  ETA2,   SCS, ZINCR,  IKPF,  IKPO,  LAXI        CINI0590
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     8          , ISEQ, NASEG, MSTI, NEPS, PEXIT, AEXIT, ECRVAT,    CINI0592
     9          NMACH, ECSTRI, PNS, PIE, RVAPF, RVAPO                CINI0594
      COMMON  /COM6/ NISO, NRISO, IERR                                CINI0600
     X              , PXR(20), XMN(20), XI(20,20), RI(20,20)         CINI0602
      COMMON /COM7/ GA, RR, RT, ZT, ZPVSR, IZBC, PZ(20), RZ(20), PSTARI,CINI0610
     1              RATVAP, CD                                       CINI0612
      COMMON  /PRCON/ IPRSST, IPRMST                                  CINI0620
      DATA  PROPF,PROPO / 4HFUEL  , 4HOXID   /                        CINI0720
      DATA  R, PI, XDIA/ 1545., 3.14159, 25400./                      CINI0730
C                                                                     CINI0740
   17 FORMAT(1H1,18X,47H BIPROPELLANT LIQUID ROCKET COMBUSTION ANALYSIS CINI0742
     1               22H USING  S T C  PROGRAM  )                     CINI0744
   18 FORMAT(/ 38X,30H MULTIPLE STREAM TUBE ANALYSIS )                CINI0746
      IZ = 1                                                          CINI0750
      REWIND 2                                                        CINI0752
      NMACH = MAXO(1,NMACH)                                           CINI0754
   60 DO 70  J=1,NST                                                  CINI0760
      AREA1(J) = XAR(J)                                               CINI0780
      AREA2(J) = XAR(J)                                               CINI0790
      GASFL(J) = XOF(J)                                               CINI0800
      SMRG(J) = XMR(J)                                                CINI0820
C                                                                     CINI0840
      DO 70  I=1,NGT                                                  CINI0860
      GMSPS(I,J) = XMS(I,J)                                           CINI0880
      GVELO1(I,J) = XVS(I,J)                                          CINI0900
      GDIAO1(I,J) = XDS(I,J)                                          CINI0920
   70 CONTINUE                                                        CINI0940
C                                                                     CINI0960
C                                                                     CINI0980
C * * * MULTIPLE STREAM TUBE INITIALIZATION.                         CINI1000
      TGASF = 0.                                                      CINI1010
      TGASO = 0.                                                      CINI1012
      SSPSF = 0.                                                      CINI1014
      SSPSO = 0.                                                      CINI1016
        DO 60 J=1,NST                                                 CINI1020
        SUMFC(J) = GASFL(J)/(1.+SMRG(J))                              CINI1030
```

```
      SUMOC(J) = GASFL(J) - SUMFC(J)                                    CINI1040
      TGASF = TGASF + SUMFC(J)                                          CINI1050
      TGASC = TGASC + SUMOC(J)                                          CINI1060
        DO 80 I=1,NGT                                                   CINI1070
        IF(I.GT.NGF)  GO TO 78                                          CINI1080
        SSPRF = SSPRF + GWSPR(I,J)                                      CINI1090
        GO TO 80                                                        CINI1100
   78   SSPRO = SSPRO + GWSPR(I,J)                                      CINI1110
   80   CONTINUE                                                        CINI1120
      FFLOWF = (TMFLR/(TGASF+SSPRF)) * (1.-HTLOSS)                      CINI1130
      FFLOWO = (TMFLO/(TGASO+SSPRO)) * (1.-HTLOSS)                      CINI1140
        DO 84 J=1,NST                                                   CINI1150
        SUMFC(J) = FFLOWF*SUMFC(J)                                      CINI1160
        SUMOC(J) = FFLOWO*SUMOC(J)                                      CINI1170
        GASFL(J) = SUMFC(J) + SUMOC(J)                                  CINI1180
        SWRG(J) = SUMOC(J)/SUMFC(J)                                     CINI1190
        FFLOW = FFLOWF                                                  CINI1200
        IF(NGF.EQ.0) FFLOW = FFLOWO                                     CINI1210
          DO 84 I=1,NGT                                                 CINI1220
          IF(I.EQ.NGF+1)FFLOW = FFLOWO                                  CINI1230
   84     GWSPR(I,J) = FFLOW*GWSPR(I,J)                                 CINI1240
      SCS = 0.                                                          CINI1260
      DO 120  J=1,NST                                                   CINI1270
      SMFLF(J) = SUMFC(J)                                               CINI1280
      SMFLO(J) = SUMOC(J)                                               CINI1300
C                                                                       CINI1320
      DO 110  I=1,NGT                                                   CINI1340
      IF (I.LE.NGF)  GO TO 90                                           CINI1360
      RL = RMOLO                                                        CINI1380
      SMFLO(J) = SMFLO(J) + GWSPR(I,J)                                  CINI1400
      GO TO 100                                                         CINI1420
   90 RL = RMOLF                                                        CINI1440
      SMFLF(J) = SMFLF(J) + GWSPR(I,J)                                  CINI1460
  100 GNDCT1(I,J) = 8.0*GWSPR(I,J)/(PI*RL*GDIAD1(I,J)**3)               CINI1480
      GNOC1(I,J) = GNDCT1(I,J)/(12.0*AREA1(J)*GVELD1(I,J))              CINI1500
      GRMOD(I,J) = GWSPR(I,J)/(12.*AREA1(J)*GVELD1(I,J))                CINI1520
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  110 CONTINUE                                                          CINI1540
C                                                                       CINI1560
      SMACH(J) = 0.                                                     CINI1570
      STFLOW = SMFLO(J) + SMFLF(J)                                      CINI1580
      STMR(J) = SMFLO(J)/SMFLF(J)                                       CINI1600
      SCS = SCS + STFLOW*YOF(STMR(J),TMR,CSTR,NMR,2)                    CINI1620
  120 CONTINUE                                                          CINI1680
C                                                                       CINI1690
      SCS = SCS/((TMFLF + TMFLO)*TCSTR*ECSENR)                          CINI1720
      IF(NC.NE.0)  GO TO 124                                            CINI1730
C                                                                       CINI1740
      CALL  ESUBM(NST)                                                  CINI1750
C                                                                       CINI1760
      WRITE(6,1300)   SCS                                               CINI1790
C                                                                       CINI1800
C * * * THE VARIABLE SCS NOW EXPRESSES MIXING INEFFICIENCY CORRESPONDINGCINI1820
C       TO COMPLETE VAPORIZATION.                                       CINI1840
C                                                                       CINI1860
  124 IF(IST.NE.1)  GO TO 170                                           CINI1870
C                                                                       CINI1960
C * * * AVERAGED VALUES OF VARIABLES ARE GENERATED FOR PERFORMING A     CINI1980
C       SINGLE STREAM TUBE ANALYSIS APPROXIMATING THE MULTIPLE STREAMS. CINI2000
      NTS = 1                                                           CINI2040
C                                                                       CINI2060
C * * * * SINGLE STREAM TUBE COMBUSTION GAS STREAM PROPERTIES.         CINI2080
C                                                                       CINI2100
      ECSMIX = SCS                                                      CINI2110
      AREA1(1) = CCSAI                                                  CINI2120
      F = ECSMIX/CD                                                     CINI2130
      SUMFC(1) = TGASF*FFLOWF*F                                         CINI2140
      SUMOC(1) = TGASC*FFLOWC*F                                         CINI2160
      SMFLF(1) = TMFLF*(1.-HTLOSS)*F                                    CINI2180
      SMFLO(1) = TMFLO*(1.-HTLOSS)*F                                    CINI2200
      SMRG(1) = SUMOC(1)/SUMFC(1)                                       CINI2220
C                                                                       CINI2240
      CALL TABLES(1)                                                    CINI2260
```

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C                                                                       CINI2280
      TCG1(1) = TCOG(1)                                                 CINI2300
      PC(1) = PIE                                                       CINI2310
      DO 140  I=1,5                                                     CINI2320
      RMOG1(I) = PC(1)*SMWG(1)/(12.*R*TCG1(1))                          CINI2340
      VELG1(I) = (SUMFC(1)*SUMDC(1))/(12.*RMOG1(1)*AREA1(1))            CINI2360
      TCG1(I) = TCOG(1)*(1. - 0.5*((SGAM(I) - 1.)*(VELG1(1)/            CINI2380
     1          SVOS(1))**2))                                           CINI2400
      PC(I) = PIE*(TCG1(I)/TCOG(1))**(SGAM(I)/(SGAM(I)-1.))             CINI2410
  140 CONTINUE                                                          CINI2420
C                                                                       CINI2440
C * * * * SINGLE STREAM TUBE PROPELLANT SPRAY PROPERTIES.              CINI2460
C                                                                       CINI2480
C                                                                       CINI2500
      DO 160  I=1,NOT                                                   CINI2520
        IF(NST.LE.1)  GO TO 154                                         CINI2530
      DDUM = GNDOT1(I,1)*GDIAD1(I,1)**3.                                CINI2540
      VDUM = GWSPR(I,1)*GVELD1(I,1)                                     CINI2560
C                                                                       CINI2580
      DO 150  J=2,NST                                                   CINI2600
      GNDOT1(I,1) = GNDOT1(I,1) + GNDOT1(I,J)                           CINI2620
      GWSPR(I,1) = GWSPR(I,1) + GWSPR(I,J)                              CINI2640
      DDUM = DDUM + GNDOT1(I,J)*GDIAD1(I,J)**3                          CINI2660
      VDUM = VDUM + GWSPR(I,J)*GVELD1(I,J)                              CINI2680
  150 CONTINUE                                                          CINI2700
C                                                                       CINI2720
      GDIAG1(I,1) = (DDUM/GNDOT1(I,1))**(1./3.)                         CINI2740
      GVELD1(I,1) = VDUM/GWSPR(I,1)                                     CINI2760
  154 GWSPR(I,1) = F*GWSPR(I,1)                                         CINI2770
      GNOD1(I,1) = GNDOT1(I,1)/(12.*GVELD1(I,1)*AREA1(1))               CINI2780
     1             * F                                                  CINI2782
      GRMOD(I,1) = GWSPR(I,1)/(12.*AREA1(1)*GVELD1(I,1))                CINI2800
  160 CONTINUE                                                          CINI2820
C                                                                       CINI2840
      GO TO  200                                                        CINI2860
C                                                                       CINI2880
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C * * * COMPUTE MULTIPLE STREAM TUBE COMBUSTION GAS PROPERTIES.          CINI2900
C                                                                        CINI2920
  170 CALL TABLES(NST)                                                   CINI2940
C                                                                        CINI2960
      DO 190  J=1,NST                                                    CINI2980
      TCG1(J) = TCCG(J)                                                  CINI3000
      DO 180  I=1,3                                                      CINI3020
      RHOG1(J) = PC(1)*SMWG(J)/(12.*R*TCG1(J))                           CINI3040
      VELG1(J) = (SUMFC(J) + SUMCC(J))/(12.*RHOG1(J)*AREA1(J))           CINI3060
      TCG1(J) = TCCG(J)*(1. - 0.5*((SGAM(J) - 1.)*(VELG1(J)/             CINI3080
     1           SVOS(J))**2.))                                          CINI3100
  180 CONTINUE                                                           CINI3120
  190 CONTINUE                                                           CINI3140
C                                                                        CINI3160
      IF(MSTI.GT.0)  GO TO 210                                           CINI3170
C                                                                        CINI3180
  200 IPR = IPRSST                                                       CINI3200
      IF(IST.GT.1)  IPR = IPRMST                                         CINI3220
C                                                                        CINI3360
C                                                                        CINI3400
C * * * SUBROUTINE SETS UP Z-ARRAY, ASSOCIATED AREAS AND WRITES DATA.    CINI3420
C                                                                        CINI3440
      IF(NC.EQ.0 .AND. IFGX.EQ.1)  CALL  AVAR(NAP,NP, ZINCR,ZSTART,ZT)   CINI3460
      IF(IST.EQ.1)  AREA2(1) = CCSAR(2)                                  CINI3462
      RT = SQRT(CCSAR(NP)/PI)                                            CINI3470
      ZPVSR = ZT                                                         CINI3472
C                                                                        CINI3480
      IF(LAXI.NE.1 .OR. IST.EQ.1) GO TO 212                              CINI3564
        ZPVSR = ZT + XI(NISO,1)*RT                                       CINI3570
     X              *1.3                                                CINI3571
        NISO = MIN0(20,NISO+1)                                           CINI3574
  210 CONTINUE                                                           CINI3578
        CALL RCOSRO                                                      CINI3580
       ISTCRT = 1                                                        CINI3582
        IF(ISTCRT.EQ.1) CALL  STCRT(1,1,NST)                             CINI3584
  212 CONTINUE                                                           CINI3586
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      IZBC = (APROF(MAP-1,I)-ZSTART)/ZINCR + 1.                          CINI3592
      Z(NP+1) = Z(NP) + ZINCR                                            CINI3600
      DO 220  J=1,NST                                                    CINI3605
      DPDR(J) = 0.0                                                      CINI3607
      SINCR(J) = ZINCR                                                   CINI3608
      DZDS(J) = 1.                                                       CINI3609
  220 PL(J) = PC(I)                                                      CINI3610
C                                                                        CINI3620
      I = ZSTART/ZINCR + 0.1                                             CINI3625
      IZP = (I/IPR + 1)*IPR - I + 1                                      CINI3630
C                                                                        CINI3635
      IF(MC.NE.0) GO TO 260                                              CINI3650
C                                                                        CINI3660
C * * * SUBROUTINE KPRIME COMPUTES AND WRITES TABLES OF EVAP'N. COEFF.   CINI3680
C                                                                        CINI3700
      TCMAX = 100.                                                       CINI3720
      DO 230  J=1,NWP                                                    CINI3740
  230 TCMAX = AMAX1(TTC(J,NMACH),TCMAX)                                  CINI3760
      TCMAX = TCMAX + 100.                                               CINI3780
C                                                                        CINI3800
      RL = 1729.*RHOLC                                                   CINI3820
C                                                                        CINI3840
      WRITE(6,1200)                                                      CINI3850
      CALL  KPRIME(TBC,TCMAX,RL,DHVO,TVO,CPVO,TCONVO,NTK,IKPC,CTKP,CKP)  CINI3860
C                                                                        CINI3880
      RL = 1728.*RHOLF                                                   CINI3900
C                                                                        CINI3920
      CALL  KPRIME(TBF,TCMAX,RL,DHVF,TVO,CPVF,TCONVF,NTK,IKPF,FTKP,FKP)  CINI3940
C                                                                        CINI3960
C * * WRITE OUT FURTHER INITIALIZATION DATA.                             CINI3980
C                                                                        CINI4000
  260 IF (IST.EQ.NST)  GO TO 350                                         CINI4020
C                                                                        CINI4040
C * * * AVERAGED INITIAL-PLANE DATA FOR SINGLE STREAM TUBE ANALYSIS.     CINI4060
      N = MC + 1                                                         CINI4070
      WRITE(6,17)                                                        CINI4080
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      WRITE(6,1310)   N                                                  CINI4090
      WRITE(6,1320)  PROPF, TMFLF, PROPO, TMFLO, CMRI                    CINI4100
      PROP = PROPF                                                       CINI4120
      WRITE(6,1330)                                                      CINI4140
      DO 308  I=1,NGT                                                    CINI4160
      GDIAM(I,1) = XDIA * GDIADI(I,1)                                    CINI4180
      WRITE(6,1340)  PROP,    I,GDIAM(I,1),GNODI(I,1),GNDOT1(I,1),       CINI4200
     1               GRMOD(I,1),GVELDI(I,1),GMSPR(I,1)                   CINI4220
      IF(I.EQ.NGF)  PROP = PROPO                                         CINI4240
  308 CONTINUE                                                           CINI4260
      GASFL(1) = SUMFC(1) + SUMDC(1)                                     CINI4280
  310 WRITE(6,1400) GASFL(1),SMRG(1),TCGI(1),VELGI(1),PC(1)              CINI4300
      GO TO 400                                                          CINI4320
C                                                                        CINI4340
C                                                                        CINI4360
C * * * SOME ADDITIONAL MULTIPLE STREAMTUBE DATA ARE WRITTEN OUT.        CINI4380
  350 WRITE(6,17)                                                        CINI4399
      WRITE(6,18)                                                        CINI4400
      WRITE(6,1305)   PC(1)                                              CINI4410
      WRITE(6,1430) (J, GASFL(J), VELGI(J), SMRG(J), TCGI(J), RMDGI(J),  CINI4460
     1  J=1,NTS)                                                         CINI4480
C                                                                        CINI4500
C * * * ASSIGN VALUES AT Z1 TO VARIABLES AT Z2.                         CINI4520
C                                                                        CINI4540
  400 CALL  CHANGS(1,NTS,NGT)                                            CINI4570
C                                                                        CINI4600
      NPO = 0                                                            CINI4640
      ETA2 = 0.0                                                         CINI4660
      IF(NPC.EQ.1.AND.IST.NE.1)  GO TO 405                               CINI4720
      DO 402  I=1,NP                                                     CINI4740
  402 U2(I) =  VELGI(1)                                                  CINI4760
C                                                                        CINI4780
  405 CALL  TIME                                                         CINI4800
C                                                                        CINI4805
 1300 FORMAT(1H1)                                                        CINI4810
 1320 FORMAT(/5X,60HMIXING C*-EFFICIENCY CORRESPONDING TO COMPLETE EVAPO CINI4820
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     1RATION = 2PF9.3,6H PERCENT )                                      CINI4830
 1305 FORMAT(// 8X, 31H CHAMBER PRESSURE AT  Z=ZSTART                 35HCINI4840
     2FOR MULTIPLE STREAM TUBE ANALYSIS = OPF9.3,5H PSIA )              CINI4860
 1310 FORMAT(/20X,51HONE DIMENSIONAL ANALYSIS OF AN AVERAGED, EQUIVALENTCINI4880
     1              19H SINGLE STREAM TUBE//11X,13HITEPATION NO. I3 // )  CINI4890
 1320 FORMAT(10X,15HTOTAL FLOWRATES,8X,A4,2H = F8.4,7H LB/SEC /33X,A4,  CINI4900
     12H = F8.4,7H LB/SEC /16X,23HOVERALL MIXTURE RATIO = F8.4 //)      CINI4920
 1330 FORMAT(37X,30HAVERAGED PROPELLANT SPRAY DATA //3X,89HGROUP NO.   DCINI4940
     1IA.MICRONS    NO./IN3      NO./SEC    DENS,LB/IN3  VEL.,FT/SEC   FCINI4960
     2LOW,LB/SEC /)                                                     CINI4980
 1340 FORMAT(3X,A4,I4,2X,1P6E13.4)                                      CINI5000
 1400 FORMAT(//37X,30HAVERAGED COMBUSTION GAS STREAM //12X,20HWT.FLOWRATCINI5020
     1F,LB/SEC.= 1PE12.5,9X,14HMIXTURE RATIO= 1PE12.5/12X,20HTEMPERATURECINI5040
     2, DEG. R.= 1PE12.5,7X,16HVELOCITY,FT/SEC= 1PE12.5/12X,20HPRESSURE, CINI5060
     3PSIA     = 1PE12.5)                                               CINI5080
 1430 FORMAT(//40X,25HCOMBUSTION GAS CONDITIONS //14X,84HSTRM      FLOW CINI5160
     1RATE        VELOCITY          MIXTURE        TEMPERATURE        DENSCINI5180
     2ITY /14X,84HTUBE          LB/SEC          FT/SEC            RATIO   CINI5200
     3          R                LB/IN3 //                                CINI5220
     4(13X,I4,0PF15.6,F16.2,F16.4,F16.2,1PE20.5))                       CINI5240
C                                                                       CINI5260
        IF(ABS(F-1.).LT.0.5)  RETURN                                    CINI5270
        CALL  ERRTRA                                                    CINI5272
        PC(800000) = 1.                                                 CINI5274
      RETURN                                                            CINI5280
      END                                                               CINI5300


C                 *    A  V  A  R    *                                  AVAR0100
C                                                                       AVAR0120
      SUBROUTINE  AVAR(NAP,NP, DELX,X1D,XT)                             AVAR0140
C                                                                       AVAR0160
C                 APROF(J,L) IS CHAMBER GEOMETRY POINTS (X,Y)           AVAR0180
C                  ABS(NAP)=NO. POINTS                                  AVAR0200
C                  L=1 FOR AXIAL DISTANCE FROM INJECTOR IN INCHES       AVAR0220
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C                IF APROF(1,2) IS *, L=2 FOR DIAMETER IN INCHES          AVAR0240
C                IF APROF(1,2) IS -, L=2 FOR AREA IN SQ INCHES           AVAR0260
C                J=1 FOR INJECTOR  &  J=NAP FOR THROAT. NDI IS DIM ON JAVAR0280
C               X1D IS 1-D START LOCATION.                               AVAR0300
C               X & AREA ARE CALC AXIAL LOCATION AND AREA(SQ IN) ARRAYSAVAR0320
C                   X(1)=X1D    &    AREA(NP)=AT                        AVAR0340
C                   X(I) ARE SPACED BY EQUAL INCREMENTS                 AVAR0360
C                   AREA CALC USING LINEAR INTERPOLATION ON DEP. VAR.   AVAR0380
C               IF(APROF(2,1).EQ.0.) ALTERNATE POINTS FOR INNER & OUTERAVAR0400
C                   SURFACES.  NET AREA=ABS DIFF IN AREA BETW SURFACES.AVAR0420
C               AINJ IS INJECTOR AREA IN SQ FT                           AVAR0440
C               CR IS AREA CONTRACTION RATIO                             AVAR0460
C               IF APROF(1,1) NOT ZERO, THROAT WALL RADIUS OF CURVATUREAVAR0480
C                 / THROAT RADIUS SET = APROF(1,1) AND APROF(1,1) = 0.  AVAR0500
C                                                                        AVAR0520
      COMMON  /AOZ/ APROF(12,2), AREA(300), X(300),DUM(154),VOL,VOL1,AS  AVAR0540
      COMMON  /COM7/   CA, RR                                            AVAR0550
C       *    *  IF  NVAR = 2  OPTION USED,  DIMENSION  ASAVE(300) *    *  AVAR0560
      DIMENSION  ASAVE(1)                                                AVAR0580
      EQUAL LSTAR                                                        AVAR0600
      DATA JFLAG/0/                                                      AVAR0620
      DATA PI/3.14159/                                                   AVAR0640
C                                                                        AVAR0660
      IVAR=1                                                             AVAR0680
      NVAR=1                                                             AVAR0700
      IF(NAP.EQ.0.) RETURN                                               AVAR0720
      A1=APROF(1,2)                                                      AVAR0740
      IF(APROF(2,1).EQ.0.) NVAR=2                                        AVAR0760
      IF(A1.LT.0.)IVAR=2                                                 AVAR0780
      APROF(1,2)=ABS(A1)                                                 AVAR0800
      XT = APROF(NAP,1)                                                  AVAR0820
      IERR=0                                                             AVAR0840
      XBC = APROF(NAP-1,1)                                               AVAR0870
      APROF(1,1) = 0.                                                    AVAR0880
      IF(IVAR.NE.1 .OR. RR.LE.0.)  GO TO 8                               AVAR0900
        RT = APROF(NAP,2)/2.                                             AVAR0920
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      RC = RR*RT                                                        AVAR0940
      RBC = APROF(NAP-1,2)/2.                                           AVAR0980
        D1 = RT*RC-RBC                                                  AVAR1000
        D2 = XT-XBC                                                     AVAR1020
        D3 = SQRT(D1**2+D2**2)                                          AVAR1040
        BETA = ATAN(ABS(D1)/D2)                                         AVAR1042
        IF(D1.LT.0.)  BETA = -BETA                                      AVAR1044
      IF(D3.GT.RC) GO TO 6                                              AVAR1060
          XBC = XT                                                      AVAR1080
          GO TO 8                                                       AVAR1100
    6 ALPHA = ATAN(RC/SQRT(D3**2-RC**2)) - BETA                         AVAR1120
      TANA = TAN(ALPHA)                                                 AVAR1140
      XTAN = XT-RC*SIN(ALPHA)                                           AVAR1160
    8 DELX=(APROF(NAP,1)-X10)/FLOAT(NP-1)                               AVAR1180
      NPM=NP-1                                                          AVAR1200
      K2=1+NVAR                                                         AVAR1220
      K2OLD=0.                                                          AVAR1240
      X(1)=X10                                                          AVAR1260
      DO 10 I=2,NPM                                                     AVAR1280
   10 X(I)=X(I-1)+DELX                                                  AVAR1300
      X(NP)=APROF(NAP,1)                                                AVAR1320
C                                                                       AVAR1340
   12 CONTINUE                                                          AVAR1360
      DO 60 I=1,NPM                                                     AVAR1380
C                                                                       AVAR1400
        IF(IVAR.NE.1 .OR. RR.LE.0.1  GO TO 18                           AVAR1410
        IF(X(I).LE.XBC) GO TO 18                                        AVAR1420
        IF(X(I).GT.XTAN) GO TO 16                                       AVAR1440
C         TANGENT  TO  THROAT  WALL  RADIUS   SECTION                   AVAR1460
        AREA(I) = 2.*(RBC-(X(I)-XBC)*TANA)                              AVAR1480
        GO TO 60                                                        AVAR1500
C         THROAT  WALL  RADIUS   SECTION                                AVAR1520
   16   AREA(I) = 2.*(RT*RC-SQRT(RC**2-(XT-X(I))**2))                   AVAR1540
        K2 = NAP                                                        AVAR1560
        GO TO 60                                                        AVAR1580
C                                                                       AVAR1600
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   10 DO 20 J=K2,NAP,NVAR                                          AVAR1620
      IF(X(I).LT.APROF(J,1)) GO TO 30                              AVAR1640
   20 CONTINUE                                                     AVAR1660
      J=J-NVAR                                                     AVAR1680
C                                                                  AVAR1700
   30 K2=J                                                         AVAR1720
      K1=K2-NVAR                                                   AVAR1740
      IF(X(I).NE.APROF(K1,1)) GO TO 50                             AVAR1760
   40 AREA(I)=APROF(K1,2)                                          AVAR1780
      GO TO 60                                                     AVAR1800
C                                                                  AVAR1820
   50 IF(K2.EQ.K2OLD.AND.DENOM.GT.1.E-12) GO TO 54                 AVAR1840
      DENOM=APROF(K2,1)-APROF(K1,1)                                AVAR1860
      IF(DENOM.GT.1.E-12) GO TO 52                                 AVAR1880
      IF(ABS(DENOM).LT.1.E-12) GO TO 40                            AVAR1900
      IERR=1                                                       AVAR1920
      GO TO 60                                                     AVAR1940
   52 SLOPE=(APROF(K2,2)-APROF(K1,2)) / DENOM                      AVAR1960
      K2OLD=K2                                                     AVAR1980
C                                                                  AVAR2000
   54 IF(ABS(SLOPE).LT.1.E-12) GO TO 40                            AVAR2020
      AREA(I)=APROF(K1,2) + SLOPE*(X(I)-APROF(K1,1))               AVAR2040
C                                                                  AVAR2060
   60 CONTINUE                                                     AVAR2080
      IF(NVAR.EQ.1)  K2 = NAP                                      AVAR2090
      AREA(NP)=APROF(NAP,2)                                        AVAR2100
C                                                                  AVAR2120
      IF(IVAR.EQ.2) GO TO 62                                       AVAR2140
      FACT=PI/4.                                                   AVAR2160
      DO 61 I=1,NP                                                 AVAR2180
   61 AREA(I)=FACT*AREA(I)**2                                      AVAR2200
      GO TO 66                                                     AVAR2220
C                                                                  AVAR2240
   62 FACT=1.                                                      AVAR2260
C                                                                  AVAR2280
   64 IF(NVAR.EQ.1) GO TO 66                                       AVAR2300
```

```
      IF(K2.GE.NAP) GO TO 66                                                    AVAR2320
C                                                                               AVAR2340
      K2=4                                                                      AVAR2360
      K2OLD=0                                                                   AVAR2380
      DO 65 I=1,NP                                                              AVAR2400
   65 ASAVE(I)=AREA(I)                                                          AVAR2420
      GO TO 12                                                                  AVAR2440
C                                                                               AVAR2460
   66 DO 67 I=1,NP                                                              AVAR2480
   67 AREA(I)=ABS(AREA(I)-ASAVE(I))                                             AVAR2500
C                                                                               AVAR2520
   68 WRITE(6,69)                                                               AVAR2540
   69 FORMAT(1H1)                                                               AVAR2560
      WRITE(6,70) ((APROF(I,J),J=1,2),I=1,NAP)                                  AVAR2580
   70 FORMAT(//45X,20HCHAMBER AREA PROFILE //2X, 4(26HDIST FROM INJ    ARAVAR2600
     1EA/DIA   )//(2X,1P8E13.3))                                                AVAR2620
      IF(IERR.EQ.01 GO TO 73                                                    AVAR2640
   71 WRITE(6,72)                                                               AVAR2660
   72 FORMAT(////30X,47HE R R O R  IN  APROF  INPUT. JOB TERMINATED.)           AVAR2680
      CALL EXIT                                                                 AVAR2700
        STOP                                                                    AVAR2710
   73 JPLAC=1                                                                   AVAR2720
C                                                                               AVAR2740
      IF(IVAR.EQ.2) GO TO 74                                                    AVAR2760
      AINJ=FACT*APROF(1,2)**2                                                   AVAR2780
      IF(NVAR.EQ.2) AINJ=ABS(FACT*APROF(2,2)**2-AINJ)                           AVAR2800
      GO TO 76                                                                  AVAR2820
   74 AINJ=FACT*APROF(1,2)                                                      AVAR2840
      IF(NVAR.EQ.2) AINJ=ABS(FACT*APROF(2,2)-AINJ)                              AVAR2860
C                                                                               AVAR2880
C               CHAMBER WALL AREA, CHAM VOLUME & L-STAR                         AVAR2900
   76 CR=AINJ/AREA(NP)                                                          AVAR2920
      AS=0.                                                                     AVAR2940
      VOL=0.                                                                    AVAR2960
      II=1                                                                      AVAR2980
   78 X2=APROF(II,2)/2.                                                         AVAR3000
```

```
      I2=I1+NVAR                                                        AVAR3040
C                                                                       AVAR3060
      DO 34 J=I2,NAP,NVAR                                               AVAR3080
      K=J-NVAR                                                          AVAR3100
      IF(J.EQ.NAP .AND. DR.GT.0.) GO TO 81                              AVAR3110
      DL=APROF(J,1)-APROF(K,1)                                          AVAR3120
      IF(IVAR.EQ.2) GO TO 80                                            AVAR3140
      R1=R2                                                             AVAR3150
      R2=APROF(J,2)/2.                                                  AVAR3160
      S=SQRT(DL**2+(R1-R2)**2)                                          AVAR3200
      AS=AS+PI*S*(R1+R2)                                                AVAR3220
      VOL = VOL + PI*DL*(R1*R1+R2*R2+R1*R2)/3.                          AVAR3230
        IF(APROF(K,1).GE.X1D .OR. X1D.GT.APROF(J,1)) GO TO 84           AVAR3240
        RX=R1 +(R2-R1)*(X1D-APROF(K,1))/DL                              AVAR3250
        VOL1=VOL - PI*(APROF(J,1)-X1D)*(RX*RX+R2*R2+RX*R2)/3.           AVAR3260
      GO TO 84                                                          AVAR3300
C                                                                       AVAR3320
   80 VOL=VOL+(APROF(J,2)+APROF(K,2))*DL*0.5                            AVAR3340
        IF(X1D.GT.APROF(K,1) .AND. APROF(J,1).GE.X1D) VOL1 = VOL -      AVAR3342
     1  (APROF(J,1)-X1D) * (APROF(K,2)+(APROF(J,2)-APROF(K,2)) *        AVAR3344
     2  (X1D-APROF(K,1))/DL + APROF(J,2))/2.                            AVAR3346
      GO TO 84                                                          AVAR3348
C                                                                       AVAR3350
   81 IF(X1D.GT.XBC) GO TO 71                                           AVAR3351
      I = (XBC-X1D)/DELX + 1.0                                          AVAR3352
      IX = I+2                                                          AVAR3354
      A = AREA(I) + (AREA(I+1)-AREA(I))*(XBC-X(I))/DELX                 AVAR3356
      DL = X(I+1)-XBC                                                   AVAR3357
      VOL = VOL + DL*(A+AREA(I+1))/2.                                   AVAR3358
        IF(IVAR.EQ.2) GO TO 82                                          AVAR3360
      R1 = SQRT(A/PI)                                                   AVAR3361
      R2 = SQRT(AREA(I+1)/PI)                                           AVAR3362
      AS = AS + SQRT(DL*DL+(R2-R1)**2)*PI*(R1+R2)                       AVAR3364
   82 CONTINUE                                                          AVAR3370
        DO 83 I=IX,NP                                                   AVAR3372
          IF(IVAR.EQ.2) GO TO 83                                        AVAR3378
```

```
      R1 = R2                                                          AVAR3380
      R2 = SQRT(AREA(I)/PI)                                            AVAR3382
      AS = AS + SQRT(DELX**2+(R2-R1)**2) * PI * (R1+R2)                AVAR3384
   82 VOL = VOL + DELX*(AREA(I-1)+AREA(I))/2.                          AVAR3386
C                                                                      AVAR3388
   84 CONTINUE                                                         AVAR3390
C                                                                      AVAR3400
      IF(NVAR.EQ.1) GO TO 88                                           AVAR3420
      IF(I1.EQ.2) GO TO 86                                             AVAR3440
      I1=2                                                             AVAR3460
      VOL=-VOL                                                         AVAR3480
      GO TO 78                                                         AVAR3500
   86 VOL=ABS(VOL)                                                     AVAR3520
C                                                                      AVAR3540
   88 LSTAR=VOL/AREA(NP)                                               AVAR3560
      CR=AINJ/AREA(NP)                                                 AVAR3580
      WRITE(6,90) AINJ,CR,VOL,LSTAR,AS,VOL1                            AVAR3600
     X ,X1D                                                            AVAR3602
   90 FORMAT(///8X,14HINJECTOR AREA= F8.3,5X,18HCONTRACTION RATIO= F8.3,AVAR3620
     1 5X 15HCHAMBER VOLUME=F10.3/8X 7HL-STAR= F8.2,5X 18HCHAMBER WALL ARAVAR3640
     2EA= F9.2, 5X 23HVOLUME UPSTREAM OF X1D=F10.3, 5X 4HX1D= F7.3)    AVAR3660
C                                                                      AVAR3680
      IF(RR.GT.0.) WRITE(6,94) RR                                      AVAR3700
   94 FORMAT(8X 35HTHROAT WALL CURVATURE RADIUS RATIO=  F6.3)          AVAR3720
C                                                                      AVAR3740
  100 CONTINUE                                                         AVAR3760
C                                                                      AVAR3771
      NPP = MIN0(NP+1,300)                                             AVAR3772
      NPE = MIN0(NP+25,2*NP-1,300)                                     AVAR3773
      DO 104 I=NPP,NPE                                                 AVAR3774
      J = NP-(I-NP)                                                    AVAR3775
      AREA(I) = AREA(J)                                                AVAR3776
  104 X(I) = X(I-1)+DELX                                               AVAR3778
      WRITE(6,110) (X(I),AREA(I),I=1,NPM,10), X(NP),AREA(NP)           AVAR3780
     X           ,(X(I),AREA(I),I=NPP,NPE)                           AVAR3790
  110 FORMAT(1HO 31X 58HCHAMBER AREA (IN2) VS DISTANCE (IN) FROM INJECTOAVAR3800
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      1R (Z,AREA) // 4(F11.2,G15.5))                                        AVAR3820
       APROF(1,21=A1                                                        AVAR3840
       RETURN                                                               AVAR3880
       END                                                                  AVAR3900


       SUBROUTINE  CGDY4(NPI)                                               CGDY0050
C                                                                           CGDY0060
       COMMON  /CRP/GRHOD(12,19),  GVELD1(12,19), GVELD2(12,19),            CGDY0120
      X              GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),           CGDY0140
      X              GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),          CGDY0160
      X              GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),           CGDY0180
      X              GDIAM(12,19)                                          CGDY0200
       COMMON  /AOZ/APROF(12,2), CCSAR(300), Z(300),                        CGDY0260
      X              AREA1(19),   AREA2(19),  DELARS(20)                   CGDY0280
      X,             RBAR1(19),   RBAR2(19),  SINCR(19)                    CGDY0290
      X,             SUMSTA                                                CGDY0292
       COMMON  /GAS/GASFL(19),  SMRG(19),   TCOG(19),   SGAM(19),           CGDY0300
      X              SMMG(19),   SVCS(19),   VISG(19),   RMCG1(19),        CGDY0320
      X              RMCG2(19),  VELG1(19),  VELG2(19),  TCG1(19),         CGDY0340
      X              TCG2(19),   VSON(19),   STO7(19),   SMACH(19)         CGDY0360
       COMMON  /VAP/EVAPF(19), EVAPO(19),  SUMFC(19),  SUMOC(19)            CGDY0440
       COMMON  /P/ PC(300),    PC1(300),   PPC(20),    U2(300)              CGDY0460
       COMMON  /PS/P1(19),   P2(19),   DPDR(19), DRDS(19), DZDS(19)         CGDY0470
       COMMON  /SUM/SMFLF(19), SMFLO(19), SDRAG(19), SSPRM(19), STMR(19)    CGDY0480
       COMMON  /VV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,       CGDY0510
      1              RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,      CGDY0520
      2             WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,      CGDY0530
      3              NSSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,      CGDY0540
      4                PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,      CGDY0550
      5                NIS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,      CGDY0560
      6                IPR,  IZPR,    ND,   NPQ,  SNCR,    IZ,   III,     CGDY0570
      7              ETA1,  ETA2,   SCS, ZINCR,  IKPF,  IKPO,  LAXI        CGDY0590
       COMMON  /COM7/GA, RR, RT, ZT, ZPVSR, IZBC,  PZ(20), RZ(20)           CGDY0600
       DIMENSION  ANORM1(19),ANORM2(19),WDOT1(19)                           CGDY0620
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      DATA  GC, R, PI / 32.174, 1545., 3.14159 /                        CGDY0730
C                                                                       CGDY0800
      IF(III.GT.1)  GO TO 520                                           CGDY0810
      IF(IZ.NE.NPI)  GO TO 510                                          CGDY0820
         DO 505  NT=1,NTS                                               CGDY0830
         ANORM2(NT) = AREA1(NT)*DZDS(NT)                                CGDY0840
  505    CONTINUE                                                       CGDY0850
C                                                                       CGDY0860
  510    DO 515  NT=1,NTS                                               CGDY0870
         ANORM1(NT) = ANORM2(NT)                                        CGDY0880
         MDOT1(NT) = GASFL(NT)                                          CGDY0890
  515    CONTINUE                                                       CGDY0900
  520 CONTINUE                                                          CGDY0910
C                                                                       CGDY0920
C * * * * SUBROUTINE TABLES PROVIDES COMBUSTION GAS PROPERTIES.        CGDY0940
C                                                                       CGDY0960
      CALL  TABLES(NTS)                                                 CGDY0980
C                                                                       CGDY1000
      III = III + 1                                                     CGDY1020
C                                                                       CGDY1080
C * * * * UPDATE ESTIMATES OF GASDYNAMIC VARIABLES                     CDGY1100
C                                                                       CGDY1140
      DO 525 NT = 1,NTS                                                 CGDY1160
      TCG2(NT) = TCOG(NT)*(1.-(SGAM(NT)-1.)*(VELG2(NT)/SVOS(NT))**2/2.) CGDY1180
      RHOG2(NT) = PZ(NT)*SMWG(NT)/(12.*R*TCG2(NT))                      CGDY1200
      GASFL(NT) = SUMOC(NT) + SUMFC(NT)                                 CGDY1210
  525 CONTINUE                                                          CGDY1320
C                                                                       CGDY1340
      IF(IST.EQ.1)  GO TO 660                                           CGDY1350
C                                                                       CGDY1460
C * * * * * * * *                                                       CGDY1480
C                                                                       CGDY1500
C                                                                       CGDY1600
      SUMSTA = 0.                                                       CGDY1620
C                                                                       CGDY1640
      DO  550  NT=1,NST                                                 CGDY1700
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```
      ABAR = (ANORM1(NT) + AREA2(NT)*DZDS(NT))/2.                          CGDY1720
C                                                                          CGDY1740
      C = (P2(NT) - P1(NT))*TCOG(NT)*R*GC/(2.*P2(NT)*SMWG(NT))             CGDY1760
      A = 1. - C*(SGAM(NT) - 1.)/(2.*SVOS(NT)**2)                          CGDY1780
      B = -(WDOT1(NT)*VELG1(NT) + ABAR*(SSPRM(NT) - GC*SDRAG(NT))*         CGDY1800
     1       SINGR(NT) + GC*ANORM1(NT)*(P1(NT) - P2(NT))/2.)/GASFL(NT)     CGDY1820
      IF(B**3.GE.4.*A*C)  GO TO 532                                        CGDY1822
      IF(III.GT.ICRC+1)  GO TO 528                                         CGDY1824
        VELG2(NT) = -0.5*B/A                                               CGDY1826
        GO TO 534                                                          CGDY1828
  528 WRITE(6,530)  Z(IZ), III, NT                                         CGDY1830
  530 FORMAT(//10X,2HZ= F7.3,6H, III= I2,5H, NT= I2)                       CGDY1832
  532 VELG2(NT) = QUAD(A,B,C,VELG2(NT))                                    CGDY1840
C                                                                          CGDY1842
  534 IF(VELG2(NT).GT.0.5*VELG1(NT))  GO TO 540                            CGDY1844
      IF(III.GT.ICRC+1)                                                    CGDY1845
     XWRITE(6,535)  Z(IZ), III, NT, VELG2(NT), NT, VELG1(NT)               CGDY1846
  535 FORMAT(//10X,2HZ= F7.3,6H, III= I2, 8H, VELG2( I2,2H)= F9.3,         CGDY1848
     1       34H WAS OVERRIDDEN WITH 1/2 OF VELG1( I2,2H)= F9.3 )          CGDY1850
      VELG2(NT) = 0.5*VELG1(NT)                                            CGDY1852
  540 CONTINUE                                                             CGDY1854
C                                                                          CGDY1856
      TCG2(NT) = TCOG(NT)*(1.-(SGAM(NT)-1.)*(VELG2(NT)/SVOS(NT))**2 /2.)CGDY1860
      RHOG2(NT) = P2(NT)*SMWG(NT)/(12.*R*TCG2(NT))                         CGDY1880
      IF(RHOG2(NT).LT.0.)  CCSAR(200000) = 1.                              CGDY1890
      AREA2(NT) = GASFL(NT)/(12.*RHOG2(NT)*VELG2(NT)*DZDS(NT))             CGDY1900
  550 SUMSTA = SUMSTA+AREA2(NT)                                            CGDY1920
      D = CCSAR(IZ)/SUMSTA                                                 CGDY1940
        IF(Z(IZ).GE.ZPWSR .AND. LAXI.GT.0)  GO TO 612                      CGDY2290
          IF(D.LT.0.2 .OR. D.GT.5.)    CCSAR(200000) = 1.                  CGDY2300
C                                                                          CGDY2400
      SUMPA = 0.                                                           CGDY2410
      SUMAN = 0.                                                           CGDY2415
  600 DO 610  NT=1,NST                                                     CGDY2420
      AREA2(NT) = D*AREA2(NT)                                              CGDY2440
      ANORM = AREA2(NT)*DZDS(NT)                                           CGDY2460
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      ABAR = (ANORM1(NT) + ANORM)/2.                                          CGDY2480
C                                                                             CGDY2500
      C = ABAR*GC*R*TCOG(NT)/(ANORM*SMWG(NT))                                 CGDY2520
      A = 1. - C*(SGAM(NT) - 1.)/(2.*SVOS(NT)**2)                             CGDY2540
      B = -(WDOTI(NT)*VELG1(NT) + ABAR*(SINCR(NT)*(SSPRM(NT) -                CGDY2560
     1      GC*SDRAG(NT)) + GC*P1(NT)))/GASFL(NT)                            CGDY2580
      IF(B**2 .LT. 4.*A*C)   WRITE(6,530)  Z(IZ), III, NT                     CGDY2590
      VELG2(NT) = QUAD(A,B,C,VELG2(NT))                                       CGDY2640
      TCG2(NT) = TCOG(NT)*(1.-(SGAM(NT)-1.)*(VELG2(NT)/SVOS(NT))**2/2.)       CGDY2660
      RHOG2(NT) = GASFL(NT)/(12.*VELG2(NT)*ANORM)                             CGDY2680
      P2(NT) = 12.*RHOG2(NT)*R*TCG2(NT)/SMWG(NT)                              CGDY2700
      SUMPA = SUMPA +P2(NT)*ANORM                                             CGDY2720
      SUMAN = SUMAN + ANORM                                                   CGDY2740
  610 CONTINUE                                                                CGDY2780
      PBAR = SUMPA/SUMAN                                                      CGDY2790
C                                                                             CGDY2800
      PC(IZ) = PBAR                                                           CGDY2820
      DO 609 I=1,NST                                                          CGDY2840
  609 P2(I) = PBAR                                                            CGDY2850
  612 CONTINUE                                                                CGDY2990
      DO 613 J=1,NST                                                          CGDY2994
  613 SMACH(J) = 1./SQRT( (SVOS(J)/VELG2(J))**2 - SGAM(J)/2. + 0.5 )          CGDY2996
      IF(III.LE.ICRC+1) RETURN                                                CGDY3000
      IF(LAXI.EQ.0) GO TO 614                                                 CGDY3010
        CALL RECORD                                                           CGDY3020
  614 IF(NPC.GT.0) GO TO 621                                                  CGDY3040
        PC1(IZ+1) = PC1(IZ)+PC(IZ)-PC(IZ-1)                                   CGDY3050
        U2(IZ+1) = 2.*VELG2(1)-VELG1(1)                                       CGDY3060
  621 CONTINUE                                                                CGDY3080
C                                                                             CGDY3090
      DO 630  NT=1,NST                                                        CGDY3120
      ANORM2(NT) = AREA2(NT)*DZDS(NT)                                         CGDY3130
  630 CONTINUE                                                                CGDY3140
      RETURN                                                                  CGDY3220
C                                                                             CGDY3240
C * * * * * * * *                                                           CGDY3260
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C * * SINGLE STREAMTUBE GASDYNAMICS. (THROUGH S/N 707)                    CGDY3280
C                                                                         CGDY3300
  660 IF(VELG2(I).GE.(0.98*VSON(I)))  GO TO 700                           CGDY3420
        IF(III.GT.2) GO TO 670                                            CGDY3422
        AREA2(I) = CCSAR(IZ)                                              CGDY3423
        IF(IZ.LE.2) FAREA = 1.                                            CGDY3424
        FAREA1 = FAREA                                                    CGDY3426
        FAREA = 1.                                                        CGDY3428
        IF(LAXI.EQ.0) GO TO 670                                           CGDY3430
        IF(ABS(AREA2(I)-AREA1(I)).LT.0.001*AREA1(I)*ZINCR) GO TO 670      CGDY3432
          TAN2 = (AREA2(I)*AREA1(I)-2.*SQRT(AREA2(I)*AREA1(I)))           CGDY3434
     X           /(PI*ZINCR**2)                                           CGDY3435
          IF(TAN2.GT.0.25) FAREA = (2.*SQRT(TAN2+1.)-2.)/TAN2             CGDY3436
          IF(TAN2.LE.0.25) FAREA = 1.-0.25*TAN2+0.125*TAN2**2             CGDY3438
  670   CONTINUE                                                          CGDY3439
C                                                                         CGDY3500
        ABAR = (AREA1(I)*FAREA1 + AREA2(I)*FAREA)/2.                      CGDY3520
        C = ABAR*R*GC*TCOG(I)/(FAREA*AREA2(I)*SMWG(I))                    CGDY3540
        A = 1. - C*(SGAM(I) - 1.)/(2.*SVOS(I)**2)                         CGDY3560
        B = -(WDOT1(I)*VELG1(I) + ABAR*(ZINCR*(SSPRM(I) - GC*SDRAG(I))    CGDY3580
     1       + GC*PC(IZ-1)))/GASFL(I)                                     CGDY3582
        IF(B**2 .LT. 4.*A*C)   WRITE(6,530)  Z(IZ), III, NT               CGDY3590
        VELG2(I)  = QUAD(A,B,C,VELG2(I))                                  CGDY3600
        TCG2(I) = TCOG(I)*(1.0 - (SGAM(I)-1.)*(VELG2(I)/SVOS(I))**2/2.)   CGDY3605
        RMDG2(I) = GASFL(I)/(12.*VELG2(I)*AREA2(I)*FAREA)                 CGDY3610
        PC(IZ) = 12.*RMDG2(I)*R*TCG2(I)/SMWG(I)                           CGDY3615
        P2(I) = PC(IZ)                                                    CGDY3617
        IF(VELG2(I).GE.(0.98*VSON(I)).OR.IZ.EQ.NP)  GO TO 700             CGDY3620
        U2(IZ) = VELG2(I)                                                 CGDY3630
        U2(IZ+1) = 2.*U2(IZ) - U2(IZ-1)                                   CGDY3635
        GO TO 707                                                         CGDY3640
C                                                                         CGDY3650
  700 VELG2(I) = VSON(I)                                                  CGDY3660
        IF(IZ.LT.NP)  SNCR = CCSAR(IZ)/CCSAR(IZ+1)                        CGDY3680
        U2(IZ+1) = 2.*U2(IZ) - U2(IZ-1)                                   CGDY3700
        TCG2(I) = TCOG(I) * (1.0-(SGAM(I)-1.)*(VELG2(I)/SVOS(I))**2/2.)   CGDY3780
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      PC(IZ) = (PC(IZ-1) + ZINCR*(SSPRM(1)/GC-SDRAG(1)) + 12.*RHOG1(1)* CGDY3800
     X       FAREA1/FAREA *                                            CGDY3802
     1  AREA1(1)*VELG1(1)**2/((AREA1(1)+AREA2(1))*0.5*GC)) /           CGDY3820
     2          (1. + SMMG(1)*VELG2(1)**2/(R*TCG2(1)*GC))              CGDY3840
      RHOG2(1) = PC(IZ)*SMMG(1) / (12.*R*TCG2(1))                      CGDY3860
      AREA2(1) = GASFL(1)/(12.*RHOG2(1)*VSON(1))                       CGDY3900
      P2(1) = PC(IZ)                                                   CGDY3910
  707 SMACH(1) = 1./SQRT( (SVOS(1)/VELG2(1))**2-SGAM(1)/2. + 0.5 )     CGDY3920
C                                                                      CGDY3975
      RETURN                                                           CGDY3980
      END                                                              CGDY4000


      SUBROUTINE  EVAPS                                                EVAP0100
C                                                                      EVAP0120
      DIMENSION  AK(19)                                                EVAP0130
      COMMON  /KP/AKF(19),    AKO(19),    TVF(20),    TVO(20),       EVAP0140
     X            CPVF(20),   CPVO(20),   TCONVF(20), TCONVO(20),    EVAP0160
     X            FTKP(95),   OTKP(95),   FKP(95),    OKP(95)        EVAP0180
      COMMON  /VAP/EVAPF(19),  EVAPO(19),  SUMFC(19),  SUMOC(19)       EVAP0200
      COMMON  /GRP/GRHOD(12,19), GVELD1(12,19), GVELD2(12,19),         EVAP0220
     X             GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),       EVAP0240
     X             GNOD2(12,19),  GNODT1(12,19), GNODT2(12,19),      EVAP0260
     X             GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),       EVAP0280
     X             GDIAM(12,19)                                      EVAP0300
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCOG(19),   SGAM(19),     EVAP0320
     X             SMMG(19),   SVOS(19),   VISG(19),   RHOG1(19),    EVAP0340
     X             RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),.    EVAP0360
     X             TCG2(19),   VSON(19),   STOT(19)                  EVAP0380
      COMMON  /P/PC(300)                                               EVAP0400
      COMMON  /SWV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,  EVAP0510
     1             RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,  EVAP0520
     2            WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,  EVAP0530
     3             NSSYI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,  EVAP0540
     4               PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,  EVAP0550
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     5                NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,     EVAP0560
     6                IPR,  IZPR,    ND,   NPQ,  SNCR,   IZ,   III,     EVAP0570
     7               ETA1,  ETA2,   SCS, ZINCR,  IKPF,  IKPO             EVAP0580
C                                                                        EVAP0590
      DO 500   J=1,NTS                                                   EVAP0600
      EVAPF(J) = 0.                                                      EVAP0604
      EVAPO(J) = 0.                                                      EVAP0606
        IF(NGF.LE.0)  GO TO 420                                          EVAP0610
      TL = TRF                                                           EVAP0620
      TNBL = TNBF                                                        EVAP0640
      TCRIT = TCRITF                                                     EVAP0660
      RHOL = RHOLF                                                       EVAP0700
      RHOLNB = RHONBF                                                    EVAP0720
      WTMLL = WTMLLF                                                     EVAP0740
      WTMLV = WTMLVF                                                     EVAP0760
      AK(J) = AKF(J)                                                     EVAP0780
      IL = 1                                                             EVAP0800
      IU = NGF                                                           EVAP0820
  100 SVAP = 0.0                                                         EVAP0840
      DO 400  I=IL,IU                                                    EVAP1150
      IF(GDIAD2(I,J))  300,300,200                                       EVAP1200
  200 TFILM =  (TL+TG2(J)) / 2.0                                         EVAP1250
      VISLF = 1.352E-6*SQRT(WTMLV*TCRIT)*(27.648*RHOLNB/                 EVAP1300
     1  WTMLL)**.667 * (TFILM/TCRIT)**1.5 / (TFILM/TCRIT + 1.47*TNBL/    EVAP1350
     2  TCRIT)                                                           EVAP1400
      VISGF = VISG(J) * (TFILM/TG2(J))**.675                             EVAP1450
      PHILG = (1.0 + (VISLF/VISGF)**.5 * (SMWG(J)/WTMLV)**.25)**2 /      EVAP1500
     1        (2.828*(1.0+WTMLV/SMWG(J))**.5)                           EVAP1550
      PHIGL = (1.0 + (VISGF/VISLF)**.5 * (WTMLV/SMWG(J))**.25)**2 /      EVAP1600
     1        (2.828*(1.0+SMWG(J)/WTMLV)**.5)                           EVAP1650
      VISFLM = VISLF / (1.0 + PHILG) + VISGF / (1.0 + PHIGL)             EVAP1700
      RHOFLM = PC(II)*(WTMLV + SMWG(J))/(24.*1545.*TFILM)                EVAP1750
      GDELV =  VELG2(J) - GVELD2(I,J)                                    EVAP1800
      REYNF = 144.*RHOFLM*ABS(GDELV*GDIAD2(I,J) / VISFLM)                EVAP1850
      ANNF =  2.0 + 0.53*SQRT(REYNF)                                     EVAP1900
      GVAP(I,J) = 3.14159*RHOL*GNGD2(I,J)*GDIAD2(I,J)*AK(J)*ANNF/8.0     EVAP1950
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      GO TO 350                                                          EVAP2000
  300 GVAP(I,J) = 0.0                                                    EVAP2050
  350 SVAP = SVAP + GVAP(I,J)                                            EVAP2100
  400 CONTINUE                                                           EVAP2150
        IF(IU.EQ.NGF)  EVAPF(J) = SVAP                                   EVAP2200
        IF(IU.EQ.NGT .AND. IU.NE.NGF)  EVAPD(J) = SVAP                   EVAP2210
          IF(IU.GE.NGT)  GO TO 500                                       EVAP2220
  420 TL = TBC                                                           EVAP2240
      TNBL = TNBO                                                        EVAP2260
      TCRIT = TCRITO                                                     EVAP2280
      RHOL = RHOLO                                                       EVAP2300
      RHOLNB = RHONBO                                                    EVAP2320
      HTMLL = HTMLLO                                                     EVAP2340
      HTMLV = HTMLVO                                                     EVAP2360
      AK(J) = AKO(J)                                                     EVAP2380
      IL = NGF + 1                                                       EVAP2400
      IU = NGT                                                           EVAP2420
      GO TO 100                                                          EVAP2440
C                                                                        EVAP2460
  500 CONTINUE                                                           EVAP2500
      RETURN                                                             EVAP2520
      END                                                                EVAP2540


      SUBROUTINE  CSPRAY                                                 CSPR0050
C                                                                        CSPR0060
      COMMON  /GRP/GRMOD(12,19),  GVELD1(12,19), GVELD2(12,19),          CSPR0120
     X            GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),           CSPR0140
     X            GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),          CSPR0160
     X            GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),           CSPR0180
     X            GDIAM(12,19)                                          CSPR0200
      COMMON  /ADJ/APROP(12,2), CCSAR(300), Z(300),                      CSPR0260
     X            AREA1(19),   AREA2(19),  DELARS(20)                   CSPR0280
     X,           RBAR1(19),   RBAR2(19),  SINCR(19)                    CSPR0290
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCOG(19),   SGAM(19),         CSPR0300
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     X              SMWG(19),   SVOS(19),   VISG(19),   RHOG1(19),        CSPR0320
     X              RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),         CSPR0340
     X             TCG2(19),    VSON(19)                                  CSPR0360
      COMMON  /KP/AKF(19),     AKO(19),     TVF(20),     TVO(20),         CSPR0380
     X             CPVF(20),   CPVO(20),   TCONVF(20), TCONVO(20),       CSPR0400
     X             DTKP(95),   OTKP(95),   FKP(95),     OKP(95)          CSPR0620
      COMMON  /VAP/EVAPF(19), EVAPO(19),  SUMFC(19),  SUMOC(19.          CSPR0440
      COMMON  /SUM/SMFLF(19), SMFLO(19), SDRAG(19), SSPRM(19), STMR(19) CSPR0480
      COMMON  /SVV/     NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,    CSPR0510
     1              RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,     CSPR0520
     2             WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,     CSPR0530
     3              NSSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XDPC,     CSPR0540
     4                PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,     CSPR0550
     5               NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,     CSPR0560
     6               IPR,  IZPR,    NO,   NPQ,  SNCR,    IZ,   III,     CSPR0570
     7              ETA1,  ETA2,   SCS, ZINCR,  IKPF,  IKPO,  LAXI      CSPR0590
      DATA  GC, PI, XDIA / 32.174, 3.14159, 25400./                      CSPR0730
C                                                                        CSPR0740
C * * * CALCULATE DRAG FORCES ON SPRAY DROPLETS.                        CSPR0760
C                                                                        CSPR0780
      DO 420 J=1,NTS                                                     CSPR0790
      SDRAG(J) = 0.                                                      CSPR0791
      DO 420 I=1,NG1                                                     CSPR0792
      GDRAG(I,J) = 0.0                                                   CSPR0794
      IF(GDIAD2(I,J)) 420,420,410                                        CSPR0796
  410 GDELV = VELG2(J) - GVELD2(I,J)                                     CSPR0798
      REYN = 144.*RHOG2(J)*GDIAD2(I,J)*ABS(GDELV) / VISG(J)              CSPR0800
      CD = 27.*REYN**(-0.84)                                             CSPR0802
      IF(REYN.GT.80.)  CD = 0.271*REYN**0.217                            CSPR0804
      GDRAG(I,J) = 12.*PI*ABS(GDELV)*RHOG2(J)*GDELV*CD*GNOD2(I,J)*       CSPR0806
     1             GDIAD2(I,J)**2 / (8.0*GC)                           CSPR0808
      SDRAG(J) = SDRAG(J)+GDRAG(I,J)                                     CSPR0809
  420 CONTINUE                                                           CSPR0810
C                                                                        CSPR0820
C * * * * DROPLET EVAPORATION COEFFICIENTS ARE OBTAINED.                CSPR0840
C                                                                        CSPR0860
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      DO 430  NT=1,NTS                                                  CSPR0880
      AKF(NT) = YDF(TCG2(NT),FTKP,FKP,IKPF,2)                           CSPR0900
      AKG(NT) = YDF(TCG2(NT),GTKP,GKP,IKPG,2)                           CSPR0920
  430 CONTINUE                                                          CSPR0940
C                                                                       CSPR0960
C * * * * SUBROUTINE EVAPS CALCULATES DROPLET GASIFICATION RATES.       CSPR0980
C                                                                       CSPR1000
      CALL EVAPS                                                        CSPR1050
C                                                                       CSPR1120
C                                                                       CSPR1140
C * * * * DRAG AND VAPORIZATION TERMS ARE USED TO CALCULATE SPRAY       CSPR1160
C         DROPLET VELOCITIES, DIAMETERS, CONCENTRATIONS, ETC.           CSPR1180
C                                                                       CSPR1200
      DO 520  NT=1,NTS                                                  CSPR1220
      SSPRM(NT) = 0.0                                                   CSPR1260
      SPRMF = 0.0                                                       CSPR1280
      SPRMG = 0.0                                                       CSPR1300
C                                                                       CSPR1320
      DO 510  NG=1,NGT                                                  CSPR1340
      IF(GDIAD2(NG,NT).LE.0.) GO TO 495                                 CSPR1350
      RL = RHOLF                                                        CSPR1360
      NCG = NGF                                                         CSPR1380
      IF(NG.LE.NGF)  GO TO 435                                          CSPR1400
      RL = RHOLG                                                        CSPR1420
      NCG = NGO                                                         CSPR1440
  435 CONTINUE                                                          CSPR1460
      GMFLX = (2.0*PI*RL*GVELD1(NG,NT)*GMOD1(NG,NT)*AREA1(NT)*          CSPR1480
     1         GDIAD1(NG,NT)**3) / (SINCR(NT)*AREA2(NT))                CSPR1500
C * * * * DROPLET SIZE-GROUP GASIFICATION CANNOT EXCEED ITS MASS-FLUX.  CSPR1520
      IF(GMFLX.LE.GVAP(NG,NT).AND.III.GT.1)  GO TO 475                  CSPR1540
C * * * * SIZE-GROUP GASIFICATION IS LIMITED TO 0.8*GMFLX IN PREDICTOR. CSPR1560
      IF(GMFLX.LE.GVAP(NG,NT))  GVAP(NG,NT) = 0.8*GMFLX                 CSPR1580
C * * * * SIZE-GROUP VELOCITY CALCULATED FROM SPRAY MOMENTUM EQ*N.       CSPR1600
  440 A = GVELD1(NG,NT)**2 + GDRAG(NG,NT)*GC*SINCR(NT)/(6.*GRMOD(NG,NT))CSPR1620
      IF (A.LT.0.0)  A=0.0                                              CSPR1640
      GVELD2(NG,NT) = SQRT(A)                                           CSPR1660
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C  *  *  *  SIZE-GROUP VELOCITY IS NOT CHANGED IF IT CROSSES GAS VELOCITY.CSPR1680
      IF(GVELD1(NG,NT).GT.VELG1(NT).AND.GVELD2(NG,NT).LT.VELG2(NT))      CSPR1700
     1          GVELD2(NG,NT) = GVELD1(NG,NT)                           CSPR1720
      IF(GVELD1(NG,NT).LT.VELG1(NT).AND.GVELD2(NG,NT).GT.VELG2(NT))      CSPR1740
     1          GVELD2(NG,NT) = GVELD1(NG,NT)                           CSPR1760
      IF(GVELD2(NG,NT).NE.GVELD1(NG,NT))  GO TO 460                      CSPR1770
        SDRAG(NT) = SDRAG(NT)-GDRAG(NG,NT)                               CSPR1780
        GDRAG(NG,NT) = 0.                                                CSPR1790
C                                                                        CSPR1800
C  *  *  *  *  EVAPORATION REDUCES DROPLET NUMBER FLOWRATE OF MONODISPERSE CSPR1820
C           SPRAY OR DROPLET DIAMETERS IN POLYDISPERSE SPRAYS.           CSPR1840
C                                                                        CSPR1860
  460 IF(NCG.GT.1)  GO TO 465                                            CSPR1880
      GDIAD2(NG,NT) = GDIAD1(NG,NT)                                      CSPR1900
      GNDOT2(NG,NT) = GNDOT1(NG,NT) - AREA2(NT)*ZINCR*GVAP(NG,NT)*6.0/   CSPR1920
     1  (PI*RL*GDIAD1(NG,NT)**3)                                         CSPR1940
      GO TO 470                                                          CSPR1960
  465 GNDOT2(NG,NT) = GNDOT1(NG,NT)                                      CSPR1980
      DIA3 = (GDIAD1(NG,NT)**3 - GVAP(NG,NT)*SINCR(NT) / (2.*PI*RL*      CSPR2000
     1         GNDOT2(NG,NT)*GVELD2(NG,NT)))                             CSPR2020
      IF(DIA3.LE.0.0)  GO TO 475                                         CSPR2040
      GDIAD2(NG,NT) = (DIA3)**(1./3.)                                    CSPR2060
C                                                                        CSPR2080
C  *  *  *  *  CALCULATE SPRAY DROPLET CONCENTRATION AND SPRAY DENSITY.  CSPR2100
  470 GNDOT2(NG,NT) = GNDOT2(NG,NT)*SINCR(NT)/(12.*ZINCR*GVELD2(NG,NT)*  CSPR2120
     1                AREA2(NT))                                        CSPR2130
      GRHOD(NG,NT) = PI*RL*GNDOT2(NG,NT)*GDIAD2(NG,NT)**3/6.0            CSPR2140
      GO TO 500                                                          CSPR2160
C                                                                        CSPR2180
C  *  *  *  *  MAINTAIN CONTINUITY AS DROPLET SIZE GROUP IS BURNED-OUT.  CSPR2200
  475 IF(NG.LE.NGF)  GO TO 480                                           CSPR2220
      EVAPO(NT) = EVAPO(NT) + GMFLX - GVAP(NG,NT)                        CSPR2240
      GO TO 490                                                          CSPR2260
  480 EVAPF(NT) = EVAPF(NT) + GMFLX - GVAP(NG,NT)                        CSPR2280
  490 GVAP(NG,NT) = GMFLX                                                CSPR2300
      GDIAD2(NG,NT) = 0.0                                                CSPR2320
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      GNOD2(NG,NT) = 0.0                                                    CSPR2340
      GNODTZ(NG,NT) = 0.0                                                   CSPR2360
      GRNOD(NG,NT) = 0.0                                                    CSPR23R0
  495 GVELD2(NG,NT) = VELG2(NT)                                             CSPR2400
      GO TO 510                                                             CSPR2410
C * * * * CALCULATE RESIDUAL FLOW-RATE OF SIZE-GROUP AND SUM OVER ALL.     CSPR2420
  500 SPRAY = PI*RL*GNODTZ(NG,NT)*GDIAD2(NG,NT)**3 / 6.0                    CSPR2440
      GDIAM(NG,NT) =  GDIAD2(NG,NT) * XDIA                                  CSPR2460
      IF(NG.GT.NGF) GO TO 505                                               CSPR2480
      SPRMF = SPRMF + SPRAY                                                 CSPR2500
      GO TO 510                                                             CSPR2520
  505 SPRMO = SPRMO + SPRAY                                                 CSPR2540
      SSPRM(NT) = SSPRM(NT) + GVELD2(NG,NT)*GVAP(NG,NT)                     CSPR2550
  510 CONTINUE                                                              CSP 2560
C                                                                           CSPR2580
C * * * * *GASIFIED FUEL AND OXIDIZER FLOWS ARE OBTAINED BY SUBTRACTING     CSPR2600
C         RESIDUAL SPRAYS FROM TOTAL STREAMTUBE PROPELLANT FLOWS.           CSPR2620
      SUMOC(NT) = SMFLO(NT) - SPRMO                                         CSPR2640
      SUMFC(NT) = SMFLF(NT) - SPRMF                                         CSPR2660
      SMRG(NT)  = SUMOC(NT) / SUMFC(NT)                                     CSPR2680
  520 CONTINUE                                                              CSPR2700
C                                                                           CSPR2720
      RETURN                                                                CSPR2740
      END                                                                   CSPR2760



      SUBROUTINE ESUBK(N)                                                   ESUB0100
C                                                                           ESUB0120
C * * * PROGRAM CALCULATES RUPE MIXING EFFICIENCY FACTOR.                  ESUB0140
C                                                                           ESUB0160
      COMMON /SUM/ MF(19), MO(19), DUM(38), C(19)                           ESUB0180
C                                                                           ESUB0200
      WRITE(6,20) (I,MF(I),MO(I),C(I),I=1,N)                               ESUB0220
   20 FORMAT(1H ,/,32X,34HSTREAMTUBE FLOWRATES (GAS + SPRAY) // 25X,        ESUB0240
     1       46HSTRM    TOTAL FUEL      TOTAL OXID        MIXTURE / 25X,   ESUB0260
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     2        45HTUBE   FLUW,LB/SEC     FLOW,LB/SEC       RATIO //      ESUB0280
     3        (26X,I2,1P3E15.5))                                        ESUB0300
C                                                                       ESUB0320
      PT = 0.                                                           ESUB0340
      QT = 0.                                                           ESUB0360
      SUM1 = 0.                                                         ESUB0380
      SUM2 = 0.                                                         ESUB0400
C                                                                       ESUB0420
      DO 50  I=1,N                                                      ESUB0440
      PT = PT + WF(I)                                                   ESUB0460
   50 QT = QT + WO(I)                                                   ESUB0480
C                                                                       ESUB0500
      TT = PT + QT                                                      ESUB0520
      RAT = QT/TT                                                       ESUB0540
C                                                                       ESUB0560
      DO 80  I=1,N                                                      ESUB0580
      R = WO(I)/(WO(I)+WF(I))                                           ESUB0600
      IF(R-RAT)  60,80,70                                               ESUB0620
   60 TERM = (WO(I)+WF(I))*(1.-T/RAT)/ TT                               ESUB0640
      SUM1 = SUM1 + TERM                                                ESUB0660
      GO TO 80                                                          ESUB0680
   70 TERM = (WO(I)+WF(I))*(RAT-R)/(TT*(RAT-1.))                       ESUB0700
      SUM2 = SUM2 + TERM                                                ESUB0720
   80 CONTINUE                                                          ESUB0740
C                                                                       ESUB0760
      EM = 100.*(1.-(SUM1+SUM2))                                        ESUB0780
C                                                                       ESUB0800
      WRITE(6,90)  EM                                                   ESUB0820
   90 FORMAT(///15X,36H RUPE MIXING EFFICIENCY FACTOR, EM = F9.5 )      ESUB0840
C                                                                       ESUB0860
      RETURN                                                            ESUB0880
      END                                                               ESUB0900
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      SUBROUTINE  CHANGS(NC,NST,NGT)                                    CHAN0100
C                                                                       CHAN0150
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCOG(19),   SGAM(19),        CHAN0200
     X              SVMG(19),   SVOS(19),   VISG(19),   RHOG1(19),     CHAN0250
     X              RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),      CHAN0300
     X              TCG2(19),   VSOU(19)                               CHAN0350
      COMMON  /GRP/GRMOD(12,19),  GVELD1(12,19), GVELD2(12,19),         CHAN0400
     X              GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),        CHAN0450
     X              GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),       CHAN0500
     X              GORAG(12,19),  GVAP(12,19),   GWSPR(12,19),        CHAN0550
     X              GDIAM(12,19)                                       CHAN0600
      COMMON  /PS/P1(19),   P2(19),   DPDR(19), DRDS(19), DZDS(19)      CHAN0610
      COMMON  /ADZ/APROF(12,2), CCSAR(300), Z(300),                     CHAN0650
     X              AREA1(19),   AREA2(19),  DELARS(20)                CHAN0700
     X,             RBAR1(19),   RBAR2(19),  SINCR(19)                 CHAN0720
     X,             SUMSTA,      RDSL1(19),  RDSL2(19)                 CHAN0730
C                                                                       CHAN0750
      IF(NC.GT.1) GO TO 200                                             CHAN0800
      DO 100  J=1,NST                                                   CHAN0850
      AREA2(J) = AREA1(J)                                               CHAN0900
      RBAR1(J) = RBAR2(J)                                               CHAN0920
      RDSL1(J) = RDSL2(J)                                               CHAN0930
      VELG2(J) = VELG1(J)                                               CHAN0950
      TCG2(J)  = TCG1(J)                                                CHAN1000
      RHOG2(J) = RHOG1(J)                                               CHAN1050
      DO 100  I=1,NGT                                                   CHAN1100
      GNOD2(I,J)  = GNOD1(I,J)                                          CHAN1150
      GNDOT2(I,J) = GNDOT1(I,J)                                         CHAN1200
      GDIAD2(I,J) = GDIAD1(I,J)                                         CHAN1250
  100 GVELD2(I,J) = GVELD1(I,J)                                         CHAN1300
      RETURN                                                            CHAN1350
C                                                                       CHAN1400
  200 DO 300  J=1,NST                                                   CHAN1450
      AREA1(J) = AREA2(J)                                               CHAN1500
      RBAR1(J) = RBAR2(J)                                               CHAN1520
      RDSL1(J) = RDSL2(J)                                               CHAN1530
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      VFLG1(J) = VFLG2(J)                                                CHAN1550
      TCG1(J)  = TCG2(J)                                                 CHAN1600
      RHOG1(J) = RHOG2(J)                                                CHAN1650
      P1(J)    = P2(J)                                                   CHAN1670
      DO 300  I=1,NGT                                                    CHAN1700
      GNOD1(I,J)  = GNOD2(I,J)                                           CHAN1750
      GNDCT1(I,J) = GNDCT2(I,J)                                          CHAN1800
      GDIAD1(I,J) = GDIAD2(I,J)                                          CHAN1850
  300 GVELD1(I,J) = GVELD2(I,J)                                          CHAN1900
C                                                                        CHAN1950
      RETURN                                                             CHAN2000
      END                                                                CHAN2050



      SUBROUTINE  RCOORD                                                 RCOOR010
      COMMON  /ACZ/APRCF(12,2), CCSAR(300), Z(300),                      RCOOR110
     X            AREA1(19),   AREA2(19),  DELARS(20)                   RCOOR120
     X           ,RBAR1(19),   RBAR2(19),  SINCR(19)                    RCOOR130
     X           ,SUMSTA,      RDSL1(19),  RDSL2(19)                    RCOOR140
      COMMON  /GAS/ GASFL(19), SMRG(19), DUM1(133), VELG1(19), VELG2(19)RCOOR142
      COMMON  /SVV/ NP,    NAP,   NMR,   NTK,   TNBF,  TBF,   RHONBF     RCOOR150
     1            , RHOLF, WTMLLF,WTMLVF,TNBO,  TBO,   RHONBO,RHOLO     RCOOR160
     2            , WTMLLO,WTMLVO,TCRITF,CRITO, DHVF,  DHVO,  IST       RCOOR170
     3            , ZSSTI, NMSTI, ICRC,  CRTOL, ARTOLD,NPC,   XDPC      RCOOR180
     4            , PCI,   ZSTART,NST,   NGT,   NGF,   NGO,   NTL       RCOOR190
     5            , NTS,   NC,    CCSAI, TMFLF, TMFLO, CMRI,  TCSTR     RCOOR200
     6            , IPR,   IZPR,  ND,    NPO,   SNCR,  IZ,    III      RCOOR210
     7            , ETA1,  ETA2,  SCS,   ZINCR, IKPF,  IKPO,  LAXI      RCOOR220
      COMMON /PS/  P1(19),  P2(19), DPDR(19), DRDS(19), DZDS(19)         RCOOR230
      COMMON  /STK1/ RDSL(19), PIL, ZIL(40), RIL(40), THIL(40)           RCOOR232
     1            , VIL(19), XMRIL(19), ZDSL(19), NPE                    RCOOR234
      COMMON /COM7/GA, RR, RT, ZT, ZPVSR, IZBC,   PZ(20), RZ(20)         RCOOR240
      DATA PI, II, L1, L2 / 3.14159, 1,1,2/                              RCOOR248
C                                                                        RCOOR250
C       INCREMENTAL  PATH  LENGTH  AND  STREAM  TUBE  RADIUS             RCOOR258
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      ZI = 0.0                                                          RCOOR260
      IF(IZ.LE.1) GO TO 5                                               RCOOR262
      IF(ABS(CCSAR(IZ-1)-CCSAR(IZ)).LT.CCSAI*1.E-5) GO TO 5             RCOOR270
      RW1 = SQRT(CCSAR(IZ-1)/PI)                                        RCOOR280
      RW2 = SQRT(CCSAR(IZ)/PI)                                          RCOOR290
      ZI = RW1 * ZINCR/ABS(RW1-RW2)                                     RCOOR300
      ZI2 = ZI*ZI                                                       RCOOR310
    5 F = 1./(2.*PI)                                                    RCOOR320
      IF(III.EQ.2)  ASOLD = ASUMO                                       RCOOR322
      ASUMI = 0.                                                        RCOOR330
        DO 10 I=1,NST                                                   RCOOR340
        ASUMO = ASUMI+AREA2(I)                                          RCOOR350
        RDSL2(I) = SQRT(ASUMO/PI)                                       RCOOR352
        RBAR2(I) = SQRT((ASUMO+ASUMI)*F)                                RCOOR360
        IF(ZI.GT.0.) GO TO 8                                            RCOOR370
          SINCR(I) = ZINCR                                              RCOOR380
          DZDS(I) = 1.                                                  RCOOR382
          GO TO 10                                                      RCOOR384
    8   SINCR(I) = ZINCR*SQRT(ZI2+RBAR1(I)**2)/ZI                       RCOOR390
        DZDS(I) = ZINCR/SINCR(I)                                        RCOOR400
   10   ASUMI = ASUMO                                                   RCOOR410
C                                                                       RCOOR430
C       RADIUS OF DIVIDING STREAMLINE WITH  TDK  INITIAL LINE           RCOOR490
      IF(III.LE.ICRC+1)  GO TO 200                                      RCOOR500
      Z2 = Z(IZ)                                                        RCOOR510
      IF(Z2.LT.ZT) GO TO 200                                            RCOOR520
      ZI = Z(IZ-1)                                                      RCOOR530
      IF(ZI.LT.ZT)  II = 1                                              RCOOR534
C                                                                       RCOOR538
      IF(I1.GT.NST) GO TO 200                                           RCOOR540
      CN = SQRT(CCSAR(IZ)/ASUMO)                                        RCOOR542
      CO = SQRT(CCSAR(IZ-1)/ASOLD)                                      RCOOR544
        DO 100 I=I1,NST                                                 RCOOR550
        NT = NST+1-I                                                    RCOOR560
        RSL1 = CO*RDSL1(NT)                                             RCOOR562
        RSL2 = CN*RDSL2(NT)                                             RCOOR564
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      ZL2 = YOFI CN*RDSL2(NT) ,RIL,ZIL,40,2)                            RCOOR570
      IF(Z2.LT.ZL2) GO TO 110                                           RCOOR580
 80     IF(RIL(L2).LT.CN*RDSL2(NT))  GO TO 90                           RCOOR590
        L2 = L2+1                                                       RCOOR600
        GO TO 80                                                        RCOOR610
 90   L1 = L2-1                                                         RCOOR620
      A1SL = (RSL2-RSL1)/ZINCR                                          RCOOR630
      A1IL = (RIL(L2)-RIL(L1))/(ZIL(L2)-ZIL(L1))                        RCOOR640
      RDSL(I) = (RSL1-RIL(L1)*A1SL/A1IL-(Z1-ZIL(L1))*A1SL)              RCOOR650
     X            /(1.-A1SL/A1IL)                                       RCOOR652
      ZDSL(I) = ZIL(L1) + A1IL*(RDSL(I)-RIL(L1))                        RCOOR654
      VIL(I) = VELG1(NT) + (ZDSL(I)-Z1)/(Z2-Z1)*(VELG2(NT)-VELG1(NT))   RCOOR656
      XMRIL(I) = SMRO(NT)                                               RCOOR658
     WRITE(6,96) Z2,I,ZL2,L1,L2,A1SL,A1IL,RDSL(I),VIL(I),XMRIL(I)       RCOOR660
     X            , RDSL2(NT)                                           RCOOR662
 96     FORMAT(/4H  Z= F7.3, 4H, I= I3, 6H, ZL2= F9.5, 5H, L1= I3,      RCOOR663
     1            5H, L2=I3, 7H, A1SL=G14.5, 7H, A1IL=G14.5/            RCOOR664
     2           10H, RDSL(I)= G14.5,  9H, VIL(I)= G14.5,               RCOOR665
     3           11H, XMRIL(I)= F8.6, 12H, RDSL2(NT)= G14.5 )           RCOOR666
100   CONTINUE                                                          RCOOR670
110 I1 = I                                                              RCOOR680
    IF(I1.LT.NST+1)  GO TO 200                                          RCOOR682
    NPF = IZ                                                            RCOOR683
    WRITE(6,120)  ((I,RDSL(I)),I=1,NST)                                 RCOOR684
120 FORMAT(1H1///69H   STREAM TUBE DIVIDING STREAM LINE RADII ALONG  TRCOOR686
   1 D K  INITIAL LINE //5X,18H POINT  RADIUS,IN.,5X,18H POINT  RADIUSRCOOR687
   2,IN. //(7X,I2,OPF12.6,7X,I2,F12.6))                                 RCOOR688
    L2 = 1                                                              RCOOR689
200 CONTINUE                                                            RCOOR690
    RETURN                                                              RCOOR900
    END                                                                 RCOOR910
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```
      SUBROUTINE  PVSR(Z)                                                PVSR0010
C                                                                        PVSR0012
C   SETS UP  PRES VS RADIUS  TABLE AT EACH AXIAL STATION                 PVSR0020
C       FROM TRANS GENERATED ISOBAR ARRAYS                               PVSR0030
C                                                                        PVSR0040
      COMMON /COM6/NI, NR, IERR                                          PVSR0050
     X              ,PXR(20), XMN(20), XI(20,20), RI(20,20)             PVSR0060
      COMMON /COM7/GA, RR, RT, ZT, ZPVSR, IZBC,     PZ(20), RZ(20)      PVSR0062
C                                                                        PVSR0070
C       LOCATE  BRACKETING  ISOBARS AT AXIS                              PVSR0074
      X = (Z-ZT)/RT                                                      PVSR0080
      NIP = NI+1                                                         PVSR0090
        DO 10 I=2,NI                                                     PVSR0100
        ISOB = NIP-I                                                     PVSR0110
        IF(XI(ISOB,NR).GT.X) GO TO 20                                    PVSR0120
   10   CONTINUE                                                         PVSR0130
   20 ISOA = ISOB+1                                                      PVSR0140
      J1 = I                                                             PVSR0150
C                                                                        PVSR0160
C       INTERPOLATE  ON  PRES & RADIUS  BETWEEN  ISOBARS                 PVSR0170
      NRP = NR+1                                                         PVSR0180
   30   DO 50 J=J1,NR                                                    PVSR0190
        K = NRP-J                                                        PVSR0200
        XB = XI(ISOB,K)                                                  PVSR0210
        IF(XB.GE.X .OR. ISOB.LE.1) GO TO 40                              PVSR0220
C       ADJUST BRACKETING ISOBARS AS REQUIRED  AS RADIUS INCREASES       PVSR0230
          ISOA = ISOB                                                    PVSR0240
          ISOB = ISOB-1                                                  PVSR0250
          J1 = J                                                         PVSR0252
          GO TO 30                                                       PVSR0260
C       DISTANCE BETW ISOBARS                                            PVSR0270
   40   XA = XI(ISOA,K)                                                  PVSR0280
        FACT = (X-XA)/(XB-XA)                                            PVSR0290
        PZ(J) = PXR(ISOA) + (PXR(ISOB)-PXR(ISOA))*FACT                   PVSR0300
   50   RZ(J) = RI(ISOA,K) + (RI(ISOB,K)-RI(ISOA,K))*FACT                PVSR0310
C                                                                        PVSR0320
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  100 RETURN                                                          PVSP0900
      END                                                             PVSP0910



      SUBROUTINE KPRIME(TL,TC,RHOL,DHV,TV,CPV,TCONV,J,IKP,TKPR,KPR)   KPRIM010
C       KPRIME CALCULATED BY MEANS OF NUMERICAL INTEGRATION           KPRIM012
C       FOR STATIC CONDITIONS AND ADJUSTED IN SUB COMB FOR NU NO.     KPRIM014
C       CP & THERMAL CONDUCTIVITY OF VAPOR ARE TABULATED FUNCTIONS OF KPRIM020
C         FILM TEMPERATURE.  J VALUES OF TV WITH CORRESPONDING VALUES KPRIM030
C         OF CPV & TCONV                                              KPRIM040
      REAL KPR                                                        KPRIM050
      DIMENSION TV(1),CPV(1),TCONV(1),TKPR(1),KPR(1)                  KPRIM060
      DATA KOUNT/0/                                                   KPRIM062
C                                                                     KPRIM063
      KOUNT=KOUNT+1                                                   KPRIM064
      L=2                                                             KPRIM068
      N=10                                                            KPRIM070
      IF(J.LE.6) GO TO 2                                              KPRIM080
      N=10                                                            KPRIM090
      IF(J.GT.10) N=8                                                 KPRIM092
      IF(J.GT.12) N=5                                                 KPRIM094
    2 XN=N                                                            KPRIM100
      CP1=YCF(TL,TV,CPV,J,L)                                          KPRIM120
      TCON1=YCF(TL,TV,TCONV,J,L)                                      KPRIM130
      SUM=0                                                           KPRIM140
      SUM1=0.                                                         KPRIM142
      I=0                                                             KPRIM144
C                                                                     KPRIM150
      DO 10 K=2,J                                                     KPRIM160
      T2=TV(K-1)                                                      KPRIM162
      DELT=AMAX1((TV(K)-T2)/XN,0.1)                                   KPRIM164
      CKPR=0.32*DELT/RHOL                                             KPRIM166
C       0.32=8*144/3600                                               KPRIM167
C                                                                     KPRIM168
      DO 10 KK=1,N                                                    KPRIM170
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      IF(T2.GT.TC) GO TO 12                                              KPRIM172
C                                                                        KPRIM174
      I=I+1                                                              KPRIM180
      T2=T2+DELT                                                         KPRIM182
      TKPR(I)=T2                                                         KPRIM184
      IF(T2.LE.TL.OR.DELT.LE.0.) GO TO 10                                KPRIM186
C                                                                        KPRIM188
      IF(KK.EQ.N) GO TO 6                                                KPRIM190
      CP2=YOF(T2,TV,CPV,J,L)                                             KPRIM192
      TCON2=YOF(T2,TV,TCONV,J,L)                                         KPRIM194
      GO TO 8                                                            KPRIM196
C                                                                        KPRIM198
    6 CP2=CPV(K)                                                         KPRIM200
      TCON2=TCONV(K)                                                     KPRIM202
C                                                                        KPRIM204
    8 CPM=(CP1+CP2)/2.                                                   KPRIM210
      TCONM=(TCON1+TCON2)/2.                                             KPRIM220
      SUM1=SUM1+CPM*DELT                                                 KPRIM222
      SUM=SUM+CKPR*TCONM/(OHV+SUM1)                                      KPRIM230
      CP1=CP2                                                            KPRIM240
      TCON1=TCON2                                                        KPRIM242
   10 KPR(I)=SUM                                                         KPRIM250
C                                                                        KPRIM260
   12 IKP=I                                                              KPRIM262
      IF(KOUNT.EQ.1) WRITE(6,20)                                         KPRIM270
   20 FORMAT(//30X,49HKPRIME VS COMB. TEMPERATURE FOR STATIC CONDITIONS  KPRIM272
     1//46X,4HTEMP,7X,8HKPRIME  ///51X,7HO X I D ///)                    KPRIM274
      IF(KOUNT.EQ.2) WRITE(6,30)                                         KPRIM276
   30 FORMAT(//51X,7HF U E L ///)                                        KPRIM278
      N=(J-1)*4                                                          KPRIM279
      WRITE(6,40) (TKPR(I),KPR(I),I=1,N)                                 KPRIM280
   40 FORMAT(OPF11.1,1PE14.4, OPF11.1,1PE14.4, OPF11.1,1PE14.4,          KPRIM282
     1       OPF11.1,1PE14.4)                                          KPRIM283
      IF(KOUNT.EQ.2) KOUNT=0                                             KPRIM284
      RETURN                                                             KPRIM290
      END                                                                KPRIM300
```

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      SUBROUTINE  PVSST(IZ,NTS,NP,III)                                  PVSST010
C                                                                       PVSST020
C     P VS ST  -  SETS UP MEAN PRESSURE IN EACH STREAM TUBE             PVSST030
C       FROM ISOBAR DATA GENERATED IN TRANS                             PVSST040
C                                                                       PVSST050
      COMMON  /AOZ/APROF(12,2), CCSAR(300), Z(300),                     PVSST060
     X              AREA1(19),    AREA2(19),   DELARS(20),             PVSST070
     X              RBAR1(19),    RBAR2(19),   SINCR(19)               PVSST080
      COMMON /P/   PC(300),      PC1(300),    PPC(20),    U2(300)      PVSST090
      COMMON /PS/  P1(19),  P2(19),  DPDR(19),  DRDS(19),  DZDS(19)     PVSST100
      COMMON /COM6/NISO,  NRISO,  IERR                                  PVSST110
     X            ,PXR(20), XMN(20), XI(20,20), RI(20,20)              PVSST120
      COMMON /COM7/GA, RR, RT, ZT, ZPVSR, IZBC,    PZ(20), RZ(20)      PVSST124
     X             , PSTARI                                           PVSST126
C                                                                       PVSST130
      IF(Z(IZ).GT.ZPVSR) GO TO 20                                       PVSST150
C       CONSTANT PRESSURE PLANE                                         PVSST160
        PCIZ = PC(IZ)                                                   PVSST162
        DO 10 NT=1,NTS                                                  PVSST170
   10   P2(NT) = PCIZ                                                   PVSST180
        GO TO 100                                                       PVSST190
C                                                                       PVSST192
   20 IF(III.GT.1) GO TO 26                                             PVSST200
      IF(Z(IZ-1).GT.ZPVSR) GO TO 24                                     PVSST202
        K = IZ-1                                                        PVSST203
        RWALL = SQRT(CCSAR(K)/3.141591/RT                               PVSST204
        DS = RWALL/FLOAT(NRISO-1)                                       PVSST206
        PSTAR = PC(1)/PC1(1) * PCI(NP)                                  PVSST208
        PXR(NISO) = PC(K)/PSTAR                                         PVSST209
        X = (Z(K)-ZT)/RT                                                PVSST210
      PSTARI = PSTAR                                                    PVSST211
        DO 22 I=1,NRISO                                                 PVSST212
        XI(NISO,I) = X                                                  PVSST216
   22   RI(NISO,I) = RWALL - FLOAT(I-1)*DS                              PVSST220
   24 CALL  PVSR(Z(IZ))                                                 PVSST230
   26 P = PZ(1)*PSTAR                                                   PVSST240
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      PC(IZ) = P                                                        PVSST244
      R = 0.                                                            PVSST246
        DO 30 NT=1,NTS                                                  PVSST250
        P2(NT) = YOF(RBAR2(NT)/RT, RZ,PZ, NRISO,2) * PSTAR              PVSST260
          P2(NT) = AMAX1(P2(NT),0.02*PC(1))                             PVSST264
        DPDR(NT) = (P2(NT)-P) / (RBAR2(NT)-R)                           PVSST270
        P = P2(NT)                                                      PVSST272
   30   R = RBAR2(NT)                                                   PVSST274
C                                                                       PVSST280
  100 RETURN                                                            PVSST900
      END                                                               PVSST910


      SUBROUTINE  CPRINT(JPR)                                           CPRI0050
C                                                                       CPRI0060
      COMMON  /COMPM/  CPMD1(19), ECSMIX, ECSENR                        CPRI0110
      COMMON  /GRP/GRHOD(12,19),  GVELD1(12,19), GVELD2(12,19),         CPRI0120
     X             GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),        CPRI0140
     X             GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),       CPRI0160
     X             GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),        CPRI0180
     X             GDIAM(12,19)                                       CPRI0200
      COMMON  /AOZ/APROF(12,2), CCSAR(300), Z(300),                     CPRI0260
     X             AREA1(19),   AREA2(19),  DELARS(20)                CPRI0280
     X,            RBAR1(19),   RBAR2(19),  SINCR(19)                 CPRI0290
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCOG(19),   SGAM(19),        CPRI0300
     X             SWWG(19),   SVOS(19),   VISG(19),   RHOG1(19),     CPRI0320
     X             RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),      CPRI0340
     X             TCG2(19),   VSON(19),   STOT(19),   SMACH(19)      CPRI0360
      COMMON  /VAP/EVAPF(19), EVAPO(19),  SUMFC(19),  SUMOC(19)        CPRI0440
      COMMON  /P/ PC(300),    PC1(300),   PPC(20),    U2(300)          CPRI0460
      COMMON  /PS/P1(19),   P2(19),   DPDR(19), DRDS(19), DZDS(19)     CPRI0470
      COMMON  /COM7/  COM7D1(4), ZPVSR, IZBC, COM7D2(41), RATVAP, CD    CPRI0500
      COMMON  /SVV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,   CPRI0510
     1              RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,   CPRI0520
     2             WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,   CPRI0530
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     3              NSSTI, NMSTI,  ICRC, CRTCL,ARTOLD,   NPC,  XDPC,     CPRI0540
     4                PCI,ZSTART,   NST,   NGT,   NGF,   NGD,   NTL,     CPRI0550
     5                NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,     CPRI0560
     6                IPR,  IZPR,    ND,   NPQ,  SNCR,   IZ,   III,     CPRI0570
     7               ETA1,  ETA2,   SCS, ZINCR,  IKPF,  IKPO,  LAXI     CPRI0590
     8               , SVVD(9), PNS                                      CPRI0600
C                                                                        CPRI0630
   17 FORMAT(1H1,18X,47H BIPROPELLANT LIQUID ROCKET COMBUSTION ANALYSIS  CPRI0640
    1                 22H USING  S T C  PROGRAM  )                       CPRI0650
   18 FORMAT(//37X, 28H SINGLE STREAM TUBE ANALYSIS )                    CPRI0660
   19 FORMAT(//26X, 30H MULTIPLE STREAM TUBE ANALYSIS )                  CPRI0680
   21 FORMAT(42X 25H* * * THROAT  PLANE * * * )                          CPRI0690
   22 FORMAT(36X 38H* * * BEGINNING  OF  CONVERGENCE * * * )             CPRI0692
   23 FORMAT(31X 48H* * START PLANE FOR RADIAL PRESSURE GRADIENT * *)    CPRI0694
      DATA  PROPF,PROPO / 4HFUEL  , 4HOXID  /                           CPRI0720
      DATA  PI, XDIA/ 3.14159, 25400./                                   CPRI0730
C                                                                        CPRI0740
C * * WRITE OUT DATA FROM MULTIPLE STREAM TUBE ANALYSIS (THRU S/N 790).  CPRI0760
C                                                                        CPRI0780
      NGP1 = NGF + 1                                                     CPRI0782
      WRITE(6,17)                                                        CPRI0790
      IF(IZ.EQ.NP)  WRITE(6,21)                                          CPRI0792
      IF(IZ.EQ.IZBC)  WRITE(6,22)                                        CPRI0794
      IF(JPR.EQ.1)  GO TO 800                                            CPRI0800
      IF(ABS(ZPVSR-Z(IZ)).LE.ZINCR)  WRITE(6,23)                         CPRI0810
  765 CRL = CCSAR(IZ) / CCSAR(NP)                                        CPRI0820
      XSMF = 0.0                                                         CPRI0840
      XSMO = 0.0                                                         CPRI0860
      DO 770   J=1,NST                                                   CPRI0880
      XSMF =  XSMF + SUMFC(J)                                            CPRI0900
      XSMO =  XSMO + SUMOC(J)                                            CPRI0920
  770 CASEL(J) = SUMFC(J) + SUMOC(J)                                     CPRI0940
      IF(IZ.LE.NP)  FMST = 1./ECSENR                                     CPRI0950
      XSPF =  100.0 * XSMF / TMFLF                                       CPRI0960
     1           * FMST                                                  CPRI0962
      XSPO =  100.0 * XSMO / TMFLO                                       CPRI0980
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     1          * FMST                                                        CPRI0982
      XSMA =  100.0 * (XSMF + XSMO) / (FMFLF + FMFLO)                        CPRI1000
     1          * FMST                                                        CPRI1002
      WRITE(6,19)                                                           CPRI1020
      WRITE(6,1550)  Z(IZ),PC(IZ),CCSAR(IZ),CRL,XSPF,XSPO,XSMA              CPRI1040
      IF(LAXI.GT.0)  GO TO 775                                              CPRI1045
      DO 773  J=1,NST                                                       CPRI1050
  773 WRITE(6,1560) J,GASFL(J),SMRG(J),TCG2(J),RHOG2(J),VELG2(J),SMACH,     CPRI1060
     1                AREA2(J)                                             CPRI1065
      GO TO 779                                                             CPRI1070
  775 DO 777  J=1,NST                                                       CPRI1075
  777 WRITE(6,1560) J, GASFL(J), SMRG(J), TCG2(J), RHOG2(J), VELG2(J),      CPRI1090
     1                SMACH(J), AREA2(J), RBAR2(J), P2(J),  SINCR(J)       CPRI1091
  779 CONTINUE                                                              CPRI1094
      IF(IZ.GT.3 .AND. IZ.NE.IZBC .AND. IZ.NE.NP)   RETURN                  CPRI1096
      WRITE(6,1570)                                                         CPRI1100
      DO 790  J=1,NST                                                       CPRI1120
      PROP = PROPF                                                          CPRI1140
      RL = RHOLF                                                            CPRI1160
      DO 790  I=1,NGT                                                       CPRI1170
        IF(I.NE.NGF1)  GO TO 780                                            CPRI1180
      PROP = PROPO                                                          CPRI1182
      RL = RHOLO                                                            CPRI1190
  780 WD = PI*RL*GNDOT2(I,J)*GDIAD2(I,J)**3 / 6.                            CPRI1200
      WRITE(6,1580)  J, PROP, I,GDIAM(I,J),GVELD2(I,J),GNDOT2(I,J),        CPRI1220
     1               GNOD2(I,J),GRHOD(I,J),WD                             CPRI1240
  790 CONTINUE                                                              CPRI1340
      RETURN                                                                CPRI1345
C                                                                           CPRI1350
C                                                                           CPRI1355
C * * * WRITE OUT SINGLE STREAM TUBE DATA.                                  CPRI1360
C                                                                           CPRI1380
  800 CONTINUE                                                              CPRI1390
      WRITE(6,18)                                                           CPRI1410
      GASFL(1) = SUMFC(1) + SUMOC(1)                                        CPRI1420
      FSST = CD/(ECSMIX*ECSENR)                                             CPRI1430
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      XSMA =  100. * CASFL(1) / (TMFLF + TMFLO)                          CPRI1440
     1          * FSST                                                   CPRI1442
      XSPO =  100. * SUMOC(1) / TMFLO                                    CPRI1460
     1          * FSST                                                   CPRI1462
      XSPF =  100. * SUMFC(1) / TMFLF                                    CPRI1480
     1          * FSST                                                   CPRI1482
      CRL =  CCSAR(IZ) / CCSAR(NP)                                       CPRI1500
C                                                                        CPRI1520
      CALL AVD3CA(GNDO2,GDIAD2,DMF,DMO,NGF,NGT,1)                        CPRI1540
C                                                                        CPRI1560
      DMO = XLTA * DMO                                                   CPRI1580
      DMF = XDIA * DMF                                                   CPRI1600
      WRITE(6,1590)  Z(IZ),VELG2(1),PC(IZ),TCG2(1),RHOG2(1),SMRG(1),     CPRI1620
     1    GASFL(1),CCSAR(IZ),CRL                                         CPRI1640
      CRX =  AREA2(1)/ CCSAR(NP)                                         CPRI1660
      IF(ABS(CRX-CRL)/CRL .GT. 2.E-4)  WRITE(6,1595) AREA2(1), CRX       CPRI1680
      WRITE(6,1600)  XSMA, XSPO, DMO, XSPF, DMF                          CPRI1700
      PROP = PROPF                                                       CPRI1720
      RL = RHOLF                                                         CPRI1740
      DO 995  J=1,NGT                                                    CPRI1760
        IF(J.NE.NGF)  GO TO 940                                          CPRI1770
      PROP = PROPO                                                       CPRI1780
      RL = RHOLO                                                         CPRI1782
  940 WD = PI*RL*GNDOT2(J,1)*GDIAD2(J,1)**3 / 6.                         CPRI1790
      WRITE(6,1610)  PROP, J, GDIAM(J,1), GVELD2(J,1), GNDOT2(J,1),      CPRI1800
     1               GNOD2(J,1), GRHOD(J,1), WD                          CPRI1820
  995 CONTINUE                                                           CPRI1900
 1590 FORMAT(//10X,26HAXIAL POSITION = F8.3,6X,18HCHAMBER PRESSURE = F9.CPRI1940
     13//10X,14HCHAMBER AREA = F9.4,7X,19HCONTRACTION RATIO = F7.3//20X,CPRI1960
     227HPROPELLANT BURNED (PERCENT) //20X,6HFUEL = F7.3,7X,10HOXIDIZER CPRI1980
     3= F7.3,7X,7HTOTAL = F8.3//10X,28HSTREAM TUBE CONDITIONS - GAS //10CPRI2000
     4X 95HSTRM    FLOW   MIXTURE    TEMP     DENSITY    STRM VEL  MACH CPRI2010
     5   AREA     MEAN   PRESSURE   PATH / 10X 98HTUBE   LB/SEC   RATIO CPRI2020
     6    R,       LB/IN3     FT/SEC  NUMBER    IN2   RAD.,IN    PSIA   CPRI2030
     7 INCREMENT / I                                                     CPRI2032
 1600 FORMAT(10X,I3,OPF10.5,F9.4,F8.1,1PE13.4,0PF9.1,F8.4,F9.5,          CPRI2040
```

```
     1       F6.4,F10.3,F10.5)                                                CPRI2050
1570 FORMAT(1/10X,30HSTREAM TUBE CONDITIONS - SPRAY // 9X,94H STRM  GROUCPRI2100
     1P    DIAMETER     VELOCITY      NO. FLOW        NO. CONC.      DENSITCPRI2120
     2Y         FLOWRATE /10X,91HTUBE PROP NO.  MICRONS      FT/SEC       DCPRI2140
     3ROPS/SEC       DROPS/IN3        LB/IN3          LB/SEC /)             CPRI2160
1580 FORMAT(9Y,I4,2X,A4,I3,OPF9.2,F12.2,1P4E15.4)                             CPRI2180
1590 FORMAT(/10X,3HZ = F7.3,18H IN. FROM INJECTOR //15X,9HGAS VEL.= F9.CPRI2200
     12,7H FT/SEC,5X,7HPRESS.= F9.3,5H PSIA,6X,6HTEMP.= F8.2,2H R//15X, CPRI2220
     29HDENSITY = 1PE10.3,7H LB/IN3,4X,9HGAS M.R.= OPF7.4,11X,14HGAS FLOCPRI2240
     3WRATE = F7.4,7H LB/SEC//19X 11HFLOW AREA = F9.4,4H IN2 6X 14HCONTRCPRI2260
     4, RATIO = F7.4)                                                         CPRI2280
1595 FORMAT( 25X F10.4,20X F10.4,29H **CALCULATED FROM CONTINUITY )           CPRI2300
1600 FORMAT(/15X,24HOVERALL PERCENT BURNED = F8.3//15X,8HOXIDIZER,5X,         CPRI2320
     116HPERCENT BURNED = F8.3,10X,17H MEAN DROP DIAM.= F7.2,8H MICRONS CPRI2340
     2//15X,6HFUEL,9X,16HPERCENT BURNED = F8.3,10X,16HMEAN DROP DIAM = FCPRI2360
     37.2,6H MICRONS///24X,22H PROPELLANT SPRAY DATA //15X,86HGROUP   DICPRI2380
     44METER     VELOCITY      NO. FLOW        NO. CONC.      DENSITY       CPRI2400
     5  FLOWRATE   .6X,64HNO.      MICRONS      FT/SEC       DROPS/SEC      CPRI2420
     6DROPS/IN3       LB/IN3          LB/SEC /)                             CPRI2440
1610 FORMAT(10X,A4,I4,OPF12.2,1P4E15.4)                                       CPRI2460
1620 FORMAT(//10X,26HCALCULATED C* EFFICIENCY     .3,9H PERCENT /1H1)        CPRI2480
     RETURN                                                                   CPRI2500
     END                                                                      CPRI2520



     SUBROUTINE  TRANS                                                        TRANS010
C    CONTROL SUB FOR SOLVING ISOBARIC LINES IN TRANSONIC NOZZLE REGION        TRANS020
     COMMON /CONS/ PST, ADG, IORDER, THIR, DELTH                              TRANS040
     COMMON /COM6/ NISC, NIT, IERR                                            TRANS050
     COMMON /COMT/ GA, RR, DUM(46), CD                                        TRANS060
C                                                                             TRANS160
     DATA CRAD/ 0.01745329/                                                   TRANS170
C                                                                             TRANS180
     NIT = 20                                                                 TRANS200
     DELALI = -1.-2./RR                                                       TRANS260
```

```
      ALI = -4.*DELALI                                                    TRANS270
      IORDER = 3                                                          TRANS280
      NISO = 10                                                           TRANS290
      ASO = 1.                                                            TRANS300
      DELTH = CRAD*DELALI                                                 TRANS350
      THIR  = CRAD*ALI                                                    TRANS370
      WRITE(6,104) RR, GA, NIT, ALI, DELALI                               TRANS400
  104 FORMAT(////40X 31HTRANSONIC  FLOW  FIELD  SECTION ///               TRANS410
     1 23X 56HTHROAT WALL RADIUS OF CURVATURE / THROAT RADIUS    RR =F9.6TRANS420
     2/23X 24HMEAN SPECIFIC HEAT RATIO      26X              4HGA =F9.6TRANS430
     3/23X 32HNUMBER OF POINTS ON EACH ISOBAR  17X           5HNIT =,I3 TRANS440
     4/23X 54HWALL ANGLE OF DOWNSTREAM ISOBAR BOUNDARY (DEG)   ALI =F6.2TRANS450
     6/23X 54HWALL ANGLE INCREMENT FOR ISOBARS (DEG)        DELALI =F6.3TRANS470
     7 ///)                                                             TRANS480
      CALL TIME                                                          TRANS600
      CALL N4MAIN                                                        TRANS610
C                                                                        TRANS890
      RETURN                                                             TRANS900
      END                                                                TRANS910


      SUBROUTINE N4MAIN                                                  N4MA0100
C                                                                        N4MA0110
      COMMON /COM5/ PST, ADD, IORDER, THIR, DELTH                        N4MA0120
      COMMON /COM6/ NISO, NIT, IERR                                      N4MA0130
     X             , PI(20), XMN(20), XI(20,20), RI(20,20)             N4MA0140
      COMMON /COM7/ GA, RR, RT, ZT, ZPVSR, IZBC,    PZ(20), RZ(20)     N4MA0150
     X             ,  PSTARI, RATVAP                                   N4MA0152
      COMMON /STRI/ ROSL(19), PIL, ZIL(40), RIL(40),  IL(40)           N4MA0160
      DIMENSION  THI(20)                                               N4MA0180
C                                                                        N4MA0240
      G = GA                                                             N4MA0600
      DO 100 LC=1,NISO                                                   N4MA0800
C                                                                        N4MA0850
C          COMPUTE INITIAL VALUES                                        N4MA0860
```

```
C                                                                       N4MA0870
      XI(LC,1)=RR*SIN(THIR)                                             N4MA0900
      RI(LC,1)=1.+RR*(1.-COS(THIR))                                     N4MA0910
      THI(1) = THIR                                                     N4MA0920
      CALL MALL(IORDER,RI(LC,1),XI(LC,1),RR,G,ADD,PPS,THET1)            N4MA0940
      PI(LC)=PPS                                                        N4MA0960
      G1 = G-1.                                                         N4MA0970
      XMN(LC) = SQRT( 2./G1 * ((1.+G1/2.)/PPS**(G1/G) -1.) )            N4MA0972
C                                                                       N4MA0980
C          COMPUTE RADIAL COORDINATES OF INITIAL LINE POINTS            N4MA0990
      FNIT=NIT                                                          N4MA1010
      NITM=NIT-1                                                        N4MA1020
      DS=RI(LC,1)/(FNIT-1.)                                             N4MA1030
C                                                                       N4MA1038
      DO 10 I=2,NITM                                                    N4MA1040
   10 RI(LC,I)=RI(LC,I-1)-DS                                            N4MA1050
C                                                                       N4MA1052
      PI(LC,NIT)=0.                                                     N4MA1060
C                                                                       N4MA1230
C          FIND X AND THETA FOR CONSTANT PRESSURE INITIAL LINE          N4MA1240
C                                                                       N4MA1250
      DO 60 I=2,NIT                                                     N4MA1260
      XI1=XI(LC,I-1)                                                    N4MA1270
      NOU=-1                                                            N4MA1280
C                                                                       N4MA1288
      DO 90 J=1,25                                                      N4MA1290
      CALL MALL(IORDER,PI(LC,I),XI1,RR,G,ADD,PPS1,THETA)                N4MA1310
      F1=PPS-PPS1                                                       N4MA1350
      IF(ABS(F1)/PPS .LT. 5.E-6) GO TO 55                               N4MA1360
      CALL ITER(F1,XI1,XNEW,NOU)                                        N4MA1370
      XI1=XNEW                                                          N4MA1380
   90 CONTINUE                                                          N4MA1390
C                                                                       N4MA1400
      WRITE(6,900) I,RI(LC,I),XI1,PPS,PPS1                              N4MA1410
  900 FORMAT(62HUNABLE TO ROOT X(I) FOR CONSTANT PRESSURE INITIAL LINE.N4MA1420
     X    I= ,I3,/,6HRI(I)=E15.5,5X,2HX=E15.5,5X,2HP=2E15.7)            N4MA1430
```

```
      GO T. 57                                                          N4MA1450
C                                                                       N4MA1460
 55   CONTINUE                                                          N4MA1470
      XI(LC,I)=XI1                                                      N4MA1480
      THI(I) = THETA                                                    N4MA1490
      IF(XI1+1.E-6 .GT. XI(LC,I-1)) GO TO 60                            N4MA1492
   57   NITO = LC                                                       N4MA1494
        XI1 = XI(LC,1)                                                  N4MA1496
        DO 58  I1=2,NIT                                                 N4MA1498
   58   XI(LC,I1) = XI1                                                 N4MA1500
      IF(LC.L .5) IERR=25                                               N4MA1502
      GO TO 110                                                         N4MA1504
   60 CONTINUE                                                          N4MA1508
C                                                                       N4MA1510
      ALPHA = THIR*57.29578                                             N4MA1520
      WRITE(6,70)   ALPHA, PI(LC), XMN(LC)                              N4MA1530
 70   FORMAT(1H1 4X 17HISOBAR AT ALPHA = F8.4,14H, WHERE P/P* = F10.7   N4MA1540
     X,15H AND MACH NO. = F10.7 )                                       N4MA1542
      WRITE(6,75)                                                       N4MA1546
   75 FORMAT( /// 5X 5HPOINT 12X 4HR/RT 16X 4HX/RT 15X 5HTHETA //)     N4MA1550
C                                                                       N4MA1558
      DO 90   I=1,NIT                                                   N4MA1560
      THETA = THI(I)*57.29578                                           N4MA1562
      WRITE(6,80)    I, RI(LC,I), XI(LC,I), THETA                       N4MA1570
 80   FORMAT(I9, 3F20.7)                                                N4MA1580
 90   CONTINUE                                                          N4MA1590
C                                                                       N4MA1592
        IF(LC.NE.5) GO TO 100                                           N4MA1600
        PIL = PI(LC)                                                    N4MA1610
        ZIL(1) = XI(LC,1)                                               N4MA1612
        RIL(1) = RI(LC,1)                                               N4MA1614
        THIL(1) = THIR                                                  N4MA1616
        DS = RIL(1)/39.                                                 N4MA1618
          DO 92 I=2,39                                                  N4MA1620
   92     RIL(I) = RIL(I-1)-DS                                          N4MA1622
        RIL(40) = 0.                                                    N4MA1630
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```
      XI1 = ZIL(1)                                                        N4MA1632
       DO 96 I=2,40                                                       N4MA1640
       NDD = -1                                                           N4MA1644
        DO 94 J=1,25                                                      N4MA1650
        CALL MALL(IORDER,RIL(I),XI1,RR,G,ADD,PPS1,THETA)                  N4MA1652
        F1 = PPS-PPS1                                                     N4MA1654
        IF(ABS(F1)/PPS .LT. 5.E-6) GO TO 95                               N4MA1656
        CALL ITER(F1,XI1,XNEW,NDD)                                        N4MA1658
94      XI1 = XNEW                                                        N4MA1660
95     ZIL(I) = XI1*RT + ZT                                               N4MA1670
       RIL(I) = RIL(I)*RT                                                 N4MA1672
96     THIL(I) = THETA                                                    N4MA1680
      ZIL(1) = ZIL(1)*RT + ZT                                             N4MA1682
      RIL(1) = RIL(1)*RT                                                  N4MA1684
       WRITE(6,70) ALPHA, PIL, XMN(LC)                                    N4MA1690
    WRITE(6,97)                                                           N4MA1691
97  FORMAT(///5X 5HPOINT 11X 7HRIL,IN. 13X 7HZIL,IN. 14X 5HTHETA //)     N4MA1692
        DO 98 I=1,40                                                      N4MA1694
        THETA = THIL(I)*57.2957E                                          N4MA1696
98      WRITE(6,90) I, RIL(I), ZIL(I), THETA                              N4MA1698
C                                                                         N4MA1770
 100 THIR = THIR*DELTH                                                    N4MA1780
C                                                                         N4MA1790
 110  CONTINUE                                                           N4MA1800
      IF(IERR.NE.25)                                                      N4MA2000
     X CALL PLOTT                                                         N4MA2010
      RETURN                                                              N4MA2320
      END                                                                 N4MA2330
```

```
      SUBROUTINE HALL(I,RR,ZZ,RI,GAMMA,ADD,PPS,THETA)                    HALL0100
C                                                                        HALL0110
C          TRANSONIC FLOW IN AXIALLY-SYMMETRIC NOZZLES                   HALL0120
C          QUART. J.M.A.M.,VOL.15,PT.4,1962                              HALL0130
C          MODIFIED BY KLIEGEL ET. AL.                                   HALL0140
C                                                                        HALL0150
      Y=RR                                                               HALL0160
      R=RI                                                               HALL0170
      G=GAMMA                                                            HALL0180
      CC=SQRT((G+1.)/2.)                                                 HALL0190
      Z=ZZ/CC*SQRT(R)                                                    HALL0200
      Y2=Y*Y                                                             HALL0210
      U1=Y2/2.-.25*Z                                                     HALL0220
      V1=((Y2-1.)/4.*Z)*Y                                                HALL0230
      P1=-G*U1                                                           HALL0240
      U2=0.                                                              HALL0250
      V2=0.                                                              HALL0260
      P2=0.                                                              HALL0270
      U3=0.                                                              HALL0280
      V3=0.                                                              HALL0290
      P3=0.                                                              HALL0300
C                                                                        HALL0310
      IF(I-1) 4,4,2                                                      HALL0320
C                                                  (77),(78)             HALL0330
    2 U2=((2.*G+9.)*Y2-4.*G-15.)/24.*Y2+(10.*G+57.)/288.                 HALL0340
     1   *Z*(Y2-5./2.)-(2.*G-3.)/6.*Z*Z                                  HALL0350
      V2=(((G+3.)/9.*Y2-(20.*G+63.)/96.)*Y2+(28.*G+93.)/288.)*Y          HALL0360
     1   *Z*((2.*G+9.)/6.*Y2-(4.*G+15.)/12.)*Y+Y*Z*Z                     HALL0370
      P2=-G*U2                                                           HALL0380
C                                                                        HALL0390
      IF(I-2) 4,4,3                                                      HALL0400
C                                                  (81),(82)             HALL0410
    3 G2=G*G                                                             HALL0420
      U3=(((956.*G2+1737.*G+3069.)/10368.*Y2                             HALL0430
     1   -(388.*G2+1161.*G+1861.)/2304.)*Y2                              HALL0440
     2   +(304.*G2+831.*G+1242.)/1728.)*Y2                               HALL0450
```

```
     3    -(2708.*G2+7839.*G+14211.)/82944.                                          HALL0460
     4    +Z*((152.*G2+51.*G+327.)/384.*Y2-(52.*G2+75.*G+279.)/192.)*Y2              HALL0470
     5    *(92.*G2+180.*G+639.)/1152.)                                               HALL0480
     6    +Z*Z*(((3.-7.*G)/8.*Y2+(13.*G-27.)/48.)                                    HALL0490
     7    *(4.*G2-57.*G+27.)/144.*Z)                                                 HALL0500
      V3=(((((6836.*G2+23031.*G+30627.)/82944.*Y2                                   HALL0510
     1    -(3380.*G2+11391.*G+15291.)/13824.)*Y2                                     HALL0520
     2    +(3424.*G2+11271.*G+15228.)/13824.)*Y2                                     HALL0530
     3    -(7100.*G2+22311.*G+30249.)/82944.)*Y                                      HALL0540
     4    +Z*(((556.*G2+1837.*G+3069.)/1728.*Y2                                      HALL0550
     5    -(388.*G2+1161.*G+1881.)/576.)*Y2                                          HALL0560
     6    *(304.*G2+831.*G+1242.)/864.)*Y                                            HALL0570
     7    +Z*Z*(((52.*G2+51.*G+327.)/192.*Y2                                         HALL0580
     8    -(52.*G2+75.*G+279.)/192.)*Y                                               HALL0590
     9    *Z*(3.-7.*G)/12.*Y)                                                        HALL0600
      P3=-G*U3-G*(G+1.)/4.*V1**2+G*(G+1.)/6.*U1**3                                  HALL0610
C                                                                                   HALL0620
  4   CONTINUE                                                                      HALL0630
      IF(ADD .EQ. C.) GO TO 5                                                       HALL0640
C                                                                                   HALL0650
      RP1=R+1.                                                                      HALL0660
      C1=CC/SQRT(RP1)                                                               HALL0670
      UB=1.+U1/RP1+(U2+U1)/RP1**2+(U3+2.*U2+U1)/RP1**3                              HALL0680
      VB=C1*(V1/RP1+(V2+1.5*V1)/RP1**2+(V3+2.5*V2+15./8.*V1)/RP1**3)                HALL0690
      PPS=1.+P1/RP1+(P1+P2)/RP1**2+(P3+2.*P2+P1)/RP1**3                             HALL0700
      GO TO 7                                                                       HALL0710
C                                                                                   HALL0720
  5   C=CC/SQRT(R)                                                                  HALL0730
      UB=1.+((U3/R+U2)/R+U1)/R                                                      HALL0740
      VB=C*((V3/R+V2)/R+V1)/R                                                       HALL0750
      PPS=1.+((P3/R+P2)/R+P1)/R                                                     HALL0760
C                                                                                   HALL0770
  7   THETA=ATAN2(VB,UB)                                                            HALL0780
      RETURN                                                                        HALL0790
      END                                                                           HALL0800
```

```
      SUBROUTINE ITER(F1,X1,XNEW,NCC)                                   ITER0100
CITER            SUBROUTINE TO FIND ROOTS USING SECANT MTD              ITER0110
      F=F1                                                              ITER0120
      X=X1                                                              ITER0130
C                 NCC=+1   IF ITERATION HAS BEEN STARTED                ITER0140
C                                                                       ITER0150
C                 NCC=-1   IF IT HAS NOT                                ITER0160
C                                                                       ITER0170
      IF(NCC.GT.0)GO TO 50                                              ITER0180
      NCC=1                                                             ITER0190
      FF=F                                                              ITER0200
      XF=X                                                              ITER0210
      FFF=0.0                                                           ITER0220
      DEL=AMAX1(ABS(1.001*X),0.001)                                     ITER0230
      XNEW=X+DEL                                                        ITER0240
      RETURN                                                            ITER0250
C                                                                       ITER0260
C        CK TO SEE IF ROOT SPANNED                                      ITER0270
C                                                                       ITER0280
 50   IF((F*FF).LT.0.0)GO TO 100                                        ITER0290
C                                                                       ITER0300
C        CK TO SEE IF ROOT HAS BEEN SPANNED PREVIOUSLY                  ITER0310
C                                                                       ITER0320
      IF((FF*FFF).GE.0.0)GO TO 100                                      ITER0330
      FF=FFF                                                            ITER0340
      XF=XFF                                                            ITER0350
      R=ABS(F/FF)                                                       ITER0360
      R=AMAX1(R,1.0/R)                                                  ITER0370
C                                                                       ITER0380
C        IF ERRORS DIFFER TOO MUCH, HALVE X                             ITER0390
C                                                                       ITER0400
      IF(R.LT. 10.0) GO TO 100                                          ITER0410
      XNEW=0.5*(X+XF)                                                   ITER0420
      FF=F                                                              ITER0430
      XF=X                                                              ITER0440
      RETURN                                                            ITER0450
```

```
  100  XNEW=X-F*(X-XF)/(F-FF)                                          ITER0460
       FFF=FF                                                          ITER0470
       FF=F                                                            ITER0480
       XFF=XF                                                          ITER0490
       XF=X                                                            ITER0500
       RETURN                                                          ITER0510
       END                                                             ITER0520


       SUBROUTINE  PLOTT                                               PLOT0010
C                                                                      PLOT0020
       COMMON  /COM7/ G4, RR                                           PLOT0028
       COMMON  /COM6/ NISO, NRISO, IERR                                PLOT0030
      X              , F(20), XMN(20), X(20,20), R(20,20)              PLOT0032
C                                                                      PLOT0040
       Y1 = 0.                                                         PLOT0050
       Y2 = 1.02*R(NISO,1)                                             PLOT0060
       X1 = X(NISO,1)                                                  PLOT0070
       X2 = X(1,20)                                                    PLOT0080
       YR = Y2                                                         PLOT0090
       XR = X2-X1                                                      PLOT0100
       DR = AMAX1(XR,YR)                                               PLOT0110
       IF(XR.GT.YR) GO TO 20                                           PLOT0120
       XM = (YR-XR)/2.                                                 PLOT0130
       X1 = X1-XM                                                      PLOT0140
       X2 = X2+XM                                                      PLOT0150
   20  CALL SCALE(X1,X2,12,XL,XR,DX,IRX)                               PLOT0160
       YB = 0                                                          PLOT0170
       YT = XR-XL                                                      PLOT0180
       CALL DXDYV(2,YB,YT,D, M,J,N, 12.,IR)                            PLOT0190
       CALL DXDYV(1,XL,XR,D, M,J,N, 12.,IR)                            PLOT0200
       CALL CAMRAV(9)                                                  PLOT0210
       CALL SETMIV(24,93,24,45)                                        PLOT0216
       CALL GRIDIV(1,XL,XR,YB,YT,D,D,-M,M,J,J,6,6)                     PLOT0220
       CALL LINEG(NISO,X,R,1,1,3)                                      PLOT0230
```

```
      DO 40 LC=1,NISO                                                    PLOT0240
        XI = LC                                                          PLOT0242
        IX = NXV(X(LC,1))                                                PLOT0244
        IY = NYV(R(LC,1)) + 6                                            PLOT0246
      CALL LABLV(XI,IX,IY,2,1,2)                                         PLOT0248
40    CALL LINEG(20,X(LC,1),R(LC,1),20,20,3)                             PLOT0250
      CALL RITE2V( 60,1014,1023,90,2,49,1,49HCONSTANT PRESSURE AND MACH  PLOT0260
     1LINES IN THROAT REGION,IL)                                         PLOT0262
      CALL PRINTV( 3,'RR=',262,990)                                      PLOT0270
      CALL LABLV(RR,294,990,7,1,3)                                       PLOT0280
      CALL PRINTV( 6,'GAMMA=',400,990)                                   PLOT0290
      CALL LABLV(GA,456, 990,7,1,2)                                      PLOT0300
      CALL RITE2V(514,9,1023, 90,2,4,1,'X/RT',NL)                        PLOT0310
      CALL RITE2V(9,514,1023,180,2,4,1,'R/RT',NL)                        PLOT0320
        IX1 = 930                                                        PLOT0330
        IX2 = 967                                                        PLOT0340
        IY = 750                                                         PLOT0350
      CALL PRINTV(4,'P/P*',IX2,IY)                                       PLOT0360
      IY = IY-5                                                          PLOT0370
       DO 50 I=1,NISO                                                    PLOT0380
       XI = I                                                            PLOT0390
       IY = IY-15                                                        PLOT0400
       CALL LABLV(XI,IX1,IY,3,1,3)                                       PLOT0410
50     CALL LABLV(P(I),IX2,IY,8,1,2)                                     PLOT0420
      IY = IY-45                                                         PLOT0430
      CALL PRINTV(4,'MACH',IX2,IY)                                       PLOT0440
      IY = IY-5                                                          PLOT0450
       DO 60 I=1,NISO                                                    PLOT0460
       XI = I                                                            PLOT0470
       IY = IY-15                                                        PLOT0480
       CALL LABLV(XI,IX1,IY,3,1,3)                                       PLOT0490
60     CALL LABLV(XMN(I),IX2,IY,8,1,2)                                   PLOT0500
      RETURN                                                             PLOT0800
      END                                                                PLOT0810
```

```
      SUBROUTINE AVD30A(ANX,DX,AVDF,AVDD,NGF,NGT,J)                    AVD00010
C                                                                      AVD00020
C        THIS IS A REVISION OF SUBR. 'AVD30' TO BE COMPATIBLE WITH THE AVD00030
C        STREAM TUBE COMPUTER MODEL (L.P.COMBS AUG.'68)                AVD00040
C                                                                      AVD00050
      DIMENSION  ANX(12,19), DX(12,19)                                 AVD00060
C                                                                      AVD00070
      AVDF = 0.0                                                       AVD00072
      AVDD = 0.0                                                       AVD00074
      LL = 1                                                           AVD00078
      LS = NGF                                                         AVD00082
      DO 500  L=1,2                                                    AVD00086
      SMN = 0.0                                                        AVD00090
      SMD30P = 0.0                                                     AVD00100
      IF(L.EQ.1)  GO TO 80                                             AVD00105
          LL = NGF + 1                                                 AVD00110
          LS = NGT                                                     AVD00115
   80 DO 100  I=LL,LS                                                  AVD00120
      IF(DX(I,J).LE.0.0)  GO TO 100                                    AVD00130
      SMD30P = ANX(I,J) * DX(I,J)**3 + SMD30P                          AVD00140
      SMN = ANX(I,J) + SMN                                             AVD00150
  100 CONTINUE                                                         AVD00160
      IF(SMN)  120,120,150                                             AVD00170
  120 AVD = 0.0                                                        AVD00180
      GO TO 200                                                        AVD00190
  150 AVD = (SMD30P/SMN)**.33333                                       AVD00200
  200 IF(L.EQ.1)  AVDF = AVD                                           AVD00210
      IF(L.GT.1)  AVDD = AVD                                           AVD00220
  500 CONTINUE                                                         AVD00230
      RETURN                                                           AVD00240
      END                                                              AVD00250
```

```
      SUBROUTINE  STCRT(KK,IZ,NST)                                      STCRT010
C       SAVES ST RADII AND PLOTS ON CRT   -MAX OF 20 ST-S               STCRT020
      COMMON  /ADZ/ APROF(12,2), CCSAR(300), Z(300),                    STCRT030
     X              AREA1(19),   AREA2(19),  DELARS(20),               STCRT040
     X              RBAR1(19),   RBAR2(19),  SINCR(19)                 STCRT050
     X             ,SUMSTA,      RDSL1(19),  RDSL2(19)                 STCRT052
      COMMON  /GRP/ RST(300,20)                                         STCRT060
C                                                                       STCRT070
      IF(NST.GT.20) RETURN                                              STCRT080
      GO TO (10,50),KK                                                  STCRT090
C                                                                       STCRT100
C          T A P E    S T O R A G E    S E C T I O N                   STCRT108
   10 WRITE(2) (RDSL2(I),I=1,NST)                                       STCRT110
      RETURN                                                            STCRT160
C                                                                       STCRT170
   50 END FILE 2                                                        STCRT180
      REWIND 2                                                          STCRT190
      NP = IZ                                                           STCRT194
      RMAX = 0.                                                         STCRT196
        DO 60 I=1,NP                                                    STCRT200
        RMAX = AMAX1(RMAX,CCSAR(I))                                     STCRT204
   60   READ(2) (RST(I,J),J=1,NST)                                      STCRT210
C                                                                       STCRT220
C            P R I N T    S E C T I O N                                 STCRT230
      DO 120 J=1,NP,38                                                  STCRT240
      WRITE(6,70)                                                       STCRT250
   70 FORMAT(1H1 46X 17HSTREAMTUBE  RADII //10X 1HZ 6X 86HST  1    ST  2STCRT260
     1    ST  3    ST  4    ST  5    ST  6    ST  7    ST  8    ST  9  STCRT270
     2 ST 10 /)                                                         STCRT280
      I2 = MIN0(J+37,NP)                                                STCRT290
      N2 = MIN0(NST,10)                                                 STCRT300
        DO 80 I=J,I2                                                    STCRT310
   80   WRITE(6,90) Z(I),(RST(I,N),N=1,N2)                             STCRT320
   90   FORMAT(4X 11F9.3)                                              STCRT330
      IF(NST.LT.11) GO TO 120                                           STCRT340
C                                                                       STCRT350
```

```
      WRITE(6,100)                                                          STCRT360
  100 FORMAT(1H1 46X 17HSTREAMTUBE  RADII //10X 1H2 6X 8HST 11    ST 12STCRT370
     1    ST 13    ST 14    ST 15    ST 16    ST 17    ST 18    ST 19    STCRT380
     2 ST 20 /)                                                           STCRT390
        DO 110 I=J,12                                                     STCRT400
  110   WRITE(6,90) Z(I),(RST(I,N),N=11,NST)                              STCRT410
  120 CONTINUE                                                            STCRT420
C                                                                         STCRT430
C                                                                         STCRT440
C           C R T    S E C T I O N                                        STCRT444
      CALL LGRID(1, Z(1),ZINP1, -RMAX,RMAX, 24,0,24,45, IR)              STCRT450
      IF(IR.EQ.0) GO TO 140                                               STCRT460
        WRITE(6,130)                                                      STCRT470
  130   FORMAT(1H)////58HOE R R O R   ENCOUNTERED IN PLOTTING STREAMTUBESTCRT480
     X RADII GRID )                                                       STCRT490
        GO TO 1000                                                        STCRT500
C                                                                         STCRT510
  140 DO 150 I=1,NST                                                      STCRT520
  150 CALL LINEG(-NP,Z,RST(1,I),1,1,2)                                    STCRT522
        DO 160 I=1,NP                                                     STCRT530
        RST(I,1) = SQRT(CCSAR(I)/3.14159)                                 STCRT532
  160   RST(I,2) = -RST(I,1)                                              STCRT534
      CALL LINEG(-NP,Z,RST,1,1,2)                                         STCRT536
      CALL  APLOTV(NP,Z,RST,10,10,1,44,IR)                                STCRT538
      CALL  APLOTV(NP,Z,RST(1,2),10,10,1,44,IR)                           STCRT539
       CALL RITE2V(379,1014,1023,90,2,19,1,19HSTREAMTUBE  PROFILE, IL)    STCRT540
       CALL RITE2V(424,9,1023,90,2,14,1,14HAXIAL DISTANCE, IL)            STCRT550
       CALL RITE2V(9,496,1023,180,2, 6,1, 6HRADIUS, IL)                   STCRT560
C                                                                         STCRT570
 1000 CONTINUE                                                            STCRT890
      RETURN                                                              STCRT900
      END                                                                 STCRT910
```

```
      SUBROUTINE TABLES (NN)                                                    TBLS0050
C                                                                               TBLS0100
      COMMON  /TBL/TMR(18), TTO(18,3), TVIS(18,3),TGAM(18,3),TMW(18,3),         TBLS0150
     1             CSTR(18),TEPS(6),   TMACH(3),  TCF(18,6)                   TBLS0200
     2           , TOXFRP(18), XMRM, TVSOND(18,3)                             TBLS0210
      COMMON  /GAS/GASPL(19),  SMRG(19),   TCOG(19),   SGAM(19),                TBLS0250
     X             SMWG(19),   SVOS(19),   VISG(19),   RHOG1(19),             TBLS0300
     X             RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),              TBLS0350
     X             TCG2(19),   VSON(19),   STOT(19),   SMACH(19)              TBLS0400
      COMMON  /SWV/    NP,   NAP,   NMR,   NTK,  TNBF,   TBF,RHONBF,          TBLS0510
     1            RHOLF,WTMLLF,WTMLVF,  TNBO,   TBO,RHONBO, RHOLO,           TBLS0520
     2           WTMLLO,WTMLVO,TCRITF,TCRITO,  DHVF,  DHVO,   IST,           TBLS0530
     3            NGSTI, NMSTI,  ICRC, CRTOL,ARTOLD,   NPC,  XOPC,           TBLS0540
     4              PCI,ZSTART,   NST,   NGT,   NGF,   NGO,   NTL,           TBLS0550
     5              NTS,    NC, CCSAI, TMFLF, TMFLO,  CMRI, TCSTR,           TBLS0560
     6              IPR,  IZPR,    ND,  NPQ, SNCR,    IZ,   II,             TBLS0570
     7          ETAI,  ETA2,  SCS,  ZINCR,  IKPF,  IKPO,  LAXI,              TBLS0572
     8          ISEQ,  NASEG, MSTI, NEPS,   PEXIT, AEXIT, ECFVAC,            TBLS0574
     9          NMACH                                                        TBLS0576
      EQUIVALENCE  ( TTO1(1), TTO(1,1)),  (TVIS1(1),TVIS(1,1)) ,            TBLS0580
     "             (TVSO1(1),TVSOND(1,1)),                                  TBLS0581
     1             (TGAM1(1),TGAM(1,1)),  ( TMW1(1), TMW(1,1))              TBLS0582
      DIMENSION  TTO1(54), TVIS1(54), TGAM1(54), TMW1(54), TVSO1(54)        TBLS0586
      DATA JK/1/                                                            TBLS0588
C                                                                           TBLS0590
      XL1(W1,W2) = W1 + FA*(W2-W1)                                          TBLS0596
      XL2(W1,W2,V1,V2) = (1.-FB)*XL1(W1,W2) +  FB*XL1(V1,V2)                TBLS0598
C                                                                           TBLS0599
      DO 200  NT=1,NN                                                       TBLS0600
      OXFRP = SMRG(NT)/(SMRG(NT)+XMRM)                                      TBLS0604
      CALL  LOCFAC(JK, OXFRP,TOXFRP,XMR,J,FA)                               TBLS0610
      J1 = J+1                                                              TBLS0612
        FA = AMIN1(1.,A  AX1(0.,FA))                                        TBLS0614
      K = 1                                                                 TBLS0620
      IF(NMACH-2) 10,30,20                                                  TBLS0630
   10   TCOG(NT) = XL1(TTO1(J),TTO1(J1))                                     TBLS0640
```

```
      VISC(NT) = XLI(TVIS1(J),TVIS1(J1))                                TBLS0650
      SGAM(NT) = XLI(TGAM1(J),TGAM1(J1))                                TBLS0660
      SMWC(NT) = XLI(TMW1(J),TMW1(J1))                                  TBLS0670
      SVCS(NT) = XLI(TVSO1(J),TVSO1(J1))                                TBLS0672
    GO TO 200                                                           TBLS0680
 20 IF(SMACH(NT).GT.TMACH(21)  K = 2                                    TBLS0690
 30 K1 = K+1                                                            TBLS0700
      I11 = (K-1)*IS + J                                                TBLS0702
      I21 = I11 + 1                                                     TBLS0704
      I12 = I11 + 10                                                    TBLS0706
      I22 = I12 + 1                                                     TBLS0708
    FR = (SMACH(NT)-TMACH(K))/(TMACH(K1)-TMACH(K))                      TBLS0710
    FR = AMIN1(AMAX1(FR,0.),1.)                                         TBLS0715
      TCSC(NT) = XL2( TTO1(I11), TTO1(I21), TTO1(I12), TTO1(I22))       TBLS0720
      VISC(NT) = XL2(TVIS1(I11),TVIS1(I21),TVIS1(I12),TVIS1(I22))       TBLS0730
      SGAM(NT) = XL2(TGAM1(I11),TGAM1(I21),TGAM1(I12),TGAM1(I22))       TBLS0740
      SMWC(NT) = XL2( TMW1(I11), TMW1(I21), TMW1(I12), TMW1(I22))       TBLS0750
      SVCS(NT) = XL2(TVSO1(I11),TVSO1(I21),TVSO1(I12),TVSO1(I22))       TBLS0760
200 VSON(NT) = SVCS(NT) / SQRT(1.0+(SGAM(NT)-1.0)/2.0)                  TBLS0950
    RETURN                                                              TBLS1000
    END                                                                 TBLS1050



    SUBROUTINE  ITER8(N,M)                                              ITER8100
    COMMON  /BLOCK/ CL, CFSF, CFSO, PVALVE, PVALVO, IEBX, PMF, PMO,     ITER8110
   1                PIE1, TMFLP1, TMFLO1                                ITER8112
    COMMON  /GRP/GRHOD(12,19),  GVELD1(12,19), GVELD2(12,19),           ITER8120
   X              GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),          ITER8140
   X              GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),         ITER8160
   X              GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19),          ITER8180
   X              GDIAM(12,19)                                         ITER8200
    COMMON  /AOZ/APROF(12,2), CCSAR(300), Z(300),                       ITER8220
   X              AREA1(19),   AREA2(19),  DELARS(20)                  ITER8240
   X,             RBAR1(19),   RBAR2(19),  SINGR(19)                   ITER8260
   X,             SUM37A,       RDSL1(19),  RDSL2(19)                  ITER8280
```

```
      COMMON  /GAS/GASFL(19),  SMRG(19),   TCOG(19),   SGAM(19),          ITER8300
     X              SMMG(19),   SVOS(19),   VISG(19),   RHOG1(19),        ITER8320
     X             RHOG2(19),  VELG1(19),  VELG2(19),  TCG1(19),         ITER8340
     X            TCG2(19),    VSON(19)                                   ITER8360
      COMMON  /VAP/EVAPF(19), EVAPO(19),  SUMFC(19),  SUMOC(19)          ITER8380
      COMMON  /P/ PC(300),    PC1(300),   PPC(2u),    U2(300)            ITER8400
      COMMON  /PS/P1(19),   P2(19),   DPDR(19), DRDS(19), DZDS(19)       ITER8420
      COMMON  /SVV/    A(20), NST, NGT, NGF, AI(5), IMFLF, IMFLO, XMRI,  ITER8430
     1                 B(3), IZPR, C(3), IZ, A2(18), PIE                 ITER8432
C                                                                        ITER8460
      IF(N.EQ.2) GO TO 100                                               ITER8480
      WRITE(M)   IZ,PC(IZ),((AREA2(J),RBAR2(J),    .2(J),VELG2(J),      ITER8500
     1           TCG2(J),RHOG2(J),SUMOC(J),SUMFC(J),GASFL(J),SMRG(J),    ITER8520
     2           P2(J),(GNOD2(I,J),GNDOT2(I,J),GDIAD2(I,J),GVELD2(I,J),  ITER8540
     3           GMSPR(I,J),GRMOD(I,J)),I=1,NGT),J=1,NST)                ITER8560
     4           ,IZPR,PC(1)                                             ITER8570
C                                                                        ITER8510
      END FILE M                                                         ITER8600
      REWIND M                                                           ITER8620
      GO TO 200                                                          ITER8640
C                                                                        ITER8660
  100 READ(M)    IZ,PC(IZ),((AREA2(J),RBAR2(J),RDSL2(J),VELG2(J),       ITER8680
     1           TCG2(J),RHOG2(J),SUMOC(J),SUMFC(J),GASFL(J),SMRG(J),    ITER8700
     2           P2(J),(GNOD2(I,J),GNDOT2(I,J),GDIAD2(I,J),GVELD2(I,J),  ITER8720
     3           GMSPR(I,J),GRMOD(I,J)),I=1,NGT),J=1,NST)                ITER8740
     4           ,IZPR,PB                                                ITER8750
      REWIND M                                                           ITER8752
C                                                                        ITER8754
      RP = PIE/PIE1                                                      ITER8760
      RF = IMFLF/IMFLF1                                                  ITER8762
      RO = IMFLO/IMFLO1                                                  ITER8764
      RM = RO/RF                                                         ITER8766
      R1 = RF                                                            ITER8768
      IF(NGF.LE.0)  R1 = RO                                              ITER8770
C                                                                        ITER8772
      PC(IZ) = RP*PC(IZ)                                                 ITER8780
```

```
      DO 120 J=1,NST                                                    ITER8782
      PZ(J) = RP*PZ(J)                                                  ITER8784
      RHOGZ(J) = RP*RHOGZ(J)                                            ITER8786
      VELGZ(J) = VELGZ(J)/RP                                            ITER8788
      SUMFC(J) = RF*SUMFC(J)                                            ITER8790
      SUMOC(J) = RO*SUMOC(J)                                            ITER8792
      GASFL(J) = SUMFC(J) + SUMOC(J)                                    ITER8794
      SMRG(J)  = RM*SMRC(J)                                             ITER8796
      RX = R1                                                           ITER8798
        DO 120 I=1,NGT                                                  ITER8800
        IF(I.EQ.NGF)  RX = RC                                           ITER8802
  120   GMSPR(I,J) = RX*GMSPR(I,J)                                      ITER8804
      CALL  CHANGS(2,NST,NGT)                                           ITER8806
C                                                                       ITER8808
      REWIND 2                                                          ITER8810
      DO 150  I=1,IZ                                                    ITER8814
  150 READ(2)  XX                                                       ITER8816
C                                                                       ITER8818
  200 RETURN                                                            ITER8820
      END                                                               ITER8840


      SUBROUTINE  TDKSET                                                TDKS0010
C                                                                       TDKS0020
      COMMON /SVV/    A(30),NST                                         TDKS0030
      COMMON /P/      PC(300)                                           TDKS0040
      COMMON /STKI/  RDSL(19), PIL, ZIL(40), RIL(40), THIL(40),         TDKS0050
     1               VIL(19), XMRIL(19), ZDSL(19)                       TDKS0060
      COMMON /CONT/  GA, RR, RT, ZT, DUM(42), PSTARI, RATVAP            TDKS0070
      DATA C,O, KSTC/ 4HTDKP, 2/                                        TDKS0072
C                                                                       TDKS0080
      REWIND KSTC                                                       TDKS0086
      PIL = PIL*PSTARI                                                  TDKS0090
        DO 1  I=1,40                                                    TDKS0100
        ZIL(I) = (ZIL(I)-ZT)/RT                                         TDKS0102
```

```
   10   RIL(I) = RIL(I)/RT                                              TDKS0104
          DO 12 I=1,NST                                                 TDKS0110
          ZDSL(I) = (ZDSL(I)-ZT)/RT                                     TDKS0114
   12     RDSL(I) = RDSL(I)/RT                                          TDKS0120
        WRITE(6,20)                                                     TDKS0130
   20 FORMAT(1H1 37X 34HPUNCHED  CARD  OUTPUT  FOR    T D K //         TDKS0140
     1  5X 23HNST, PC(1), PIL, RATVAP )                                 TDKS0150
        NSEQ = 1000                                                     TDKS0160
        WRITE(6,30) NST, CID, NSEQ                                      TDKS0170
        PUNCH 30, NST, CID, NSEQ                                        TDKS0180
   30 FORMAT(I12, 60X A4,I4)                                            TDKS0190
        NSEQ = 1010                                                     TDKS0200
        WRITE(6,40) PC(1),PIL, RATVAP, CID, NSEQ                        TDKS0210
        PUNCH 40, PC(1), PIL, RATVAP, CID, NSEQ                         TDKS0220
   40 FORMAT(1P3E12.5,36X A4,I4)                                        TDKS0230
C                                                                       TDKS0238
        NSEQ = 1020                                                     TDKS0240
        WRITE(6,50)                                                     TDKS0250
   50 FORMAT(1GHO    XMRIL)                                             TDKS0260
        CALL PUN(XMRIL,NST,CID,NSEQ)                                    TDKS0270
C                                                                       TDKS0278
        NSEQ = (NSEQ/10+1)*10                                           TDKS0280
        WRITE(6,60)                                                     TDKS0290
   60 FORMAT( 8HO     VIL)                                              TDKS0300
        CALL PUN(VIL,NST,CID,NSEQ)                                      TDKS0310
C                                                                       TDKS0318
        NSEQ = (NSEQ/10+1)*10                                           TDKS0320
        WRITE(6,62)                                                     TDKS0322
   62 FORMAT( 9HO     ZDSL)                                             TDKS0324
        CALL  PUN(ZDSL,NST,CID,NSEQ)                                    TDKS0326
C                                                                       TDKS0327
        NSEQ = (NSEQ/10+1)*10                                           TDKS0328
        WRITE(6,70)                                                     TDKS0330
   70 FORMAT( 9HO     RDSL)                                             TDKS0340
        CALL PUN(RDSL,NST,CID,NSEQ)                                     TDKS0350
C                                                                       TDKS0358
```

```
      NSEQ = (NSEQ/10+1)*10                                              TDKS0360
      WRITE(6,80)                                                        TDKS0370
   80 FORMAT( 8HO     ZIL)                                               TDKS0380
      CALL PUN(ZIL,40,CID,NSEQ)                                          TDKS0390
C                                                                        TDKS0398
      NSEQ = (NSEQ/10+1)*10                                              TDKS0400
      WRITE(6,90)                                                        TDKS0410
   90 FORMAT( 8HO     PIL)                                               TDKS0420
      CALL PUN(PIL,40,CID,NSEQ)                                          TDKS0430
C                                                                        TDKS0438
      NSEQ = (NSEQ/10+1)*10                                              TDKS0440
      WRITE(6,100)                                                       TDKS0450
  100 FORMAT( 8HO     TMIL)                                              TDKS0460
      CALL PUN(TMIL,40,CID,NSEQ)                                         TDKS0470
C                                                                        TDKS0480
      WRITE(KSTC) (I,I=1), PIL, NST, (XMPIL(I),VIL(I),I=1,NST)           TDKS0490
      WRITE(KSTC) (ZDSL(I),RDSL(I),I=1,NST)                              TDKS0500
      WRITE(KSTC) (ZIL(I),PIL(I),TMIL(I),I=1,40)                         TDKS0502
      WRITE(KSTC) RATVAP                                                 TDKS0504
      END FILE KSTC                                                      TDKS0510
      REWIND KSTC                                                        TDKS0520
C                                                                        TDKS0530
      RETURN                                                             TDKS0800
      END                                                                TDKS0810
```

```
      SUBROUTINE  CPM1                                                   CPM10010
C       COMPUTES  TOTAL WEIGTH OF GAS IN CHAMBER,  DROP RESIDENT TIMES   CPM10020
C         AND RESIDUAL SPRAY MASS    FOR   P M P M                       CPM10030
C                                                                        CPM10040
      COMMON /CRP/ GRMOD(12,19),  GVELD1(12,19), GVELD2(12,19),          CPM10050
     X             GDIAD1(12,19), GDIAD2(12,19), GNOD1(12,19),           CPM10060
     X             GNOD2(12,19),  GNDOT1(12,19), GNDOT2(12,19),          CPM10070
     X             GDRAG(12,19),  GVAP(12,19),   GWSPR(12,19)-           CPM10080
     X             GDIAM(12,19),  TRES(12,19)                            CPM10090
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      COMMON  /AD7/ APROF(12,2), CCSAR(300), Z(300), AREA1(19),          CPM10100
     X              AREA2(19), DUM4(58), SINCR(19), DUM(39),            CPM10102
     X              VOL, VOL1, AS, ZATO, WG                             CPM10104
      COMMON  /GAS/ DUM5(133), RHOG1(19), RHOG2(19)                      CPM10110
      COMMON /SVV/ NP, DUM1(6), RHOLF, DUM2(5), RHOLO, DUM3(15), ZSTART,CPM10120
     1             NST, NGT, NGF, DUM8(5), TMFLF, TMFLO, DUM6(7), IZ,   CPM10130
     2             DUM7(4), ZINCR                                       CPM10132
      COMMON  /COMPM/ JTAPE, NREC, ICRTSD, VOLC, AT, LCHAM, DCHAM,       CPM10140
     1          AWCHAM, WGCHAM, ESPIMP,ECSTAR,ECF, THRUST,SIMP,         CPM10142
     2          CSTAR, CF, DXFR, HTLOSS, CR, ECSMIX, ECSENR, ZIMPF, ZIMPOCPM10144
      REAL  LCHAM                                                        CPM10190
C                                                                        CPM10200
      IF(IZ.GT.1)  GO TO 20                                              CPM10210
C       INITIALIZE  AT  ZSTART                                           CPM10220
      JTAPE = 4                                                          CPM10230
      NREC = 0                                                           CPM10232
      REWIND JTAPE                                                       CPM10240
      WRITE(JTAPE) NST, NGT, NGF, TMFLF, TMFLO                           CPM10242
      IIZ = 1                                                            CPM10250
      IZSAVE = 1                                                         CPM10260
      DZC = ZINCR                                                        CPM10270
      SRHOA = 0.                                                         CPM10280
      ZF = (ZSTART-ZIMPF)/12.                                            CPM10290
      ZO = (ZSTART-ZIMPO)/12.                                            CPM10292
        DO 10 NT=1,NST                                                   CPM10300
        ZX = ZF                                                          CPM10302
        SRHOA = SRHOA + RHOG1(NT)*AREA1(NT)                              CPM10310
          DO 10 NG=1,NGT                                                 CPM10330
          IF(NG.GT.NGF)  ZX = ZO                                         CPM10332
   10     TRES(NG,NT) = ZX/GVELD1(NG,NT)                                 CPM10340
      RHO = SRHOA/CCSAR(1)                                               CPM10350
      WG = RHO*VOL1                                                      CPM10360
        GO TO 35                                                         CPM10364
C                                                                        CPM10370
   20 IF(IZ.GT.NP)  GO TO 40                                             CPM10380
      SRHOA = 0.                                                         CPM10390
```

```
      SUMA = 0.                                                          CPM10400
        DO 30 NT=1,NST                                                   CPM10410
        SUMA = SUMA + AREA2(NT)                                          CPM10420
        SRHOA = SRHOA + (AREA1(NT)+AREA2(NT))*(RHOG1(NT)+RHOG2(NT))      CPM10430
          DO 30 NG=1,NGT                                                 CPM10440
          IF(GDIAD1(NG,NT).GT.0.)   TRES(NG,NT) = TRES(NG,NT) +          CPM10450
     X      SINCR(NT)/(6.*(GVELD1(NG,NT)+GVELD2(NG,NT)))                CPM10460
   30     CONTINUE                                                       CPM10470
      SRHOA = SRHOA/4.                                                   CPM10480
      WG = WG + SRHOA*D2C*CCSAR(IZ)/SUMA                                 CPM10490
C                                                                        CPM10500
      IF(IZ.LT.IZSAVE)  GO TO 40                                         CPM10510
        IF(IZ.EQ.6)     IIZ = 2                                          CPM10520
        IF(IZ.EQ.20)    IIZ = 5                                          CPM10530
        IF(IZ.EQ.90)    IIZ = 10                                         CPM10540
        IF(IZ.EQ.140)   IIZ = 20                                         CPM10550
   35   DO 38 NT=1,NST                                                   CPM10551
        RL = RHOLP                                                       CPM10552
         DO 30 NG=1,NGT                                                  CPM10554
         GMSPR(NG,NT) = 3.14159*RL*GNDOT2(NG,NT)*GDIAD2(NG,NT)**3/6.     CPM10555
         IF(NG.EQ.NGP)  RL = RHOLO                                       CPM10556
   38   CONTINUE                                                         CPM10558
      WRITE(JTAPE)  ((GMSPR(NG,NT),TRES(NG,NT),NG=1,NGT),NT=1,NST)       CPM10560
      NREC = NREC + 1                                                    CPM10562
      IZSAVE = MIND(IZSAVE+IIZ,NP)                                       CPM10570
      IF(IZ.LT.NP)  GO TO 40                                             CPM10580
        END FILE JTAPE                                                   CPM10590
        REWIND  JTAPE                                                    CPM10600
        VOLC = VOL                                                       CPM10620
        AT = CCSAR(NP)                                                   CPM10630
        LCHAM = Z(NP)                                                    CPM10640
        DCHAM = SQRT(CCSAR(1)/0.7854)                                    CPM10650
        AMCHAM = AS                                                      CPM10660
        WGCHAM = WG                                                      CPM10670
C                                                                        CPM10800
   40 RETURN                                                             CPM10810
```

```
      END                                                                CPM10820



      SUBROUTINE  CPM2                                                   CPM20010
C       SETS  UP  SPRAY  MASS  DEPLETION  TABLE                          CPM20020
C                                                                        CPM20030
      COMMON  /CPM2C/ TR(50), SPRAYF(50), SPRAYO(50)                     CPM20040
      COMMON  /COMPM/ JTAPE, NREC, ICRTSO, VOLC, AT, LCHAM, DCHAM,       CPM20050
     1         AWCHAM, WGCHAM, ESPIMP,ECSTAR,ECF, THRUST,SIMP,           CPM20052
     2         CSTAR,  CF,   CXFR,   HTLOSS                              CPM20054
      COMMON  /PMWORK/ SPRAY(228,36),  TRES(228,36)                      CPM20060
      DATA  CIO, NSEQ / 4H0000,4320/                                     CPM20070
C                                                                        CPM20080
        REWIND  JTAPE                                                    CPM20084
        READ(JTAPE)  NST, NGT, NGF, NFT, NOT                             CPM20086
      NI = NGT*NST                                                       CPM20090
      NGF1 = NGF + 1                                                     CPM20094
       DO 10 J=1,NREC                                                    CPM20100
   10  READ(JTAPE) (SPRAY(I,J),TRES(I,J),I=1,NI)                         CPM20110
      REWIND JTAPE                                                       CPM20120
      TMAX = 0.                                                          CPM20130
      TMINF = 0.                                                         CPM20132
      TMINO = 0.                                                         CPM20134
       L = 0                                                             CPM20136
       DO 20 NT=1,NST                                                    CPM20140
        DO 20 NG=1,NGT                                                   CPM20142
        L = L + 1                                                        CPM20144
        IF(NG.LE.NGF)  TMINF = AMAX1(TRES(L,1),TMINF)                    CPM20146
        IF(NG.GT.NGF)  TMINO = AMAX1(TRES(L,1),TMINO)                    CPM20148
   20   TMAX = AMAX1(TRES(L,NREC),TMAX)                                  CPM20150
      DELT = TMAX/46.                                                    CPM20160
      JIF = TMINF/DELT + 3.                                              CPM20162
      JIO = TMINO/DELT + 3.                                              CPM20164
       DO 30 I=1,50                                                      CPM20170
       TR(I) = FLOAT(I-1)*DELT                                           CPM20180
```

```
      SPRAYF(I) = 0.                                                    CPM20190
   30 SPRAYO(I) = 0.                                                    CPM20200
C                                                                       CPM20210
      L = 0                                                             CPM20216
      DO 100 NT=1,NST                                                   CPM20220
      J1 = J1F                                                          CPM20224
      DO 100 NG=1,NGT                                                   CPM20230
       L = L + 1                                                        CPM20240
      K = 2                                                             CPM20250
      IF(NG.EQ.NGF1)  J1 = J1O                                          CPM20252
        DO 80 J=J1,50                                                   CPM20260
   40     IF(TR(J).LE.TRES(L,K)) GO TO 50                              CPM20280
          K = K+1                                                       CPM20290
          IF(K.LE.NREC)  GO TO 40                                       CPM20300
          K = NREC                                                      CPM20302
          IF(TR(J).GT.TRES(L,NREC))  GO TO 100                          CPM20304
   50     K1 = K-1                                                     CPM20310
          DTRES = TRES(L,K)-TRES(L,K1)                                  CPM20312
          IF(DTRES.LE.0.)  GO TO 100                                    CPM20314
          F = (TR(J)-TRES(L,K1)) / DTRES                                CPM20320
          SPR = SPRAY(L,K1)*(1.-F) + SPRAY(L,K)*F                       CPM20330
          IF(SPR.LE.0.)  GO TO 100                                      CPM20334
          IF(NG.GT.NGF)  GO TO 70                                       CPM20340
          SPRAYF(J) = SPRAYF(J) + SPR                                   CPM20350
          GO TO 80                                                      CPM20360
   70     SPRAYO(J) = SPRAYO(J) + SPR                                   CPM20370
   80     CONTINUE                                                      CPM20380
  100 CONTINUE                                                          CPM20390
      DO 104 J=2,50                                                     CPM20400
      SPRAYF(J) = SPRAYF(J)/WFT                                         CPM20402
  104 SPRAYO(J) = SPRAYO(J)/WOT                                         CPM20410
C        CURVE  FIT  FROM  IMPINGEMENT  POINT  TO  ZSTART               CPM20420
      IF(NGF.EQ.0)  GO TO 150                                           CPM20430
      W1 = SPRAYF(J1F)                                                  CPM20460
      S1 = (SPRAYF(J1F+1)-W1)/DELT                                      CPM20470
      SLM = 0.02*S1                                                     CPM20480
```

```
      A2 = (1.+S1*TR(J1F)-W1)/TR(J1F)**2                                CPM20490
      A1 = S1-2.*A2*TR(J1F)                                             CPM20494
      J2 = J1F-1                                                        CPM20500
        DO 120 J=1,J2                                                   CPM20510
  120   SPRAYF(J) = AMIN1(1.+A1*TR(J)+A2*TR(J)**2, 1.+SLM*TR(J), 1.)    CPM20520
  130 IF(NGF.GE.NGT) GO TO 180                                          CPM20530
      W1 = SPRAYO(J1O)                                                  CPM20540
      S1 = (SPRAYO(J1O+1)-W1)/DELT                                      CPM20550
      SLM = 0.02*S1                                                     CPM20560
      A2 = (1.+S1*TR(J1O)-W1)/TR(J1O)**2                                CPM20570
      A1 = S1-2.*A2*TR(J1O)                                             CPM20574
      J2 = J1O-1                                                        CPM20580
        DO 160 J=1,J2                                                   CPM20590
  160   SPRAYO(J) = AMIN1(1.+A1*TR(J)+A2*TR(J)**2, 1.+SLM*TR(J), 1.)    CPM20600
C                                                                       CPM20720
  180  DO 190 I=1,50                                                    CPM20724
  190  TR(I) = TR(I)*1000.                                              CPM20726
C                                                                       CPM20728
  200 WRITE(6,210) (TR(I),SPRAYF(I),SPRAYO(I),I=1,50)                   CPM20730
  210 FORMAT(1H1 33X 43HFUEL AND OXIDIZER SPRAY DEPLETION FUNCTIONS //  CPM20740
     1 23X 64HFRACTION UNVAPORIZED AS A FUNCTION OF TIME (MS) FROM IMPINCPM20750
     2GEMENT //, 16X 4HTIME 10X 4HFUEL 8X 8HOXIDIZER 12X 4HTIME 10X    CPM20760
     3 4HFUEL 8X 8HOXIDIZER //  (7X 3F14.4, 4X 3F14.4) )               CPM20770
C                                                                       CPM20774
        ICRTSD = 1                                                      CPM20778
      IF(ICRTSD.NE.1) GO TO 250                                         CPM20780
C       C R T   PLOT                                                    CPM20790
      CALL LGRID(0.,0.,TR(50),0.,1., 24,0,2,45, IR)                    CPM20800
      CALL LINEG(50,TR,SPRAYF,1,1,2)                                    CPM20810
      CALL LINEG(50,TR,SPRAYO,1,1,2)                                    CPM20820
      CALL APLOTV(48,TR(2),SPRAYF(2),10,10,1,22,IR)                     CPM20830
      CALL APLOTV(43,TR(7),SPRAYO(7),10,10,1,34,IR)                     CPM20840
      CALL RITE2V(325,1014,1023,90,2,25,1,25HSPRAY DEPLETION FUNCTIONS, CPM20850
     X IL)                                                              CPM20860
      CALL RITE2V(469,9,1023,90,2,9,1,9HTIME (MS), IL)                  CPM20870
      CALL RITE2V(9,370,1023,180,2,20,1,20HFRACTION UNVAPORIZED,IL)     CPM20880
```

```
C                                                                                CPM20892
  250 PUNCH 260                                                                  CPM20900
  260 FORMAT(1X 4H**** 14X 43HFUEL AND OXIDIZER SPRAY DEPLETION FUNCTION         CPM20910
     1S 14X 4H****)                                                             CPM20920
      WRITE(6,270)                                                              CPM20922
  270 FORMAT(1H1)                                                               CPM20924
      CALL PUN(TR,50,CID,NSEQ)                                                  CPM20930
      CALL PUN(SPRAYF,50,CID,NSEQ)                                              CPM20940
      CALL PUN(SPRAYD,50,CID,NSEQ)                                              CPM20950
C                                                                               CPM20960
      RETURN                                                                    CPM20980
      END                                                                       CPM20990
```

P U L S E SUBPROGRAM BLOCK

```
      SUBROUTINE  PULSE                                                          PULS0010
      DIMENSION  TTIMP(12), TSPIMP(12), TMIXR(12)                                PULS0020
      COMMON  /PULCOM/ N,      IIGN,   DTIME,  TIME,   TAMB,   PBARSS,          PULS0050
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,         PULS0060
     2                 NFIRST, INITB,  TSTART, TOFF,   TLAST,  COMB,           PULS0070
     3                 ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,          PULS0072
     4                 AVF,    AVO,    STOPW,  IPPRT,  ICRTP,  TVC,            PULS0080
     5                 RHOF,   RHOO,   WGFGEN, WGOGEN, TVO,    TAUIGC,         PULS0082
     6                 IPER,   ITWALL, TFSBF,  TFSBO                            PULS0084
      COMMON  /PCOM1/  SUMIMP, TRISE, TIRISE, TRISE2, TDROP, TIDROP,            PULS0090
     1          POVER, PWIDTH, OFF1, OFF2, PNS, THRUST, DXFRAC, TIA,            PULS0092
     2          TWALL2, TWALLM, SUMPC, SUMPCA, TITAIL, TWALL, TAUIGN            PULS0094
      COMMON  /IGNGOF/ WENSF, VENSF, TENSF, SUMSPF, WGFCUM, WFSF,               PULS0100
     1                 WENSO, VENSO, TENSO, SUMSPO, WGOCUM, WFSO, TGAS         PULS0102
      COMMON  /PULDYC/  COEMTH, COEMTC, TCWSS, QSBFSS, QSBOSS, TGASSS,          PULS0120
     1          PSPACE(12),  TTWALL(6),  TWF(12,6),  TWO(12,6),                 PULS0122
     2          TTIA(12,6), TTIB(12,6), TTRISE(12,6), TTIRIS(12,6),             PULS0124
     3          TTRIS2(12,6), TTDROP(12,6), TTIDRP(12,6), TPOVER(12,6),         PULS0126
     4          TTITAL(12,6), TIPDTA(12,6), TIPDTB(12,6)                        PULS0128
      LOGICAL  COMB                                                              PULS0400
      COMB = .FALSE.                                                             PULS0450
      CALL  PULSIN                                                               PULS0500
      PWIDTH = STOPW                                                             PULS0520
      TWALLM = TCWSS                                                             PULS0530
C                                                                                PULS0540
      DO 30  ITWALL=1,NTWALL                                                     PULS0580
      TIME = -DTIME                                                              PULS0590
      N = 0                                                                      PULS0601
      TWALL2 = TTWALL(ITWALL)                                                    PULS0602
       DO 20 ISPACE=1,NSPACE                                                     PULS0604
        NFIRST = N + 1                                                           PULS0610
        TWALL = TWALL2 - (TWALL2-TAMB) *(1.-EXP(-COEMTC*PSPACE(ISPACE)))         PULS0612
        TSTART = AMAX1(TIME,0.)                                                  PULS0620
        TOFF = TSTART + STOPW*1.E-3                                              PULS0630
        TLAST = TOFF + PSPACE(ISPACE)*1.E-3 - 0.1*DTIME                          PULS0640
        SUMIMP = 0.                                                              PULS0650
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      SUMPC = 0.                                                        PULS0652
      CALL  TCOMB                                                       PULS0670
      IF(COMB .OR. IIGN.LT.1)  GO TO 10                                 PULS0680
      CALL  IGM(ISPACE)                                                 PULS0700
      IF(COMB)  GO TO 10                                                PULS0730
        WRITE(6,8)                                                      PULS0740
    8   FORMAT(1HI 34X 43HIGNITION  NOT  ATTAINED  -  JOB  TERMINATED)  PULS0750
        CALL  EXIT                                                      PULS0760
        STOP                                                            PULS0770
   10   CALL  TCOMB                                                     PULS0800
      IF(IPPRT.GT.0)  CALL  PULPRT                                      PULS0820
        IF(ICRTP.EQ.1)  CALL PULPLT                                     PULS0824
          II = ISPACE-1                                                 PULS0826
          IF(II.EQ.0)  II=NSPACE                                        PULS0828
        TTIA(II,ITWALL) = TIA                                           PULS0830
        TTIB(ISPACE,ITWALL) = SUMIMP - TIA                              PULS0832
        TWF(II,ITWALL) = WCUMVF                                         PULS0834
        TWO(II,ITWALL) = WCUMVO                                         PULS0836
        TTRISE(II,ITWALL) = TRISE                                       PULS0840
        TTIRIS(II,ITWALL) = TIRISE                                      PULS0842
        TTRIS2(II,ITWALL) = TRISE2                                      PULS0843
        TTCROP(ISPACE,ITWALL) = TCROP                                   PULS0844
        TTIDRP(ISPACE,ITWALL) = TIDROP                                  PULS0846
        TPOVER(ISPACE,ITWALL) = POVER                                   PULS0850
        TTITAL(ISPACE,ITWALL) = TITAIL                                  PULS0852
        TIPDTA(II,ITWALL) = SUMPCA                                      PULS0860
        TTPDTC(ISPACE,ITWALL) = SUMPC - SUMPCA                          PULS0862
        IF(ISPACE.EQ.NSPACE)  GO TO 22                                  PULS0864
   20  CONTINUE                                                         PULS0866
   22  CONTINUE                                                         PULS0868
      TWF(NSPACE,ITWALL) = TWF(NSPACE,ITWALL) - WFSF                    PULS0870
   30 TWO(NSPACE,ITWALL) = TWO(NSPACE,ITWALL) - WFSO                    PULS0872
C                                                                       PULS0890
      WRITE(6,40)                                                       PULS0900
   40 FORMAT(1HI 24X 59HPULSE PERFORMANCE FOR EQUALLY SPACED, STANDARD WPULS0901
     1OTH PULSES ///                                                    PULS0902
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P U L S E SUBPROGRAM BLOCK

```
     1  9X 7HSPACING 7X 9HWALL TEMP 7X 5HTOTAL 6X 5HTOTAL 8X 5HTOTAL     PULS0904
     2 6X 9HMEAN SPEC 4X 12HMEAN MIXTURE/                               PULS0906
     3 7X 52HBETM PULSES   AT OFF-SIGNAL   FUEL FLOW    OXID FLOW  5X   PULS0908
     4      7HIMPULSE 6X 7HIMPULSE 6X 5HRATIO // )                      PULS0910
       DO 70  J=1,NTWALL                                                PULS0920
         DO 50  I=1,NSPACE                                              PULS0930
         TTIMP(I) = TTIA(I,J) + TTIB(I,J)                               PULS0932
         TSCIMP(I) = TTIMP(I)/(TWF(I,J)+TWO(I,J))                       PULS0934
50       YMIXR(I) = TWO(I,J)/TWF(I,J)                                   PULS0936
       WRITE(6,60)  (RSPACE(I),TTWALL(J),TWF(I,J),TWO(I,J),TTIMP(I),    PULS0940
     1 TSCIMP(I), YMIXR(I), I=1,NSPACE)                                 PULS0942
60   FORMAT( 5X F10.1, F15.0, 1PE16.4, E13.4, E14.4, 0PF10.1, F14.4)    PULS0950
70   CONTINUE                                                           PULS0960
       CALL  PUNCCY                                                     PULS0970
       RETURN                                                           PULS0990
       END                                                              PULS0992
```

```
       SUBROUTINE  PULSIN                                               PULN0010
       COMMON  /MEAD/ AMAT(72), CRAYE(2), ILISP, ISTC, ITRANS, ITDK, IPM PULN0020
       COMMON  /SVV/ NP, NAP, NNR, DUMI(5), MTDF, MTVF, DUM2(4), MTDD,   PULN0030
     1               MTVD, TXF, TXO, LMBDEF, LMBDEO, DUM3(18),          PULN0040
     2               WOSSF, WOSSO, DUM4(19), NEPS, PAMB, AEXIT, ECFVAC,  PULN0050
     3               NMACH, ECSTRI, PNSSS, PIESS, RVAPF, RVAPO           PULN0060
       COMMON  /COMPR/ JTAPE, NREC, ICRTSD, VOLC, AT, LCHAM, DCHAM,      PULN0100
     1          AWCHAM, WGCHAM, ESISS, ECSSS, ECFSS, FSS, SIMPSS, CSTRSS,PULN0110
     2          CPSS, CXFRSS, HTLOSS, CR, ECSMIX, ECSENR, ZIMPF, ZIMPO   PULN0120
       COMMON  /CPM2C/ TR(50), SPRAYF(50), SPRAYO(50)                   PULN0130
       COMMON  /PULFED/ TLF, TLO, VVALF, VVALO, NTVEF, NTVEO, NTVDEF,   PULN0140
     X          NTVDEO, TTVEF(9), TAVEF(9), TTVEO(9), TAVEO(9),        PULN0150
     1          TTVDEF(9), TAVDEF(9), TTVDEO(9), TAVDEO(9),            PULN0160
     2          AVEF, CFVF, AOVEF, AIVEF, AOVDEF, AIVDEF,              PULN0170
     3          AVEO, CFVO, AOVEO, AIVEO, AOVDEO, AIVDEO,              PULN0180
     4          ALF, LLF, RFLF, ALO, LLO, RFLO,                        PULN0190
     5          AMF, LMF, RFMF, AMO, LMO, RFMO,                        PULN0200
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     6          SAIF,LIF, RFIF, SAIO,LIO, RFIO, CFIF, CFIO,                PULN0210
     7          DIMPF, DIMPO, VFSF,  VFSO,  IBOIL, EPS,                    PULN0220
     8          VLF, VOLMF, VIF, VLO, VOLMO, VIO                           PULN0230
      COMMON  /PULCOM/ N,       IIGN,   DTIME,  TIME,   TAMB,   PBARSS,    PULN0280
     1                 RPCIN,   RPCNB,  NSPACE, NTWALL, INITTC, INITGG,    PULN0290
     2                 NFIRST,  INITB,  TSTART, TOFF,   TLAST,  COMB,      PULN0300
     3                 ISPACE,  PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,     PULN0310
     4                 AVF,     AVO,    STOPW,  IPPRT,  ICRTP,  TVC,       PULN0320
     5                 RHCF,    RHOO,   WGFGEN, WGOGEN, TVO,    TAUIGC     PULN0322
     6               , IPER,    ITWALL, TFSBF,  TFSBO                      PULN0324
      COMMON  /PULDYC/  COEHTH, COEHTC, TCWSS, QSBFSS, QSBOSS, TGASSS,     PULN0330
     1          PSPACE(12), TTWALL(6)                                      PULN0332
      COMMON  /IGN1/    C(3),   DELTN, LF,    LO,    LIF,   LIO,   TMAX    PULN0340
      COMMON  /IGN2/    OFINT, AIIMI, EINT,  AQIGN, EIGN,  DELHRC,DELHRV,PULN0350
     1                  TINT,   TCV,    QEXIGN,DPRT                        PULN0360
      COMMON  /IGN5A/   LIWF,   LITF,   LIMPF, CPSF,  CPVF,  MUVF,  KCF,    PULN0380
     1                  LMBDSF,LMBDFF,ALPHAF,STENF, THTF,  FMAXF, FMINF    PULN0390
     2                , PVF,    EDVF,   CVVF,  PVF,   DELTNF,THETAF,NF,     PULN0392
     3                  MVF,    MDVF,   MWALLF,KDF,   NIF                  PULN0394
      COMMON  /IGN6A/   LIWO,   LITO,   LIMPO, CPSO,  CPVO,  MUVO,  KCO,    PULN0400
     1                  LMBDSO,LMBDFO,ALPHAO,STENO, THTO,  FMAXO, FMINO    PULN0410
     2                , PVO,    EDVO,   CVVO,  PVO,   DELTNO,THETAO,NO,     PULN0412
     3                  MVO,    MDVO,   MWALLO,KDO,   NIO                  PULN0414
      REAL  LLF, LLO, LMF, LMO, LCHAM, LIWF, LITF, LIWO, LITO, MTDF,      PULN0420
     1      MTVF, MTDO, MTVO, LMBDEF, LMBDEO, MUVF, KCF, LMBDSF, LMBDFF,PULN0430
     2      MUVO, KCO, LMBDSO, LMBDFO                                     PULN0440
     3    , MVF, MVO                                                      PULN0442
      DIMENSION  TITLEP(18)                                               PULN0450
      ISRS = 0                                                            PULN0452
    4 FORMAT(1H1)                                                         PULN0454
   20 FORMAT(6I12)                                                        PULN0460
   30 FORMAT(6E12.8)                                                      PULN0470
C                                                                         PULN0500
      WRITE(6,50)                                                         PULN0510
   50 FORMAT(1H1 ///// 29X 53HP U L S E - M O D E   C H A R A C T E R I PULN0520
     1Z A T I O N  /// 37X 36HWITH  P M P M  SUBPROGRAM  P U L S E /////PULN0530
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```
     2 47X 15HJUL 72 REVISION )                                                    PULN0540
C                                                                                  PULN0740
C        PRIMARY CONTROLS,  PULSE SPECIFICATIONS AND OPERATING CONDITIONSPULN0750
  100 READ(5,20)  NSPACE, NTWALL, IIGN,   IBOIL,  IPPRT,  ICRTP                    PULN0760
       IF(NSPACE.GT.12 .OR. NTWALL.GT.6)  IERR = 1                                 PULN0762
      WRITE(6,110)                                                                 PULN0800
  110 FORMAT(1H1 36X 18HPULSE  INPUT  DATA // 5X 63HPRIMARY CONTROLS, PUPULN0810
     1LSE SPECIFICATIONS AND OPERATING CONDITIONS )                                PULN0820
      WRITE(6,114)  NSPACE, NTWALL, IIGN,   IBOIL,  IPPRT,  ICRTP                  PULN0830
  114 FORMAT(2X 7HNSPACE= I10, 8H NTWALL= I10, 8H IIGN  = I10,                     PULN0840
     1          8H IBOIL = I10, 8H IPPRT = I10, 8H ICRTP = I10)                   PULN0842
      READ(5,30)  DTMS,   STDPW,  TAMB,   PAMB,   TLO,    TLF,                   PULN0850
     1            VVALF,  VVALO,  COEHTH, COEHTC, TAUIGC, TCWSS,                 PULN0852
     2            QSBFSS, QSBOSS, TFSBF,  TFSBO                                  PULN0854
      WRITE(6,120)DTMS,   STDPW,  TAMB,   PAMB,   TLO,    TLF,                   PULN0860
     1            VVALF,  VVALO,  COEHTH, COEHTC, TAUIGC, TCWSS,                 PULN0861
     2            QSBFSS, QSBOSS, TFSBF,  TFSBO                                  PULN0862
  120 FORMAT( 9H  DTMS  = 1PE10.3, 8H STDPW = E10.3, 8H TAMB  = E10.3,            PULN0864
     1          8H PAMB  =  E10.3, 8H TLO   = F10.3, 8H TLF   = F10.3/           PULN0865
     2         9H  VVALF =  E10.3, 8H VVALO = E10.3, 8H COEHTH= E10.3,           PULN0866
     3          8H COEHTC=  E10.3, 8H TAUIGN= E10.3, 8H TCWSS = E10.3/           PULN0867
     4         9H  QSBFSS=  E10.3, 8H QSBOSS= E10.3, 8H TFSBF = E10.3,           PULN0868
     5          8H TFSBO =  E10.3)                                               PULN0869
      DTIME = DTMS*1.E-3                                                         PULN0870
        DIMPF = ZIMPF                                                            PULN0872
        DIMPO = ZIMPO                                                            PULN0874
      READ(5,30)     (PSPACE(I),I=1,NSPACE)                                      PULN0890
      WRITE(6,124)   (PSPACE(I),I=1,NSPACE)                                      PULN0892
  124 FORMAT(2X 7HPSPACE= 1P6E13.3 / (9X 6E13.3) )                               PULN0894
      READ(5,30)     (TTWALL(J),J=1,NTWALL)                                      PULN0895
      WRITE(6,126)   (TTWALL(J),J=1,NTWALL)                                      PULN0896
  126 FORMAT(2X 7HTTWALL= 1P6E13.3 )                                             PULN0898
      CALL  VALINP                                                               PULN0900
        IF(ISTO.NE.0)  GO TO 250                                                 PULN0902
      READ(5,30)     VOLC,   LCHAM,  AEXIT,  AWCHAM, DIMPF,  DIMPO              PULN0906
      WRITE(6,130)   VOLC,   LCHAM,  AEXIT,  AWCHAM, DIMPF,  DIMPO              PULN0910
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  130 FORMAT( 9H  VOLC  = 1PE10.3, 8H LCHAM = E10.3, 8H AEXIT = E10.3,   PULN0912
     1          8H AWCHAM=   E10.3, 8H DIMPF = E10.3, 8H DIMPO = E10.3)  PULN0914
      WRITE(6,132)                                                       PULN0918
  132   FORMAT(1HO 4X 24HSTEADY-STATE PERFORMANCE )                      PULN0920
      READ(5,30)   ECFVAC, WGCHAM                                        PULN0930
      WRITE(6,140) ECFVAC, WGCHAM                                        PULN0940
  140 FORMAT( 9H  ECFVAC= 1PE10.3, 8H WGCHAM= E10.3)                     PULN0950
      READ(5,30) (TR(I),I=1,50)                                          PULN1010
      READ(5,30) (SPRAYF(I),I=1,50)                                      PULN1020
      READ(5,30) (SPRAYO(I),I=1,50)                                      PULN1030
      WRITE(6,150)  (TR(I),SPRAYF(I),SPRAYO(I),I=1,50)                   PULN1040
  150 FORMAT(1HO 4X 26HSPRAY DEPLETION RATE TABLE  /                     PULN1050
     X  17X 2HTR 10X 6HSPRAYF 8X 6HSPRAYO 14X 2HTR 10X 6HSPRAYF          PULN1052
     1 8X 6HSPRAYO / (7X 3F14.4, 4X 3F14.4) )                            PULN1060
      WRITE(6,6)                                                         PULN1062
  250   IF(IIGN.LE.0)  GO TO 410                                         PULN1130
      READ(5,30)  LIWF,   LITF,   LIWO,   LITO                           PULN1140
      WRITE(6,260)  LIWF,   LITF,   LIWO,   LITO                         PULN1150
  260 FORMAT(2X 7HLIWF  = 1PE10.3, 8H LITF  = E10.3, 8H LIWO  = E10.3,   PULN1160
     1          8H LITO  =   E10.3)                                      PULN1170
        WRITE(6,394)                                                     PULN1820
  394   FORMAT(4X 35H CONTROL AND MISC. DATA FOR SUB IGN )               PULN1830
      READ(5,20)  LF,     L1F,    LO,     L1O                          PULN1840
      WRITE(6,400)  LF,     L1F,    LO,     L1O                        PULN1850
  400 FORMAT(           2X 7HLF    = I10, 8H L1F   = I10, 8H LO    = I10,PULN1860
     1                   8H L1O   = I10)                                PULN1870
      READ(5,30)  TMAX,   DPRT,   THTF,   FMAXF,  FMINF,  THTO,         PULN1880
     1           FMAXO,  FMINO,  DTNMS                                 PULN1890
        DELTN = DTNMS*1.E-3                                              PULN1894
      WRITE(6,404)  TMAX,   DPRT,   THTF,   FMAXF,  FMINF,  THTO,       PULN1900
     1           FMAXO,  FMINO,  DTNMS                                 PULN1910
  404 FORMAT(2X 7HTMAX  = 1PE10.3, 8H DPRT  = E10.3, 8H THTF  = E10.3,   PULN1920
     1          8H FMAXF =   E10.3, 8H FMINF = E10.3, 8H THTO  = E10.3/ PULN1930
     2        2X 7HFMAXO =   E10.3, 8H FMINO = E10.3, 8H DTNMS = E10.3)  PULN1940
  410   CONTINUE                                                         PULN1950
C                                                                        PULN1960
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C       I N I T I A L I Z A T I O N   S E C T I O N                    PULN1970
        CALL  PINIT                                                    PULN1980
        IF(IERR.EQ.0)  RETURN                                          PULN1990
          CALL  EXIT                                                   PULN1992
          STOP                                                         PULN1994
        END                                                            PULN2000



        SUBROUTINE  VALINP                                             VALI0010
        COMMON  /PULDYC/ CDEHTH, CDEHTC, TCWSS, QSBFSS, QSBCSS, TGASSS VALI0060
        COMMON  /PULFED/ TLF, TLC, VVALF, VVALC, NTVEF, NTVEC, NTVDEF, VALI0100
       X          NTVDEC, TTVEF(9), TAVEF(9), TTVEC(9), TAVEC(9),      VALI0120
       1          TTVDEF(9), TAVDEF(9), TTVDEC(9), TAVDEC(9),          VALI0140
       2          AVEF, CFVF, AOVEF, A1VEF, AOVDEF, A1VDEF,            VALI0160
       3          AVEC, CFVC, AOVEC, A1VEC, AOVDEC, A1VDEC,            VALI0180
       4          ALF, LLF, RFLF, ALC, LLC, RFLC,                      VALI0200
       5          AMF, LMF, RFMF, AMC, LMC, RFMC,                      VALI0220
       6          SAIF,LIF, RFIF, SAIC,LIC, RFIC, CFIF, CFIC,          VALI0240
       7          DIMPF, DIMPC, VFSF, VFSC, I8CIL, EPS,                VALI0260
       8          VLF, VOLMF, VIF, VLC, VOLMC, VIC                     VALI0280
        REAL  LIF, LIC, LLF, LLC, LMF, LMC                             VALI0288
     20 FORMAT(6I12)                                                   VALI0290
     30 FORMAT(6E12.8)                                                 VALI0292
          WRITE(6,164)                                                 VALI0320
    164   FORMAT(4X 59H HARDWARE DESIGN - VALVE, LINE, MANIFOLD, INJECTOR,VALI0340
       1 CHAMBER )                                                     VALI0360
        READ(5,20)   NTVEF,  NTVDEF, NTVEC,  NTVDEC                   VALI0380
        WRITE(6,168) NTVEF,  NTVDEF, NTVEC,  NTVDEC                   VALI0390
    168 FORMAT(2X 7HNTVEF =  I10, 8H NTVDEF=  I10,  8H NTVEC =  I10,   VALI0400
       1        8H NTVDEC=  I10)                                       VALI0410
        READ(5,30)  (TTVEF(I),I=1,NTVEF)                              VALI0440
        READ(5,30)  (TAVEF(I),I=1,NTVEF)                              VALI0460
        READ(5,30)  (TTVDEF(I),I=1,NTVDEF)                            VALI0480
        READ(5,30)  (TAVDEF(I),I=1,NTVDEF)                            VALI0500
        READ(5,30)  (TTVEC(I),I=1,NTVEC)                              VALI0520
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      READ(5,30)  (TAVEC(I),I=1,NTVEC)                                  VALI0540
      READ(5,30)  (TTVDEC(I),I=1,NTVDEC)                                VALI0560
      READ(5,30)  (TAVDEC(I),I=1,NTVDEC)                                VALI0580
      WRITE(6,170)  (TTVEF(I),I=1,NTVEF)                                VALI0600
  170 FORMAT(2X 7HTTVEF = 1P6E13.3 / (9X 6E13.3) )                       VALI0620
      WRITE(6,172)  (TAVEF(I),I=1,NTVEF)                                VALI0640
  172 FORMAT(2X 7HTAVEF = 1P6E13.3 / (9X 6E13.3) )                       VALI0660
      WRITE(6,180)  (TTVDEF(I),I=1,NTVDEF)                              VALI0680
  180 FORMAT(2X 7HTTVDEF= 1P6E13.3 / (9X 6E13.3) )                       VALI0700
      WRITE(6,182)  (TAVDEF(I),I=1,NTVDEF)                              VALI0720
  182 FORMAT(2X 7HTAVDEF= 1P6E13.3 / (9X 6E13.3) )                       VALI0740
      WRITE(6,190)  (TTVEC(I),I=1,NTVEC)                                VALI0760
  190 FORMAT(2X 7HTTVEC = 1P6E13.3 / (9X 6E13.3) )                       VALI0780
      WRITE(6,192)  (TAVEC(I),I=1,NTVEC)                                VALI0800
  192 FORMAT(2X 7HTAVEC = 1P6E13.3 / (9X 6E13.3) )                       VALI0820
      WRITE(6,200)  (TTVDEC(I),I=1,NTVDEC)                              VALI0840
  200 FORMAT(2X 7HTTVDEC= 1P6E13.3 / (9X 6E13.3) )                       VALI0860
      WRITE(6,202)  (TAVDEC(I),I=1,NTVDEC)                              VALI0880
  202 FORMAT(2X 7HTAVDEC= 1P6E13.3 / (9X 6E13.3) )                       VALI0900
      READ(5,30)   AVEF,   CFVF,   AOVEF,  A1VEF,  AOVDEF, A1VDEF,      VALI0920
     1             AVEC,   CFVC,   AOVEC,  A1VEC,  AOVDEC, A1VDEC       VALI0940
      WRITE(6,210)  AVEF,   CFVF,   AOVEF,  A1VEF,  AOVDEF, A1VDEF,     VALI0960
     1              AVEC,   CFVC,   AOVEC,  A1VEC,  AOVDEC, A1VDEC      VALI0980
  210 FORMAT(2X 7HAVEF  = 1PE10.3, 8H CFVF  = E10.3, 8H AOVEF = E10.3,   VALI1000
     1         8H A1VEF =   E10.3, 8H AOVDEF= E10.3, 8H A1VDEF= E10.3    VALI1020
     2      / 2X 7HAVEC  =   E10.3, 8H CFVC  = E10.3, 8H AOVEC = E10.3,  VALI1040
     3         8H A1VEC =   E10.3, 8H AOVDEC= E10.3, 8H A1VDEC= E10.3)   VALI1060
      READ(5,30)    LLF,    LLO,    VOLMF, VOLMO, LIF,    LIO           VALI1130
      WRITE(6,220)  LLF,    LLO,    VOLMF, VOLMO, LIF,    LIO           VALI1140
  220 FORMAT( 9H  LLF   = 1PE10.3, 8H LLO   = E10.3, 8H VOLMF = E10.3,   VALI1170
     1         8H VOLMO =   E10.3, 8H LIF   = E10.3, 8H LIO   = E10.3)   VALI1180
      RETURN                                                             VALI2000
      END                                                                VALI2010
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      SUBROUTINE  PINIT                                                      PINI0010
      COMMON  /HEAD/ AMAT(72), CDATE(2), ILISP, ISTC, ITRANS, ITDK, IPM      PINI0120
      COMMON  /FBCOM/  C1, CFSF, CFSO, PVALVF, PVALVO, IEBX, PMF, PMO        PINI0130
      COMMON  /SVV/ NP, NAP, NMR, DUM1(5), MTDF, MTVF, DUM2(4), MTDC,        PINI0140
     1              MTVC, TXF, TXO, LMBDEF, LMBDEO, DUM3(18),               PINI0160
     2              WDSSF, WDSSO, DUM4(19), NEPS, PAMB, AEXIT, ECFVAC,      PINI0170
     3              NMACH, ECSTR1, PNSSS, PIESS, RVAPF, RVAPO               PINI0200
      COMMON  /COM7/   GA, RR, COM7D(45), RATVAP, CD                         PINI0210
      COMMON  /TEL/ TMR(18), TTO(18,3), TTOMW(18), TCF1(18), TTO1(18),       PINI0220
     X              DUM6(54),                                               PINI0240
     1              TMW(18,3), CSTR(18), TEPS(6), TMACH(3), TCF(18,6)       PINI0260
     4            , TOXERP(18), XMRM                                        PINI0270
      COMMON  /COMPM/ JTAPE, NREC, ICRTSD, VOLC, AT, LCHAM, DCHAM,          PINI0280
     1          AWCHAM, WGCHAM, ESISS, ECSSS, ECFSS, FSS, SIMPSS, CSTRSS,PINI0300
     2          CFSS, OXERSS, HTLOSS, CR, ECSMIX, ECSENR, ZIMPF, ZIMPO      PINI0320
      COMMON  /CPM2C/ TR(50), SPRAYF(50), SPRAYO(50)                         PINI0340
      COMMON  /PULFED/ TLF, TLO, VVALF, VVALO, NTVEF, NTVEO, NTVDEF,         PINI0360
     X          NTVDEO, TTVEF(9), TAVEF(9), TTVEO(9), TAVEO(9),             PINI0380
     1          TTVDEF(9), TAVDEF(9), TTVDEO(9), TAVDEO(9),                 PINI0400
     2          AVEF, CFVF, AOVEF, A1VEF, AOVDEF, A1VDEF,                   PINI0420
     3          AVEO, CFVO, AOVEO, A1VEO, AOVDEO, A1VDEO,                   PINI0440
     4          ALF, LLF, RFLF, ALO, LLO, RFLO,                             PINI0460
     5          AMF, LMF, RFMF, AMO, LMO, RFMO,                             PINI0480
     6          SAIF,LIF, RFIF, SAIO,LIO, RFIO, CFIF, CFIO,                 PINI0500
     7          DIMPF, DIMPO, VFSF,  VFSO,  IBOIL, EPS,                     PINI0520
     8          VLF, VOLMF, VIF, VLO, VOLMO, VIO                            PINI0540
      COMMON  /IGNFED/                              TDFPF, CPLF,             PINI0560
     1                TDFPO, CPLO,  NRHOF, NRHOO, NPVAPF,NPVAPO,            PINI0580
     2                TTRLF(12), TRHOF(12), TTRLO(12), TRHOO(12),           PINI0600
     3                TTPVF(12), TPVAPF(12),TTPVO(12), TPVAPO(12)           PINI0620
      COMMON  /PULCOM/ N,      IIGN,   DTIME,  TIME,   TAMB,   PBARSS,      PINI0640
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,      PINI0660
     2                 NFIRST, INITB,  TSTART, TOFF,   TLAST,  COMB,        PINI0680
     3                 ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,       PINI0700
     4                 AVF,    AVO,    STDPW,  IPPRT,  ICRTP,  TVC,         PINI0710
     5                 RHOF,   RHOO,   WGFGEN, WGOGEN                       PINI0720
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      COMMON  /PULDYC/ CDEHTH, CDEHTC, TCWSS, QSBFSS, QSBDSS, TGASSS    PINI0740
      COMMON  /IGN1/   C(3),  DELTN, LF,    LO,    L1F,   L1O,   IMAX   PINI0760
      COMMON  /IGN3/   VC,    ASTAR, TW,    LC,    D,     ACC          PINI0820
      COMMON  /IGN4/ IGN4D(7), TG                                       PINI0830
      COMMON  /IGN5A/  LIWF, LITF, LIMPF                                PINI0840
      COMMON  /IGN6A/  LIWO, LITO, LIMPO                                PINI0860
      REAL  LLF, LLO, LMF, LMO, LCHAM, LC, LIF, LIO, LIMPF, LIMPO       PINI0940
      DATA  JK/1/                                                       PINI0970
      DIMENSION  TITLEP(18)                                             PINI0980
C       I N I T I A L I Z A T I O N   S E C T I O N                     PINI1000
      EPS = AEXIT/AT                                                    PINI1020
      K = 1                                                             PINI1024
      OXFRSS = WDSFO/(WDSSO+WDSSF)                                      PINI1040
      OXFRP = WDSSO/(XMRM*WDSSF+WDSSO)                                  PINI1050
      IF(NEPS.LT.2)  GO TO 470                                          PINI1060
        DO 450 L=2,NEPS                                                 PINI1080
        K = L                                                           PINI1100
        IF(EPS.LT.TEPS(K))  GO TO 460                                   PINI1120
  450   CONTINUE                                                        PINI1140
  460 FACT = (EPS-TEPS(K-1))/(TEPS(K)-TEPS(K-1))                        PINI1160
  470 J = 1                                                             PINI1180
      IF(NMACH.GT.1)  J = 2                                             PINI1200
        DO 480 I=1,NMR                                                  PINI1220
        IF(NEPS.GT.1)  TCF1(I) = TCF(I,K-1)*(1.-FACT) + TCF(I,K)*FACT   PINI1240
        IF(NEPS.EQ.1)  TCF1(I) = TCF(I,1)                               PINI1260
        TTO1(I) = TTO(1,J)                                              PINI1300
  480   TTOMW(I) = TTO(I,J)/TMW(I,J)                                    PINI1320
      OXFRGP = WDSSO*RVAPO/(WDSSO*RVAPO+XMRM*WDSSF*RVAPF)               PINI1330
      CALL  LOCFAC(JK,OXFRGP,TOXFRP,NMR, LX,SL)                         PINI1340
      IF(ISTC.NE.0)  GO TO 490                                          PINI1402
        CALL  LOCFAC(JK,OXFRP,TOXFRP,NMR, JX,FA)                        PINI1404
        T = EPS*PAMB/PNSSS                                              PINI1406
        CFTVAC = TCF1(JX) + FA*(TCF1(JX+1)-TCF1(JX))                    PINI1408
      CFSS = ECFVAC*(TCF1(LX)+SL*(TCF1(LX+1)-TCF1(LX))) - T             PINI1410
        ECFSS = CFSS/(CFTVAC-T)                                         PINI1412
        SIMPSS = CFSS*CSTRSS/32.174                                     PINI1414
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      FSS = AT*PNSSS*CFSS                                                    PINI1416
      ESISS = ECSSS*ECFSS                                                    PINI1418
490 ECSTR1 = ECSMIX*ECSENR/CD                                                PINI1424
    TGASSS = TTC(LX,NMACH) + SL*(TTC(LX+1,NMACH)-TTC(LX,NMACH))              PINI1426
    RPCIN = PIESS/PNSSS                                                      PINI1430
    PBARSS = 12.*1545.*WGCHAM*(TTOMW(LX)+SL*(TTOMW(LX+1)-TTOMW(LX)))         PINI1440
   X          / VOLC                                                         PINI1442
    RPCNS = PNSSS/PBARSS                                                     PINI1450
    LMF = VOLMF/AMF                                                          PINI1460
    LMO = VOLMO/AMO                                                          PINI1480
    VC = VOLC/1728.                                                          PINI1500
    ASTAR = AT/144.                                                          PINI1520
    TW = TAMB                                                                PINI1540
    LC = LCHAM/12.                                                           PINI1560
    D = DCHAM/12.                                                            PINI1580
    ACC = AWCHAM/144.                                                        PINI1600
    TG = 1150.                                                               PINI1610
    C(1) = 0.3                                                               PINI1620
    C(2) = 0.4                                                               PINI1640
    C(3) = 0.3                                                               PINI1660
    LIMPF = DIMPF/12.                                                        PINI1700
    LIMPO = DIMPO/12.                                                        PINI1720
    INITTC = 1                                                               PINI1800
    RHOF = VOF(TLF,TTRLF,TRHOF,NRHOF,2)                                      PINI1820
    RHOO = VOF(TLO,TTRLO,TRHOO,NRHOO,2)                                      PINI1840
    PVALF = PVALVF                                                           PINI1900
    PVALO = PVALVO                                                           PINI1910
    VLF = ALF*LLF                                                            PINI1980
    VLO = ALO*LLO                                                            PINI2000
    VIF = SAIF*LIF                                                           PINI2020
    VIO = SAIO*LIO                                                           PINI2040
    VFSF = VLF + VOLMF + VIF                                                 PINI2060
    VFSO = VLO + VOLMO + VIO                                                 PINI2080
    WRITE(6,600)  PVALF,  PVALO,  VFSF,   VFSO,   RHOF,   RHOO              PINI2090
600 FORMAT( 9HO PVALF = 1PE10.3, 8H PVALO = E10.3, 8H VFSF  = E10.3,         PINI2092
   1          8H VFSO  =   E10.3, 8H RHOF  = E10.3, 8H RHOO  = E10.3 )     PINI2094
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      RETURN                                                                PINI2100
      END                                                                   PINI2120



      SUBROUTINE  TCOMB                                                     TCOMB010
C       P M P M   TRANSIENT  COMBUSTION  MODEL                              TCOMB020
C       *CSTAR* NOT ACTUAL C*, BUT CONTAINS ADJUSTMENT FACTORS              TCOMB024
      DIMENSION  TEPSP(13), TRPAE(13)                                       TCOMB030
      COMMON  /PULOYC/  CDFMTH, CDFMTC, TCWSS, QSBFSS, QSBOSS, TGASSS,      TCOMB032
     1          PSPACE(12), TTWALL(6)                                       TCOMB034
      COMMON  /PULFED/ PFD1(116), IBDIL                                     TCOMB038
      COMMON  /TPL/  TMW(18), TTO(18,3), TTOMW(18), TCF1(18), TTO1(18),     TCOMB040
     2               DUM6(54),                                              TCOMB042
     2               TMW(18,3), CSTR(18), TEPS(6), TMACH(3), TCF(18,6)      TCOMB044
     4             , TOXFRP(18), XMRM                                       TCOMB046
      COMMON  /CTCOMB/ KK, PX, P9, EPS, PMAX, CSTAR, OXFRP, WGEXH           TCOMB048
      COMMON  /PULCOM/ N,      IIGN,   DTIME,  TIME,   TAMB,   PBARSS,      TCOMB050
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,     TCOMB052
     2                 NFIRST, INITB,  TSTART, TOFF,   TLAST,  COMB,       TCOMB054
     3                 ISPACE, PIE,    WCUMVF, WCUMVC, PVALF,  PVALO,      TCOMB056
     4                 AVF,    AVO,    STDPW,  IPPRT,  ICRTP,  TVC,        TCOMB057
     5                 RHOF,   RHOO,   WGFGEN, WGOGEN, TVO,    TAUIGC,     TCOMB058
     6                 IPER,   ITWALL                                      TCOMB059
      COMMON  /COMPW/ JTAPE, NREC, ICRTSO, VOLC, AT, LCHAM, DCHAM,          TCOMB062
     1          RHCHAM, WGCHAM, ESISS, ECSSS, ECFSS, FSS, SIMPSS, CSTRSS,  TCOMB064
     2          CFSS, OXFRSS, HILOSS, CR, ECSMIX, ECSENR, ZIMPF, ZIMPO      TCOMB066
      COMMON  /CVV/  NP, NAP, NMR, DUM1(5), MTOF, MTVF, DUM2(4), MTOO,      TCOMB070
     1               MTVO, TXF, TXO, LMBDEF, LMBDEO, DUM3(18),              TCOMB072
     2               WOSSF, WOSSO, DUM4(19), NEPS, PAMB, AEXIT, ECFVAC,     TCOMB074
     3               NMACH, ECSTRI, PNSSS, PIESS, RVAPF, RVAPO              TCOMB076
      COMMON  /IGN4/ IGN4D(7), TG                                           TCOMB079
      COMMON  /IGN5A/ CIGN5(21), MVF                                        TCOMB080
      COMMON  /IGN6A/ CIGN6(21), MVO                                        TCOMB084
      COMMON  /IGNOUF/  WENSF, VENSF, TENSF, SUMSPF, WGFCUM, WFSF,          TCOMB090
     1                  WENSO, VENSO, TENSO, SUMSPO, WGOCUM, WFSO, TGAS     TCOMB092
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      COMMON  /COM7/   GA, RR, COM7D(45), RATVAP, CD                          TCOMB096
      COMMON  /PCOM1/  SUMIMP, TRISE, TIRISE, TRISEC, TDROP, TIDROP,          TCOMB100
     1          PCVFS, PWIDTH, OFF1, OFF2, PNS, THRUST, OXFRAC, TIA,         TCOMB102
     2          TWALL2, TWALLM, SUMPC, SUMPCA, TITAIL, TWALL, TALIGN         TCOMB104
      LOGICAL  COMB                                                          TCOMB106
      REAL  MVF, MVO                                                         TCOMB108
      DATA TEPSP/ 1. ,1.1,1.4,2.,3.,  4.2,6., 9.5, 15.5,30., 51.,  100.     TCOMB110
     1 ,200./                                                                TCOMB120
      DATA TPPNS/1.66,3., 5.,10.,18.6,30.,50.,100.,200.,500.,1000.,2400.     TCOMB130
     1 ,4000./                                                               TCOMB140
      DATA  JK/0/                                                            TCOMB150
      TIPCT(F) = SUMIMP + 0.5*F*DTIME*(F1+F1*(1.-F)+THRUST*F)                TCOMB160
C                                                                            TCOMB181
      IF(IPRT.GE.1)  WRITE(6,4)                                              TCOMB182
    4 FORMAT(1H1 3X 1HN 4X 4HTIME 5X 6HTHRUST 7X 3HPNS 7X 5HOXFRP 6X         TCOMB184
     1 5HWENSF 7X 5HWENSO 6X 5HVENSF 4X 5HVENSO 5X 5HWGEXH /                 TCOMB185
     2 24X 6HWCFCUM 6X 6HWGOCUM 6X 6HSUMSPF 6X 6HSUMSPO 7X 4HCOMB            TCOMB186
     3 8X 4HTGAS / )                                                         TCOMB187
      LINE = 3                                                               TCOMB188
      NTIME = (TIME+0.49999*DTIME)/DTIME                                     TCOMB189
      IRETRN = 0                                                             TCOMB190
        IF(N+1.GT.NFIRST)  GO TO 6                                           TCOMB200
      OFF2 = PSPACE(ISPACE)                                                  TCOMB202
      PMAX = 0.                                                              TCOMB204
      KK = 0                                                                 TCOMB206
      IPSP = 0                                                               TCOMB208
      IF(ISPACE.EQ.1)  GO TO 6                                               TCOMB210
      OFF1 = PSPACE(ISPACE-1)                                                TCOMB212
        GO TO 10                                                             TCOMB214
C         N = 0 SEC FROM  STMT 6 TO 6                                        TCOMB218
    6 OFF1 = 0.                                                              TCOMB220
      INITB = 0                                                              TCOMB221
      THRUST = 0.                                                            TCOMB222
      INITGO = 1                                                             TCOMB224
      OXFRP = 0.                                                             TCOMB226
      OXFRAC = 0.                                                            TCOMB230
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      WGFXM = 0.                                                        TCOMB232
      CSTAR = 500.                                                      TCOMB234
      WGFCUM = 0.                                                       TCOMB240
      WGOCUM = 0.                                                       TCOMB242
      PNS = PAMB                                                        TCOMB244
        EPS = 1E-11/AT                                                  TCOMB250
        PX = 0.10*(PNSSS-PAMB)                                          TCOMB252
        PO = 2.*PX                                                      TCOMB254
        GO TO 12                                                        TCOMB256
    8 IF(ISIGN.EQ.0)  GO TO 10                                          TCOMB260
      INITGG = 2                                                        TCOMB262
      WGFCUM = WVF                                                      TCOMB264
      WGOCUM = WVO                                                      TCOMB266
      OXFRP = WGFCUM/(THRM*WGFCUM+WGOCUM)                               TCOMB270
      CALL  LOCFRAC(JX,OXFRP,TOXFRP,NMR, JX,FA)                         TCOMB272
      CSTAR = TCSTR1*(CSTR(JX) + FA*(CSTR(JX+1)-CSTR(JX)))              TCOMB280
C       START  TIME  LOOP                                               TCOMB290
   10 NTIME = NTIME + 1                                                 TCOMB300
      TIME = FLOAT(NTIME)*DTIME                                         TCOMB302
      N = N + 1                                                         TCOMB304
      CALL  GASGEN                                                      TCOMB310
      IF(PAMB.LT.PNS)  GO TO 12                                         TCOMB312
        RPAN = 1.                                                       TCOMB314
        WGFXM = 0.                                                      TCOMB316
        GO TO 14                                                        TCOMB318
   12 RPAN = PAMB/PNS                                                   TCOMB320
      IF(RPAN.GE.1.1  GO TO 14                                          TCOMB324
      IF(RPAN.LE.0.547) WGFXM = PNS*AT*32.174*DTIME/CSTAR               TCOMB330
      IF(RPAN.GT.0.547) WGFXM = .424*AT*PNS*SQRT((RPAN**1.54-RPAN**1.77)TCOMB340
        /RTOMM1)*DTIME                                                  TCOMB350
   14 CONTINUE                                                          TCOMB352
      WGFCUM = WGFCUM + WGFGEN - (1.-OXFRAC)*WGFXM                      TCOMB360
      WGOCUM = WGOCUM + WGOGEN - OXFRAC*WGFXM                           TCOMB370
      IF(  FCUM*WGOCUM.GT.0.)  GO TO 16                                 TCOMB372
        P  XP = 0.                                                      TCOMB374
        OXF  AC = 0.                                                    TCOMB376
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      GO TO 10                                                          TCOMB378
   10 OXFRP = WGOCUM/(WGOCUM+XMRM*WGFCUM)                               TCOMB380
      OXFRAC = WGOCUM/(WGFCUM+WGOCUM)                                   TCOMB382
   10 CALL  LOCFAC(JX,OXFRP,TOXFRP,NMR, JX,FA)                          TCOMB384
      TGASB = TTO1(JX) + FA*(TTO1(JX+1)-TTO1(JX))                       TCOMB388
        TGASB = AMAX1(TAMB,TGASB)                                       TCOMB389
      IF(COMB)  GO TO 20                                                TCOMB390
        TGAS = TAMB                                                     TCOMB392
        FACT = OXFRAC                                                   TCOMB393
        IF(TMR(1).GT.TMR(NMR))  FACT = 1.-FACT                          TCOMB394
        XMW = (1.-FACT)*TTO1(1)/TTOMW(1) + FACT*TTO1(NMR)/TTOMW(NMR)    TCOMB395
        RTOMW = TGAS/XMW                                                TCOMB396
        GO TO 22                                                        TCOMB398
   20 RTOMW = TTOMW(JX) + FA*(TTOMW(JX+1)-TTOMW(JX))                    TCOMB402
      TGAS = TGASB                                                      TCOMB404
   22 PCBAR = (WGFCUM+WGOCUM)*RTOMW*12.*1545./VOLC                      TCOMB410
        PCBAR = AMAX1(PCBAR,PAMB)                                       TCOMB411
      CSTAR = ECSTR1*(CSTR(JX)+FA*(CSTR(JX+1)-CSTR(JX)))                TCOMB412
      PNS1 = PNS                                                        TCOMB416
      PNS = PCBAR*RPCNB                                                 TCOMB420
      PMAX = AMAX1(PMAX,PNS)                                            TCOMB424
      PIF = PNS*RPCIN                                                   TCOMB430
      CF = 0.                                                           TCOMB432
      IF(PNS.LE.PAMB)  GO TO 50                                         TCOMB434
      IF(RPAN.LT.0.547)  GO TO 30                                       TCOMB440
C       FLOW  NOT  CHOKED                                               TCOMB450
        CF = 1.97*SQRT(1.-RPAN**0.231)                                  TCOMB460
        GO TO 50                                                        TCOMB470
C       CHOKED  FLOW                                                    TCOMB480
   30 RPAN = YOF(EPS,TEPSP,TRPNE,13,2)*PAMB/PNS                         TCOMB490
      IF(RPAN.LE.3.)  GO TO 40                                          TCOMB500
C       FLOW  SEPARATION  (ASSUMES GAMMA=1.3)                           TCOMB510
        RPWN = PAMB/(3.*PNS)                                            TCOMB520
        EPS1 = YOF(1./RPWN,TRPNE,TEPSP,13,2)                            TCOMB530
        CF = FCPVAC*(1.97+SQRT(1.-RPWN**0.231)+RPWN*EPS1) - RPAN*EPS1   TCOMB540
        GO TO 50                                                        TCOMB550
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C       NO  FLOW  SEPARATION                                          TCOMB560
   40 CF = ECFVAC*(TCF1(JX)*FA*(TCF1(JX+1)-TCF1(JX)))                 TCOMB570
      IF(PAMB.GT.0.)  CF = CF - PAMB*EPS/PNS                          TCOMB572
   50 FL = THRUST                                                     TCOMB580
      THRUST = AT*PNS*CF                                              TCOMB590
        THRUST = AMAX1(0.,THRUST)                                     TCOMB594
C         CALC  ASCF AND DROP  TIMES AND TOTAL IMPULSES               TCOMB600
      IF(IPER.GT.0)  GO TO 100                                        TCOMB602
        IF(N.EQ.NFIRST)  GO TO 150                                    TCOMB603
        IF(TIME+1.0001*DTIME .LT. TVC)  GO TO 150                     TCOMB605
        IPER = 1                                                      TCOMB606
        IPERM = 1                                                     TCOMB607
          GO TO 150                                                   TCOMB608
  100   PNSC = PNS - PAMB                                             TCOMB610
      GO TO (110,120,130,134,140,145), IPER                           TCOMB620
  110   IF(PNSC.LT.PX)  GO TO 150                                     TCOMB630
          FACT = (PX*PAMB-PNS1)/(PNS-PNS1)                            TCOMB634
          TI = (TIME - (1.-FACT)*DTIME - TSTART) * 1000.              TCOMB636
          IPER = 2                                                    TCOMB642
          GO TO 150                                                   TCOMB646
  120   IF(PNSC.LT.P90)  GO TO 150                                    TCOMB650
          FACT = (P90*PAMB-PNS1)/(PNS-PNS1)                           TCOMB652
          TASE =(TIME - (1.-FACT)*DTIME - TSTART) * 1000.             TCOMB654
          TASE2 = TASE - TI                                           TCOMB656
          TIMPSE = TIFCT(FACT)                                        TCOMB660
          IPER = 3                                                    TCOMB662
          GO TO 150                                                   TCOMB664
  130   IF(TIME.LT.TOFF)  GO TO 150                                   TCOMB670
          FACT = (TOFF-TIME+DTIME)/DTIME                              TCOMB672
          TI3 = TIFCT(FACT)                                           TCOMB676
          IPER = 4                                                    TCOMB680
          GO TO 150                                                   TCOMB682
  134   IF(TIME.LT.TVC)  GO TO 150                                    TCOMB684
          FACT = (TVC-TIME+DTIME)/DTIME                               TCOMB685
          TI4 = TIFCT(FACT)                                           TCOMB686
          IPER = 5                                                    TCOMB687
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          INITB = 1                                                              TCOMB688
          SUMPCA = SUMPC+C.5*FACT*DTIME*(PNS1+PNS1*(1.-FACT)+PNS*FACT)           TCOMB689
  140   IF(PNSC.GT.PA)  GO TO 150                                                TCOMB690
          FACT = (PX+PAMB-PNS1)/(PNS-PNS1)                                       TCOMB692
          T4 = TIME - (1.-FACT)*DTIME                                            TCOMB694
          TDROP = (T4-TOFF)*1000.                                                TCOMB700
          TI4 = TIFCT(FACT)                                                      TCOMB702
          TIDROP = TI4-TI3                                                       TCOMB703
          IPER = 6                                                               TCOMB704
          GO TO 150                                                              TCOMB705
  148 WLIQP = SUMSPF + SUMSPO                                                    TCOMB706
      IF(IBOIL.NE.0)  WLIQP = WLIQP +  WFSF + WFSO                               TCOMB707
      IF(WLIQP.LE.0. .AND. PIE.LE.PAMB+0.002)  GO TO 200                         TCOMB708
C        ARBITRARY TEST -  PIE.LE.PAMB+0.002 FOR TERMINATING COMBUSTION          TCOMB709
  150 SUMIMP = SUMIMP + DTIME * 0.5 *(F1+THRUST)                                 TCOMB710
      SUMPC = SUMPC + DTIME * 0.5 * (PNS1+PNS)                                   TCOMB720
        IF(.NOT.COMB .OR. TGASB.GE.TG)  GO TO 156                                TCOMB730
      WRITE(6,152)                                                               TCOMB740
  152 FORMAT(27H   COMBUSTION  EXTINGUISHED )                                    TCOMB742
      COMB = .FALSE.                                                             TCOMB750
  156   CALL  FEEDS                                                              TCOMB760
        IF(N.EQ.1)  NTIME = MAXO(NTIME,INT(TVO/DTIME))                           TCOMB770
        CALL  TCSAV(KK)                                                          TCOMB780
      IF(IPPRT.LT.1)  GO TO 180                                                  TCOMB790
      LINE = LINE + 2                                                            TCOMB800
      IF(LINE.LE.43)  GO TO 160                                                  TCOMB810
      WRITE(6,4)                                                                 TCOMB820
      LINE = 5                                                                   TCOMB830
  160 WRITE(6,170)  N, TIME, THRUST, PNS, OXFRP,  WENSF,                         TCOMB840
     1 WENSO, VENSF, VENSO, WGEXH, WGFCUM, WGOCUM, SUMSPF, SUMSPO                TCOMB842
     2,COMB, TGAS                                                                TCOMB844
  170 FORMAT(1H  I5,3PF8.1,1P2E12.4,0PF9.5,1P2E12.4,0P2F9.2, 1PE12.4 /           TCOMB850
     1  20X 4E12.4, L7, E17.4)                                                   TCOMB860
  180   IF(TIME.LT.TLAST .AND. IRETRN.EQ.0)  GO TO 10                            TCOMB950
      IF(TIME.LT.TLAST)  GO TO 190                                               TCOMB954
        TITAIL = SUMIMP - TI4                                                    TCOMB956
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      IF(IPPRT.GE.1)  WRITE(6,184)  WFSF, WFSO                          TCOMB960
  184   FORMAT(50HO    RESIDUAL PROPELLANT IN FEED SYSTEM --  WFSF =     TCOMB962
     1          1PE13.5, 10H,   WFSO =   E13.5)                         TCOMB964
      POVER = (PMAX-PNSSS)/PNSSS                                        TCOMB970
  190 MVF = WGFCUM                                                      TCOMB980
      MVO = WGOCUM                                                      TCOMB982
      RETURN                                                            TCOMB984
  200   COMB = .FALSE.                                                  TCOMB986
        IF(ITWALL.GT.1)  GO TO 150                                      TCOMB987
        IRETRN = 1                                                      TCOMB988
        NSPACE = ISPACE                                                 TCOMB990
        PSPACE(NSPACE) = (TIME-TOFF)*1000.                              TCOMB991
        TLAST = TIME                                                    TCOMB992
        WRITE(6,210)  NSPACE, PSPACE(NSPACE)                            TCOMB993
  210   FORMAT(88H1   PULSE TERMINATED EARLY DUE TO COMPLETE COMBUSTION TCOMB994
     1AND INSIGNIFICANT CHAMBER PRESSURE / 4X 12HNSPACE SET = I3,       TCOMB995
     2 23H,  PSPACE(NSPACE) SET = F8.2)                                 TCOMB996
        GO TO 150                                                       TCOMB998
      END                                                               TCOMB999



      SUBROUTINE  GASGEN                                                GASG0010
C       SETUP  AND  VAPORIZE  SPRAY  ENSEMBLES  AS  FUNCTION  RES. TIME GASG0020
      COMMON  /TBL/ TBLCD1(108), TTO1(18), TBLCD2(243), TOXFRP(18), XMRMGASG0022
      COMMON  /SVV/ NP, NAP, NMR, SVVD1(37), XMRI, SVVD2(19), PAMB,     GASG0024
     1              SVVD3(6), RVAPF, RVAPO                              GASG0026
      COMMON  /IGN4/ IGN4D(7), TG                                       GASG0028
      COMMON  /CPM2C/  TR(50),  SPRAYF(50),  SPRAYO(50)                 GASG0030
      COMMON  /IGN5X/ MAXJF, WDF(401), JMAXF(401)                       GASG0034
      COMMON  /IGN6X/ MAXJO, WDO(401), JMAXO(401)                       GASG0036
      COMMON  /IGNGGF/ WENSF, VENSF, TENSF, SUMSPF, WGFCUM, WFSF,       GASG0040
     1                 WENSO, VENSO, TENSO, SUMSPO, WGOCUM, WFSO, TGAS GASG0042
      COMMON  /PCOM1/  PC1DUM(20), TAUIGN                               GASG0048
      COMMON  /PULCOM/ N,      IIGN,   DTIME,  TIME,   TAMB,   PBARSS,  GASG0050
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,  GASG0060
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     2                 NFIRST, INITB,  TSTART, TOFF,   TLAST,   COMB,    GASG0062
     3                 ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,    GASG0063
     4                 AVF,    AVO,    STDPW,  IPPRT,  ICRTP,  TVC,      GASG0064
     5                 RHOF,   RHOO,   WGFGEN, WGOGEN, TVO,    TAUIGC,   GASG0065
     6                 IPER,   ITWALL                                    GASG0066
      COMMON  /PULFED/ DUMPF(112), DIMPF, DIMPO                          GASG0068
      COMMON  /CGASG/  WEFI(500), WEOI(500), WEF(500), WEO(500),         GASG0074
     1                 TIMPF(500),TIMPO(500),WENSF1, WENSO1, NNN,       GASG0075
     2                 MINF, MINO, EVAPFC,  EVAPOC, DTR, FACT, TFMAX,   GASG0076
     3                 DMNBF, DMNBO, VFMAXF, VFMAXO, TRESF, TRESO,      GASG0077
     4                 TIMPF1, TIMPO1, DTMS                             GASG0078
      LOGICAL  COMB                                                      GASG0079
      DATA  NOINC,BIG/ 500, 1.E+20/                                      GASG0080
      DATA  KOUNT / 0 /                                                  GASG0082
C                                                                        GASG0090
C  UNITS OF  TR, TRFS, TRFSF AND TRFSO  ARE MILLISECONDS -               GASG0092
C       ALL OTHER TIME VARIABLES ARE IN SECONDS                          GASG0094
      N1 = N - 1                                                         GASG0096
      IF(INITGO.EQ.0)  GO TO 8                                           GASG0130
C        INITGO SET = 0  AT STMT 52                                      GASG0132
      DTMS = 1000.*DTIME                                                 GASG0133
      NNN = 0                                                            GASG0134
      MINF = 1                                                           GASG0136
      SUMSPF = 0.                                                        GASG0138
      SUMSPO = 0.                                                        GASG0139
      MINO = 1                                                           GASG0140
      OXFRSS = XMRI/(XMRI+XMRM)                                          GASG0141
      WENSF1 = 0.                                                        GASG0142
      WENSO1 = 0.                                                        GASG0143
    8     IF(N.NE.1)  GO TO 10                                           GASG0144
      EVAPFC = 1. - RVAPF                                                GASG0150
      EVAPOC = 1. - RVAPO                                                GASG0160
      DTR = TR(2)-TR(1)                                                  GASG0170
C        NON BURNING DELTA MASS VAPORIZATION  PER TIME STEP              GASG0171
      FACT = 0.3*DTMS/DTR                                                GASG0172
      DMNBF = FACT*AMAX1(5.E-4, 1.-SPRAYF(2) )                           GASG0174
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      DMNPO = FACT*AMAX1(F.E-4, 1.-SPRAYU(2) )                          GASG0176
      TFMAX = FLOAT(NOINC)*DTIME/2.                                     GASG0180
      VFMAXF = DIMPF/(12.*TFMAX)                                        GASG0182
      VFMAXO = DIMPO/(12.*TFMAX)                                        GASG0184
      TRESF = YOF(EVAPFC,SPRAYF,TR,50,2)                                GASG0190
      TRESO = YOF(EVAPOC,SPRAYO,TR,50,2)                                GASG0192
      TIMPF1 = BIG                                                      GASG0196
      TIMPO1 = BIG                                                      GASG0198
      TAUICN = TAUIGC                                                   GASG0200
   10 IF(INITGC.NE.2)  GO TO 18                                         GASG0206
      IF(N1.GE.NNN+NOINC)  NNN = NNN + NOINC                            GASG0208
        DO 14 J=1,MAXJF                                                 GASG0210
        I = N - J                                                       GASG0212
        K = I - NNN                                                     GASG0214
        IF(K.LE.0)  K = K + NOINC                                       GASG0216
        WEFI(K) = WDF(J)                                                GASG0220
        TRES = TRESF*FLOAT(J)/FLOAT(JMAXF(J))                           GASG0230
        WEF(K) = YOF(TRES,TR,SPRAYF,50,2)*WEFI(K)                       GASG0240
   14   TIMPF(K) = TIME - 1.5*DTIME - TRES*1.E-3                        GASG0250
      MINF = I                                                          GASG0260
        DO 16 J=1,MAXJO                                                 GASG0270
        I = N - J                                                       GASG0272
        K = I - NNN                                                     GASG0274
        IF(K.LE.0)  K = K + NOINC                                       GASG0276
        WEOI(K) = WDO(J)                                                GASG0280
        TRES = TRESO*FLOAT(J)/FLOAT(JMAXO(J))                           GASG0290
        WEO(K) = YOF(TRES,TR,SPRAYO,50,2)*WEOI(K)                       GASG0300
   16   TIMPO(K) = TIME - 1.5*DTIME - TRES*1.E-3                        GASG0310
      MINO = I                                                          GASG0320
C                                                                       GASG0324
   18 FACENS = 1.                                                       GASG0330
      IF(IPER.GE.6 .OR. (WENSF.LE.0. .AND. WENSO.LE.0.))  GO TO 20      GASG0332
        OXFENS = WENSO/(WENSO+XMRM*WENSF)                               GASG0340
        DOXF = ABS(OXFENS-OXFRSS)                                       GASG0342
        ROXF = OXFRSS                                                   GASG0350
        IF(OXFENS.GT.OXFRSS)  ROXF = 1.-OXFRSS                          GASG0352
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      DOR = DOXF/ROXF                                                    GASG0354
       IF(DOR.LE.0.02)  GO TO 20                                         GASG0356
      IF(DOR.LE.0.07)  FACENS = 1. - 0.4*(DOR-0.02)/0.05                 GASG0358
      IF(DOR.GT.0.07)  FACENS = 0.6 - 0.3*(DOR-0.07)/0.93                GASG0359
   20 WGFGEN = 0.                                                        GASG0360
      WGOGEN = 0.                                                        GASG0370
      WENSF = FACENS*WENSF                                               GASG0380
      WENSO = FACENS*WENSO                                               GASG0382
      NS = N1 - NNN                                                      GASG0404
      IF(N1.GE.NNN+NCINC)  NNN = NNN + NCINC                             GASG0408
      IF(N1.LT.1)  RETURN                                                GASG0410
      IMIN = 0                                                           GASG0412
       IF(INITGG.EQ.2)  GO TO 23                                         GASG0414
      WEFI(NS) = WENSF                                                   GASG0430
      WEF(NS) = WENSF                                                    GASG0440
       IF(AVF.EQ.0.)  GO TO 21                                           GASG0448
      TIMPF(NS) = TIME - 1.5*DTIME + DIMPF/(12.*AMAX1(VENSF,VFMAXF))     GASG0450
      GO TO 22                                                           GASG0452
   21   TIMPF(NS) = TIME - 1.5*DTIME                                     GASG0454
   22 IF(SUMSPF+WENSF1.LE.0.)  GO TO 41                                  GASG0460
   23 SUMSPF = 0.                                                        GASG0464
       DO 40 J=MINF,N1                                                   GASG0470
C      J IS ENSEMBLE SEQUENCE NUMBER                                     GASG0480
      K = J - NNN                                                        GASG0490
      IF(K.LE.0)  K = K + NCINC                                          GASG0500
C     K IS ENSEMBLE STORAGE LOCATION                                     GASG0510
      TRES = (TIME - TIMPF(K))*1000.                                     GASG0520
      IF(TRES.LE.0.)  GO TO 30                                           GASG0530
      WOLD = WEF(K)                                                      GASG0540
      IF(WOLD.LE.0)  GO TO 40                                            GASG0550
   24   LOC = MIN1(TRES/DTR+1.,49.1)                                     GASG0570
      F = (TRES-TR(LOC))/DTR                                             GASG0580
      SPRAY = AMAX1(EVAPFC,SPRAYF(LOC)*(1.-F)+SPRAYF(LOC+1)*F)           GASG0590
   26   WEF(K) = SPRAY*WEFI(K)                                           GASG0600
      DGG = WOLD - WEF(K)                                                GASG0610
       IF(.NOT.COMB)  DGG = DMNBF*WEFI(K)                                GASG0612
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      WGFGEN = WGFGEN + DGG                                                  GASG0614
      IF(SPRAY.LE.EVAPFC)  WEF(K) = 0.                                       GASG0620
      SUMSPF = SUMSPF + (SPRAY-EVAPFC)*WEFI(K)                               GASG0630
      IF(WEF(K).GT.0.0)  IMIN = 1                                            GASG0640
      IF(IMIN.EQ.0)  MINF = J                                                GASG0650
   30   CONTINUE                                                            GASG0660
   40   CONTINUE                                                            GASG0670
   41 IF(IMIN.EQ.0)  MINF = N                                               GASG0672
   42 IF(MINF+NOINC.GT.N1)  GO TO 50                                        GASG0680
      K = MINF - NNN                                                        GASG0690
      IF(K.LE.0)  K = K + NOINC                                             GASG0700
      W = WEF(K)/WEFI(K) - EVAPFC                                           GASG0710
      KOUNT = KOUNT + 1                                                     GASG0714
      IF(KOUNT.LE.30)  WRITE(6,44)  N, W                                    GASG0720
   44 FORMAT(/// 5X 49HINSUFFICIENT SPRAY STORAGE SPACE (SEE SUB GASGEN)GASG0730
     1 / 5X 31HCLOSEST SPRAY ENSEMBLE VAPORIZED 5X 2HN= I6, 8H  SPRAY=    GASG0740
     2 1PE14.4 // )                                                         GASG0750
      IF(KOUNT.EQ.30)  WRITE(6,46)                                          GASG0752
   46 FORMAT(42H0* GASGEN DIAGNOSTIC NOW SUPPRESSED  * * * )                GASG0754
      WGFGEN = WGFGEN + WEF(K) - WEFI(K)*EVAPFC                             GASG0760
      MINF = MINF + 1                                                       GASG0770
C                                                                           GASG0780
   50 IMIN = 0                                                              GASG0790
        IF(INITGC.EQ.2)  GO TO 52                                           GASG0792
      WEOI(NS) = WENSO                                                      GASG0798
      WEO(NS) = WENSO                                                       GASG0802
        IF(AVO.EQ.0.)  GO TO 51                                             GASG0804
      TIMPO(NS) = TIME - 1.5*DTIME + DIMPO/(12.*AMAX1(VENSO,VFMAXO))        GASG0806
      GO TO 52                                                              GASG0810
   51   TIMPO(NS) = TIME - 1.5*DTIME                                        GASG0812
   52 INITGC = 0                                                            GASG0816
      IF(SUMSPC+WENSO1.LE.0.)  GO TO 72                                     GASG0820
      SUMSPC = 0.                                                           GASG0822
        DO 70 J=MINC,N1                                                     GASG0830
        K = J - NNN                                                         GASG0840
        IF(K.LE.0) K = K + NOINC                                            GASG0850
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      TRES = (TIME - TIMPO(K))*1000.                                    GASG0860
      IF(TRES.LE.0.)  GO TO 60                                          GASG0870
      WOLD = WEO(K)                                                     GASG0880
      IF(WOLD.LE.0.)  GO TO 70                                          GASG0890
   54 LOC = MINI(TRES/DTR+1.,49.1)                                      GASG0910
      F = (TRES-TR(LOC))/DTR                                            GASG0920
      SPRAY = AMAX1(EVAPOC,SPRAYO(LOC)*(1.-F)+SPRAYO(LOC+1)*F)          GASG0930
   56 WEO(K) = SPRAY*WEOI(K)                                            GASG0940
      DGG = WOLD - WEO(K)                                               GASG0950
        IF(.NOT.COMB)  DGG = DMNBO*WEOI(K)                              GASG0952
      WGOGEN = WGOGEN + DGG                                             GASG0954
      IF(SPRAY.LE.EVAPOC)  WEO(K) = 0.                                  GASG0960
      SUMSPO = SUMSPO + (SPRAY-EVAPOC)*WEOI(K)                          GASG0970
      IF(WEO(K).GT.0.0)  IMIN = 1                                       GASG0980
      IF(IMIN.EQ.0)  MINO = J                                           GASG0990
   60 CONTINUE                                                          GASG1000
   70 CONTINUE                                                          GASG1010
   72 IF(IMIN.EQ.0)  MINO = N                                           GASG1012
   80 IF(MINO+NOINC.GT.N1)  GO TO 90                                    GASG1020
      K = MINO - NNN                                                    GASG1030
      IF(K.LE.0)  K = K + NOINC                                         GASG1040
      W = WEO(K)/WEOI(K) - EVAPOC                                       GASG1050
      KOUNT = KOUNT + 1                                                 GASG1054
      IF(KOUNT.LE.30)  WRITE(6,44)  N, W                                GASG1060
      IF(KOUNT.EQ.30)  WRITE(6,46)                                      GASG1062
      WOOGEN = WOOGEN + WEO(K) - WEOI(K)*EVAPOC                         GASG1070
      MINO = MINO + 1                                                   GASG1080
C                                                                       GASG1090
   90 IF(COMB .OR. IICN.GE.1)  GO TO 200                                GASG1100
        IF(WENSF.GT.0.)  GO TO 92                                       GASG1110
          TIMPFI = BIG                                                  GASG1112
          GO TO 94                                                      GASG1114
   92   TIMPFI = AMINI(TIMPFI,TIMPF(NS))                               GASG1120
   94   IF(WENSO.GT.0.)  GO TO 96                                      GASG1130
          TIMPOI = BIG                                                  GASG1132
          GO TO 98                                                      GASG1134
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   96   TIMPOI = AMIN1(TIMPOI,TIMPO(NS))                                  GASG1140
   98   TIMPI = AMAX1(TIMPFI,TIMPOI)                                      GASG1146
          IF(TIME.LT.TIMPI)  GO TO 200                                    GASG1150
C     * *    IF(IIGN.LE.-1)  TAUIGN = TAUFCT(XX)                         GASG1170
          TICOMB = TIMPI + TAUIGN*1.E-3                                   GASG1180
        IF(WGFCUM.LE.0.)  GO TO 99                                        GASG1181
        T = YOF(WGCCUM/(WGCCUM+XMRM*WGFCUM), TOXFRP, TTOI, NMR, 2)        GASG1182
        IF(T.GT.TG .AND. PIE.GT.PAMB+0.002)  GO TO 100                    GASG1184
C       PIE.LE.PAMB+0.002 FOR NO COMBUSTION IS AN ARBITRARY TEST          GASG1185
   99     TIMPFI = TIME + DTIME                                          GASG1186
          GO TO 200                                                       GASG1188
  100   IF(TIME+DTIME.LT.TICOMB)  GO TO 200                               GASG1190
        COMB = .TRUE.                                                     GASG1200
        TIMPFI = BIG                                                      GASG1204
        TIMPOI = BIG                                                      GASG1206
        WRITE(6,110)                                                      GASG1220
  110   FORMAT(1PH   I G N I T I O N )                                    GASG1230
C                                                                         GASG1280
  200 WFNSFI = WFNSF                                                      GASG2004
      WFNSOI = WFNSO                                                      GASG2006
      RETURN                                                              GASG2008
      END                                                                 GASG2010


      SUBROUTINE FEEDS                                                    FEED0010
C                                                                         FEED0020
      COMMON  /PULFED/ TLF, TLO, VVALF, VVALO, NTVEF, NTVEO, NTVDEF,      FEED0120
     1          NTVDEO, TTVEF(9), TAVEF(9), TTVEO(9), TAVEO(9),          FEED0122
     2          TTVDEF(9), TAVDEF(9), TTVDEO(9), TAVDEO(9),              FEED0124
     3          AVEF, CFVF, AOVEF, A1VEF, AOVDEF, A1VDEF,                FEED0126
     4          AVEO, CFVO, AOVEO, A1VEO, AOVDEO, A1VDEO                 FEED0128
     5        , PFEDO(24), IBOIL                                         FEED0130
      COMMON  /PULCOM/ N,      IIGN,   DTIME,  TIME,   TAMB,   PBARSS,   FEED0150
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,  FEED0152
     2                 NFIRST, INITE, TSTART, TOFF, TLAST, COMB,        FEED0154
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     3                 ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,   FEED0156
     4                 AVF,    AVO,    STDPW,  IPPRT,  ICRTP,  TVC,     FEED0158
     5                 RHOF,   RHOC,   WGFGEN, WGOGEN, TVO,    TAUIGC,  FEED0160
     6                 IPER                                             FEED0162
      COMMON  /ICNGLF/  WENSF, VENSF, TENSF, SUMSPF, WGFCUM, WFSF,       FEED0170
     1                  WENSO, VENSO, TENSO, SUMSPO, WGOCUM, WFSO, TGAS  FEED0172
C                                                                        FEED0280
      WENSF = 0.                                                         FEED0290
      WENSO = 0.                                                         FEED0292
      IF(N.GT.NFIRST)  GO TO 20                                          FEED0300
      WCUMVF = 0.                                                        FEED0340
      WCUMVO = 0.                                                        FEED0350
C        TIMES THAT VALVES BEGIN TO OPEN.                                FEED0360
      TVOF = TSTART + (AOVEF + AIVEF*VVALF)/1000.                        FEED0380
      TVOO = TSTART + (AOVEO + AIVEO*VVALO)/1000.                        FEED0400
      TVDF = TOFF + (AOVDEF + AIVDEF*VVALF)/1000.                        FEED0420
      TVDO = TOFF + (AOVDEO + AIVDEO*VVALO)/1000.                        FEED0440
        IF(IPRT.GE.0) WRITE(6,10) TVOF, TVOO, TVDF, TVDO, TSTART, TOFF   FEED0442
   10   FORMAT( 8HO  TVOF=,1PE10.3, 6H TVOO= E10.3, 6H TVDF= E10.3,      FEED0444
     1           6H TVDO= E10.3, 8H TSTART= E10.3, 6H TOFF= E10.3)       FEED0446
      TVO = AMIN1(TVOF,TVOO)                                             FEED0449
      TVC = AMIN1(TVOF,TVOO)                                             FEED0450
      IF(N.GT.1)  GO TO 20                                               FEED0451
      VENSF = 0.                                                         FEED0452
      VENSO = 0.                                                         FEED0454
      AVF = 0.                                                           FEED0455
      AVO = 0.                                                           FEED0456
C                                                                        FEED0460
      WFSF = 0.                                                          FEED0470
      WFSO = 0.                                                          FEED0472
   20 IF(TIME.LT.TVOF)  GO TO 60                                         FEED0480
      IF(TIME.GE.TVDF)  GO TO 40                                         FEED0482
      IF(AVF.GE.AVEF)   GO TO 60                                         FEED0484
C        FUEL VALVE IS OPENING                                           FEED0490
        T = 1000.*(TIME - TVOF)                                          FEED0500
        AVF = VOF(T,TTVEF,TAVEF,NTVEF,2)*AVEF                            FEED0520
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          AVF = AMIN1(AVEF,AVF)                                          FEED0530
           GO TO 60                                                      FEED0532
C                                                                        FEED0540
   40  IF(AVF.LE.0.) GO TO 60                                            FEED0560
C         FUEL VALVE IS CLOSING.                                         FEED0570
         T = 1000.*(TIME - TVDF)                                         FEED0580
         AVF = YOF(T,TTVDEF,TAVDEF,NTVDEF,2)*AVEF                        FEED0600
          AVF = AMAX1(AVF,0.)                                            FEED0610
C                                                                        FEED0620
   60  IF(TIME.LT.TVDO)  GO TO 100                                       FEED0640
       IF(TIME.GE.TVDO)  GO TO 80                                        FEED0642
       IF(AVO.GE.AVEO)   GO TO 100                                       FEED0644
C         OXIDIZER VALVE IS OPENING.                                     FEED0650
         T = 1000.*(TIME - TVDO)                                         FEED0660
         AVO = YOF(T,TTVDEO,TAVDEO,NTVDEO,2)*AVEO                        FEED0680
          AVO = AMIN1(AVEO,AVO)                                          FEED0690
           GO TO 100                                                     FEED0692
C                                                                        FEED0700
   80  IF(AVO.LE.0.)  GO TO 100                                          FEED0720
C         OXIDIZER VALVE IS CLOSING.                                     FEED0730
         T = 1000.*(TIME - TVDO)                                         FEED0740
         AVO = YOF(T,TTVDEO,TAVDEO,NTVDEO,2)*AVEO                        FEED0760
          AVO = AMAX1(AVO,0.)                                            FEED0770
C                                                                        FEED0780
  100  IF(AVF.GT.0. .OR. AVO.GT.0.)  CALL FLOW                           FEED0800
C                                                                        FEED0820
       IF(IBOIL.EQ.0)  RETURN                                            FEED0830
       IF(ISPACE.EQ.1 .AND. TIME.LT.TVC)  RETURN                         FEED0834
       IF(IPER.EQ.1)  RETURN                                             FEED0836
       IF(AVF.EQ.0. .OR. AVO.EQ.0.)  CALL BOIL                           FEED0840
C                                                                        FEED0860
       RETURN                                                            FEED1000
       END                                                               FEED1020
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      SUBROUTINE FLOW                                                    FLOW0010
C                                                                        FLOW0020
      COMMON /PULCOM/ N, IIGN, DT, ADUM(9), NFIRST, INITB, BDUM(5),      FLOW0100
     1               PIE, WCUMVF, WCUMVO, PVALF, PVALO, AVF, AVO         FLOW0102
     2             , STOPW, IPRNT, ICPTP, TVC, RHOF, RHOO                FLOW0104
     3             , WGFGEN, WGOGEN, TVO                                 FLOW0106
      COMMON /PULFED/ TLF, TIO, CDUM(78),                                FLOW0116
     X          AVEF, CFVF, AOVEF, AIVEF, AOVLEF, AIVDEF,               FLOW0118
     Y          AVEO, CFVO, AOVEO, AIVEO, AOVDEO, AIVDEO,               FLOW0120
     1          ALF, LLF, RFLF, ALO, LLO, RFLO,                         FLOW0122
     2          AMF, LMF, RFMF, AMO, LMO, RFMO,                         FLOW0124
     3          SAIF, LIF, RFIF,SAIO, LIO, RFIO, CFIF, CFIO,            FLOW0126
     4          DUMPF, DUMPO, VFSF, VFSO, IBCIL, EPS,                   FLOW0128
     5          VLF, VOLMF, VIF, VLO, VOLMO, VIO                        FLOW0130
      COMMON /ICONDF/ WFNSF, VFNSF, TFNSF, SUMSPF, WGFCUM, WFSF,         FLOW0160
     1               WFNSO, VFNSO, TFNSO, SUMSPO, WGOCUM, WFSO, TGAS     FLOW0162
      REAL      LLF,   LMF,   LIF,   LLO,   LMO,   LIO                  FLOW0280
C                                                                        FLOW0288
C * * * SOLUTION FOR FUEL FEED SYSTEM.                                  FLOW0290
C                                                                        FLOW0292
      IF(INITB.NE.0)  GO TO 20                                           FLOW0300
      TFNSF = TLF                                                        FLOW0330
      VOLF = 1728.*WFSF/GMOF                                             FLOW0340
      VIF = CFIF*(1./SAIF**2 - 1./AMF**2)                                FLOW0360
      XMF = 0.0                                                          FLOW0380
      XIF = 0.0                                                          FLOW0400
      VLF = AMIN1(1.,VOLF/VLF)                                           FLOW0420
      IF(VLF.EQ.1.)  XMF = AMIN1(1.,(VOLF - VLF)/VOLMF)                  FLOW0440
      IF(XMF.EQ.1.)  XIF = AMIN1(1.,(VOLF - VLF - VOLMF)/VIF)            FLOW0460
      CDOTF1 = 0.0                                                       FLOW0480
      CDOTF2 = 0.0                                                       FLOW0490
      DUMPF = 0.0                                                        FLOW0500
   20 IF(AVF.EQ.0.0)  GO TO 210                                          FLOW0530
        IXIF = 0                                                         FLOW0532
        IF(XIF.EQ.0.0 .AND. PVALF.GT.PIE)  IXIF = 1                      FLOW0533
      VV = 0.0                                                           FLOW0535
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      IF(AVF.NE.AVEF)  VV = CFVF*(1./AVF**2 - 1./AVEF**2)                    FLOW0540
      VOLF1 = VOLF                                                           FLOW0550
      J = 2                                                                  FLOW0560
      IF(ABS(PVALF - PIF)/PVALF .LE. 0.05)  J = 4                            FLOW0570
C                                                                            FLOW0578
      DO 100  I=1,J                                                          FLOW0580
        VENTF = 0.0                                                          FLOW0590
        IF(PIF.LT.PVALF .OR. XLF.GT.0.)  GO TO 40                            FLOW0600
            QDOTF2 = 0.0                                                     FLOW0620
            QBARF = 0.0                                                      FLOW0640
            VENTF = 0.0                                                      FLOW0660
            VOLF = 0.0                                                       FLOW0700
            GO TO 200                                                        FLOW0720
   40   SIGN = SIGN(1.,QBARF)                                                FLOW0740
        IF(-QDOTF2*DTIME .GT. VOLF1)  GO TO 70                               FLOW0750
        X = TIME**(XLF*XLF/ALF + XMF*XMF/AMF + XIF*XIF/SAIF)                 FLOW0760
     1           /667160.                                                    FLOW0762
C          * * (667160.*32.174*12**4) * *                                    FLOW0764
        Y = VV * SIGN*(XFLF*XLF/ALF**2 + XFMF*XMF/AMF**2 +                   FLOW0780
     1                 XFIF*XIF/SAIF**2)                                     FLOW0782
        IF(XIF.GT.0. .AND. QDOTF2.GT.0.)  Y = Y + YIF                        FLOW0800
        A = RHOF*Y/5337280.                                                  FLOW0820
C          * * (5337280.*32.174*2*4*12**4) * *                               FLOW0822
        B = X/DTIME + 2.*A*QDOTF1                                            FLOW0840
        C = QDOTF1*(A*QDOTF1 - X/DTIME) + PIF - PVALF                        FLOW0860
C                                                                            FLOW0880
        QDOTF2 = QUAD(A,B,C,QDOTF2)                                          FLOW0900
          IF(PVALF.GT.PIF)  QDOTF2 = AMAX1(0.,QDOTF2)                        FLOW0910
C                                                                            FLOW0920
        IF(IPRNT.GE.3)  WRITE(2,50)  X,Y,A,B,C,QDOTF1,QDOTF2                FLOW0930
   50 FORMAT(10X,2HX=1PE11.3,3H,Y=E11.3,3H,A=E11.3,3H,B=E11.3,3H,C=          FLOW0932
     1       E11.3,4H,Q1=E11.3,4H,Q2=E11.3)                                  FLOW0933
        QBARF = (QDOTF1 + QDOTF2)*DTIME/2.                                   FLOW0940
   55   IF(QBARF)  60,100,120                                                FLOW0960
   60   IF(VOLF1.GE.-QBARF)  GO TO 80                                        FLOW0980
   70        QBARF = -VOLF1                                                  FLOW1000
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      WFSO = VOLO**WOF/1728.                                          FLOW1450
C                                                                     FLOW2240
C * * * SOLUTION FOR OXIDIZER FEED SYSTEM.                           FLOW2260
C                                                                     FLOW2280
  210 IF(INITO.NE.0)  GO TO 220                                       FLOW2300
      INITO = 1                                                       FLOW2310
      TWSO = TLO                                                      FLOW2330
      VOLO = 1728.*WFSO/RHOO                                          FLOW2340
      YIO = CFVO*(1./SAIO**2 - 1./AMO**2)                             FLOW2360
      XWO = 0.0                                                       FLOW2380
      XIO = 0.0                                                       FLOW2400
      XLO = AMIN1(1.,VOLF/VLO)                                        FLOW2420
      IF(XLO.EQ.1.)  XWO = AMIN1(1.,(VOLO - VLO)/VOLMO)               FLOW2440
      IF(XWO.EQ.1.)  XIO = AMIN1(1.,(VOLO - VLO - VOLMO)/VIO)         FLOW2460
      QQOTO1 = 0.0                                                    FLOW2480
      QQOTO2 = 0.0                                                    FLOW2490
      QQARO = 0.0                                                     FLOW2500
  220 IF(AVO.EQ.0.0)  GO TO 405                                       FLOW2530
        IXIO = 0                                                      FLOW2532
        IF(XIO.EQ.0. .AND. PVALO.GT.PIE)  IXIO = 1                    FLOW2533
      VV = 0.0                                                        FLOW2535
      IF(AVO.NE.AVEO)  VV = CFVO*(1./AVO**2 - 1./AVEO**2)             FLOW2540
      VOLO1 = VOLO                                                    FLOW2550
      J = 2                                                           FLOW2560
      IF(ABS(PVALO - PIE)/PVALO .LE. 0.05)  J = 4                     FLOW2570
C                                                                     FLOW2578
      DO 300  I =1,J                                                  FLOW2580
        WFNSO = 0.0                                                   FLOW2590
        IF(PIE.LT.PVALO .OR. XLO.GT.0.)  GO TO 240                    FLOW2600
            QQOTO2 = 0.0                                              FLOW2620
            QQARO = 0.0                                               FLOW2640
            WFNSO = 0.0                                               FLOW2660
            VOLO = 0.0                                                FLOW2700
            GO TO 400                                                 FLOW2720
  240   SIGNO = SIGN(1.,QQARO)                                        FLOW2740
        IF(-QQOTO2*DTIME .GT. VOLO1)  GO TO 270                       FLOW2750
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      X = RHOO*(LLO*XLO/ALO + LMO*XMO/AMO + LIO*XIO/SAIO)                FLOW2760
     1          /667160.                                                 FLOW2762
C        * * (667160.=32.174*12**4) * *                                  FLOW2764
      Y = YV + SIGNQ*(RFLO*XLO/ALO**2 + RFMO*XMO/AMO**2 +                FLOW2780
     1                RFIO*XIO/SAIO**2)                                  FLOW2782
      IF(XIO.GT.0. .AND. QDOTO2.GE.0.)  Y = Y + YIO                      FLOW2800
      A = RHOO*Y/5337280.                                                FLOW2820
C        * * (5337280.=32.174*2*4*12**4) * *                             FLOW2822
      B = X/DTIME + 2.*A*QDOTO1                                          FLOW2840
      C = QDOTO1*(A*QDOTO1 - X/DTIME) + PIE - PVALO                      FLOW2860
C                                                                        FLOW2880
      QDOTO2 = QUAD(A,B,C,QDOTO2)                                        FLOW2900
        IF(PVALO.GT.PIE)  QDOTO2 = AMAX1(0.,QDOTO2)                      FLOW2910
C                                                                        FLOW2920
     IF(IPPRT.GE.3)  WRITE(6,50)  X,Y,A,B,C,QDOTO1,QDOTO2                FLOW2930
      QBARO = (QDOTO1 + QDOTO2)*DTIME/2.                                 FLOW2940
  256 IF(QBARO)  260,300,320                                             FLOW2960
  260 IF(VOLO1.GE.-QBARO)  GO TO 280                                     FLOW2980
  270     QBARO = -VOLO1                                                 FLOW3000
          QDOTO2 = 2.*QBARO/DTIME - QDOTO1                               FLOW3020
  280 VOLO = VOLO1 + QBARO                                               FLOW3040
      IF(I.EQ.J)  WCUMVO = WCUMVO + QBARO*RHOO/1728.                     FLOW3060
  300 WENSO = 0.0                                                        FLOW3080
      GO TO 340                                                          FLOW3120
C                                                                        FLOW3140
  320 VOLO = VOLO1 + QBARO                                               FLOW3160
      QINJ = AMAX1(0.,VOLO-VFSO)                                         FLOW3180
      VOLO = AMIN1(VFSO,VOLO)                                            FLOW3200
      WENSO = QINJ*RHOO/1728.                                            FLOW3220
      IF(I.EQ.J)  WCUMVO = WCUMVO + QBARO*RHOO/1728.                     FLOW3222
      IF(QINJ.EQ.0.)  GO TO 340                                          FLOW3230
      VENSO = QINJ/(12.*SAIO*DTIME)                                      FLOW3240
      XIO = 1.0                                                          FLOW3246
      XMO = 1.                                                           FLOW3250
      XLO = 1.                                                           FLOW3252
      IF(IXIO) 360,360,370                                               FLOW3254
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C                                                                       FLOW3260
  340   IF(QBARO.EQ.0.)  GO TO 360                                      FLOW3280
        XLO = AMIN1(1.,VOLO/VLO)                                        FLOW3300
        XMO = 0.0                                                       FLOW3320
        IF(XLO.EQ.1.)  XMO = AMIN1(1.,(VOLO - VLO)/VOLMO)               FLOW3340
        XIO = 0.0                                                       FLOW3360
        IF(XMO.EQ.1.)  XIO = (VOLO - VLO - VOLMO)/VIO                   FLOW3380
        IF(IXIO.EQ.1 .AND. XIO.GT.0.)  GO TO 370                        FLOW3390
  360 CONTINUE                                                          FLOW3400
      GO TO 400                                                         FLOW3402
C                                                                       FLOW3404
  370 QBARO = VLO + VOLMO + 0.001*VIO - VOLO1                           FLOW3408
      VOLO = VOLO1 + QBARO                                              FLOW3410
      XIO = 0.001                                                       FLOW3412
      WCUMVO = WCUMVO + QBARO*RHOO/1728.                                FLOW3414
      QDOTO2 = QDOTO1*SAIO/AMO                                          FLOW3416
      WFNSO = 0.                                                        FLOW3418
C                                                                       FLOW3420
  400 QDOTO1 = QDOTO2                                                   FLOW3430
      WFSO = VOLO*RHOO/1728.                                            FLOW3432
  405 CONTINUE                                                          FLOW3436
      IF(IPPRT.GE.2)  WRITE(6,410)  XLF, XMF, XIF, WCUMVF, AVF, WFSF,   FLOW3440
     1                              XLO, XMO, XIO, WCUMVO, AVO, WFSO    FLOW3442
  410 FORMAT(5H     XLF= F6.3, 5H XMF= F6.3, 5H XIF= F6.3,               FLOW3450
     1       8H WCUMVF= 1PE12.5, 5H AVF=  F10.3, 6H WFSF=  E10.3 /      FLOW3452
     2      4X 4HXLO= 0PF6.3, 5H XMO= F6.3, 5H XIO= F6.3,               FLOW3454
     3       8H WCUMVO= 1PF12.5, 5H AVO=  E10.3, 6H WFSO=  E10.3 )      FLOW3456
      RETURN                                                            FLOW3480
      END                                                               FLOW3500
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      SUBROUTINE  BOIL                                                      BOIL0010
C                                                                           BOIL0020
      COMMON  /PULDYC/ COEHTH, COEHTC, TCWSS, QSBFSS, QSBOSS                BOIL0060
      COMMON  /SVV/ADUM(9), MTVF, BDUM(5), MTVO, TXF, TXO, LMBDEF, LMBDEO   BOIL0080
      COMMON  /PULCOM/ N, IIGN, DTIME, TIMF, TAMB, EDUM(8), INITB,          BOIL0100
     1                 EDUM(5), PIE, GDUM(4), AVF, AVO                      BOIL0102
     2               , STOPW, IPPRT, GDUM1(10), TFSBF, TFSBO                BOIL0104
      COMMON  /PULFED/ TLF, TLO, CDUM(96), AMF, D1, D2, AMO, D4, D5,        BOIL0120
     6          SAIF, LIF, RFIF, SAIO, LIO, RFIO, CFIF, CFIO,              BOIL0122
     7          DIMPF, DIMPO, VFSF, VFSO                                   BOIL0124
      COMMON  /IGNFED/ TDFPF, CPLF, TDFPO, CPLO, NRHOF, NRHOO, DDUM(2),     BOIL0140
     1                 TTRLF(12), TRHOF(12), TTRLO(12), TRHOO(12)           BOIL0142
      COMMON  /IGNGOF/ WFNSF, VFNSF, TFNSF, SUMSPF, WGFCUM, WFSF,           BOIL0160
     1                 WFNSO, VFNSO, TFNSO, SUMSPO, WGOCUM, WFSO,           BOIL0162
     2                 TGAS, RLF, RLO                                       BOIL0164
      COMMON  /PCOM1/  PCDUM(12), CXFRAC, TIA, TWALL2                       BOIL0170
      DIMENSION  RK(4)                                                      BOIL0300
      REAL       LMBDEF,LMBDEO,MTVF,  MTVO                                  BOIL0320
C                                                                           BOIL0325
      IF(INITB.NE.1)  GO TO 100                                             BOIL0330
      INITB = 0                                                             BOIL0335
C                                                                           BOIL0340
        TFSF = TLF                                                          BOIL0350
        TFMAX = AMAX1(TTRLF(1),TTRLF(NRHOF))                                BOIL0351
        RLF = YOF(TFSF,TTRLF,TRHOF,NRHOF,2)                                 BOIL0352
        PFSF = PFNCTF(TFSF)                                                 BOIL0355
        RHOVF = 144.*PFSF*MTVF/(1545.*TFSF)                                 BOIL0360
        RLFPF = YOF(TDFPF,TTRLF,TRHOF,NRHOF,2)                              BOIL0365
        PVFPF = PFNCTF(TDFPF)                                               BOIL0368
        XVF = 0.0                                                           BOIL0370
        XVPF = 0.0                                                          BOIL0375
        CDF = SQRT(1./(CFIF*(1.-(SAIF/AMF)**2)))                            BOIL0376
C        772.18 = 2*32.174*12                                               BOIL0378
        COEFF = CDF*SAIF*SQRT(772.18/VFSF)                                  BOIL0380
C                                                                           BOIL0385
        TFSO = TLO                                                          BOIL0395
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      TOMAX = AMAX1(TTRLO(1),TTRLO(NRHOO))                                  BOIL0396
      RLO = YOF(TFSO,TTRLO,TRHOO,NRHOO,2)                                   BOIL0398
      PFSO = PFNCTO(TFSO)                                                   BOIL0400
      WOVO = 144.*PFSO*MTVO/(1545.*TFSO)                                    BOIL0405
      RLFPO = YOF(TDFPO,TTRLO,TRHOO,NRHOO,2)                                BOIL0410
      PVFPO = PFNCTO(TDFPO)                                                 BOIL0412
      XVO = 0.0                                                             BOIL0415
      XVPO = 0.0                                                            BOIL0420
      CDO = SQRT(1./(CFIO*(1.-(SAIO/AMO)**2)))                              BOIL0422
      COEFO = CDO*SAIO*SQRT(772.18/VFSO)                                    BOIL0425
C                                                                           BOIL0428
  100 IF(AVF.GT.0. .OR. WFSF.LE.0.)  GO TO 350                              BOIL0430
      T = TFSF                                                              BOIL0431
      TFS = TAMB + (TFSBF-TAMB)*(TWALL2-TAMB)/(TCWSS-TAMB)                  BOIL0432
      QSBF = QSBFSS*(1.-0.95*XVF)*AMAX1(0.,(TFS-T)/(TFSBF-TLF))             BOIL0434
      T = T + QSBF*DTIME/(CPLF*WFSF)                                        BOIL0436
        T = AMIN1(T,TFMAX)                                                  BOIL0438
      P = PFNCTF(T)                                                         BOIL0440
      RLF1 = RLF                                                            BOIL0442
      WF1 = WFSF                                                            BOIL0444
        RL = YOF(T,TTRLF,TRHOF,NRHOF,2)                                     BOIL0446
        IF(RL.LT.1728.*WFSF/VFSF .AND. PIE.GT.P)  WFSF = RL*VFSF/1728.      BOIL0448
      IF(PIE.GT.P)  GO TO 300                                               BOIL0460
C                                                                           BOIL0520
C * * * SOLUTION FOR FUEL FEED-SYSTEM PARAMETERS, USING RUNGE-KUTTA 4TH     BOIL0540
C       ORDER SCHEME FOR TEMPERATURE.                                       BOIL0542
C                                                                           BOIL0544
      RK(1) = (QSBF/WFSF - LMBDEF*XVPF)*DTIME/CPLF                          BOIL0560
      C = 0.5                                                               BOIL0580
C                                                                           BOIL0600
      DO 200  I=1,4                                                         BOIL0620
        IF(I.EQ.3)  C = 1.0                                                 BOIL0640
        IF(I.LE.3)  T = TFSF + C*RK(I)                                      BOIL0660
        P = PFNCTF(T)                                                       BOIL0680
        P = AMAX1(P,PIE)                                                    BOIL0690
        WV = 144.*P*MTVF/(1545.*T)                                          BOIL0700
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      RL = YOF(T,TTRLF,TRHOF,NRHOF,2)                                    BOIL0720
      W = (SQRT(WFSF) - COEFF*C*DTIME*SQRT((P-PIE)/4.))**2               BOIL0740
      RVP = (RV - RHOVF)/(C*DTIME)                                       BOIL0760
      RMP = -COEFF*SQRT(W*(P-PIE))*1728./VFSF                            BOIL0780
      XVP = (RMP-XVF*RVP-(1.-XVF)*(RL-RLF1)/DTIME) / (RV-RL)             BOIL0800
      IF(I.LE.3)  RK(I+1) = DTIME*(QSBF/W - LMBDEF*XVP)/CPLF             BOIL0820
      IF(I.EQ.3)  T = TFSF + (RK(1)+2.*RK(2)+2.*RK(3)+RK(4))/6.          BOIL0840
      T = AMIN1(T,TFMAX)                                                 BOIL0850
  200 CONTINUE                                                           BOIL0860
C                                                                        BOIL0868
      IF(T.GE.TDFPF)  GO TO 210                                          BOIL0870
      T = TDFPF                                                          BOIL0872
      RL = RLFPF                                                         BOIL0874
      DWF = QSPF*DTIME/LMBDEF                                            BOIL0876
      W = WF1 - DWF                                                      BOIL0878
      P = AMAX1(PVFPF,PIE)                                               BOIL0880
      RV = 144.*P*MTVF/(1545.*T)                                         BOIL0882
      RVP = (RV-RHOVF)/DTIME                                             BOIL0884
      RMP = -COEFF*SQRT(W*(P-PIE))*1728./VFSF                            BOIL0886
      XVP = (RMP-XVF*RVP)/(RV-RL)                                        BOIL0890
C                                                                        BOIL0920
  210 RHOVF = RV                                                         BOIL0940
      WFSF = W                                                           BOIL0960
      XVPF = XVP                                                         BOIL0980
      XVF = (RL - 1728.*W/VFSF)/(RL - RV)                                BOIL1000
      IF(XVF.LT.0.99)  GO TO 300                                         BOIL1002
        XV = 1.                                                          BOIL1004
        WFSF = 0.                                                        BOIL1006
  300 DWF = WF1 - WFSF                                                   BOIL1010
      WOFCUM = WOFCUM + XVF*DWF                                          BOIL1012
      WFNSF = (1.-XVF)*DWF                                               BOIL1014
      SUMSPF = SUMSPF + WFNSF                                            BOIL1016
      VFNSF = 0.0                                                        BOIL1020
      IF(WFSF.GT.0.0)  VFNSF = 2.*VFSF*(WF1-WFSF)/(12.*DTIME*            BOIL1022
     1                         SAIF*(WF1+WFSF))                        BOIL1024
      TFNSF = (T + TFSF)/2.                                              BOIL1030
```

```
      TFSF = T                                                          BOIL1040
      RLF = RL                                                          BOIL1042
C                                                                       BOIL1050
  350 IF(AVO.GT.C. .OR. WFSO.LE.0.)  GO TO 550                          BOIL1060
      T = TFSO                                                          BOIL1061
      TFS = TAMB + (TFSBO-TAMB)*(TWALL2-TAMB)/(TCWSS-TAMB)              BOIL1064
      QSBO = QSBOSS*(1.-0.95*XVO)*AMAX1(0.,(TFS-T)/(TFSBO-TLO))         BOIL1066
      T = T + QSBO*DTIME/(CPLO*WFSO)                                    BOIL1070
        T = AMIN1(T,TOMAX)                                              BOIL1072
      P = PFNCTO(T)                                                     BOIL1080
      RLO1 = RLO                                                        BOIL1088
      WO1 = WFSO                                                        BOIL1090
        RL = YOF(T,TTRLO,TRHOO,NRHOO,2)                                 BOIL1092
        IF(RL.LT.1728.*WFSO/VFSO .AND. PIE.GT.P)  WFSO = RL*VFSO/1728.  BOIL1094
      IF(PIE.GT.P)  GO TO 500                                           BOIL1100
C                                                                       BOIL1120
C * * * SOLUTION FOR OXIDIZER FEED-SYSTEM PARAMETERS.                  BOIL1140
                                                                        BOIL1142
      RK(1) = (QSBO/WFSO - LMBDEO*XVPO)*DTIME/CPLO                      BOIL1160
      C = 0.5                                                           BOIL1180
C                                                                       BOIL1200
      DO 400  I=1,4                                                     BOIL1220
        IF(I.EQ.3)  C = 1.0                                             BOIL1240
        IF(I.LE.3)  T = TFSO + C*RK(I)                                  BOIL1260
        P = PFNCTO(T)                                                   BOIL1280
        P = AMAX1(P,PIE)                                                BOIL1290
        RV = 144.*P*VTVO/(1545.*T)                                      BOIL1300
        RL = YOF(T,TTRLO,TRHOO,NRHOO,2)                                 BOIL1320
        W = (SQRT(WFSO) - COEFO*C*DTIME*SQRT((P-PIE)/4.))**2            BOIL1340
        RVP = (RV - RHOVO)/(C*DTIME)                                    BOIL1360
        RWP = -COEFO*SQRT(W*(P-PIE))*1728./VFSO                         BOIL1380
        XVP = (RWP-XVO*RVP-(1.-XVO)*(RL-RLO1)/DTIME) / (RV-RL)          BOIL1400
        IF(I.LE.3)  RK(I+1) = DTIME*(QSBO/W - LMBDEO*XVP)/CPLO          BOIL1420
        IF(I.EQ.3)  T = TFSO + (RK(1)+2.*RK(2)+2.*RK(3)+RK(4))/6.       BOIL1440
        T = AMIN1(T,TOMAX)                                              BOIL1450
  400 CONTINUE                                                          BOIL1460
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```
C                                                                       BOIL1468
      IF(T.GE.TOFPO)  GO TO 410                                         BOIL1470
        T = TOFPO                                                       BOIL1472
        RL = RLFPO                                                      BOIL1474
        DWO = QSLO*DTIME/LMBOED                                         BOIL1476
        W = WO1 - DWO                                                   BOIL1478
        P = AMAX1(PVFPO,PIE)                                            BOIL1480
        RV = 144.*P*WTVO/(1545.*T)                                      BOIL1482
        RVP = (RV-RHOVO)/DTIME                                          BOIL1484
        PWP = -COEFO*SQRT(W*(P-PIE))*1728./VFSO                         BOIL1486
        XVP = (PWP-XVO*RVP)/(RV-RL)                                     BOIL1488
C                                                                       BOIL1520
  410 RHOVO = RV                                                        BOIL1540
      WFSO = W                                                          BOIL1560
      XVPO = XVP                                                        BOIL1580
      XVO = (RL - 1728.*W/VFSO)/(RL - RV)                               BOIL1600
      IF(XVO.LT.0.99)  GO TO 500                                        BOIL1602
        XVO = 1.                                                        BOIL1604
        WFSO = 0.                                                       BOIL1606
  500 DWO = WO1 - WFSO                                                  BOIL1610
      WGOCUM = WGOCUM + XVO*DWO                                         BOIL1612
      WENSO = (1.-XVO)*DWO                                              BOIL1614
      SUMSPO = SUMSPO + WENSO                                           BOIL1616
      VENSO = 0.0                                                       BOIL1620
      IF(WFSO.GT.0.0)  VENSO = 2.*VFSO*(WO1-WFSO)/(12.*DTIME*           BOIL1622
     1                         SAIO*(WO1+WFSO))                         BOIL1624
      TENSO = (T + TFSO)/2.                                             BOIL1630
      TFSO = T                                                          BOIL1640
      RLO = RL                                                          BOIL1642
C                                                                       BOIL1650
  550   IF(IPRNT.GE.2)  WRITE(6,600)  WFSF,TFSF,XVF, WFSO,TFSO,XVO      BOIL1660
  600 FORMAT( 7H  WFSF= 1PE11.4, 7H  TFSF= 0PF7.1,6H  XVF= F7.4,        BOIL1670
     1        7H  WFSO= 1PE11.4, 7H  TFSO= 0PF7.1,6H  XVO= F7.4)      BOIL1672
C                                                                       BOIL1800
      QXFSAC = WGOCUM/(WGOCUM+WGFCUM)                                   BOIL1810
      RETURN                                                            BOIL1820
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      END                                                                BOIL1840


      SUBROUTINE PULPRT                                                  PPRT0010
C                                                                        PPRT0020
      COMMON /SVV/ NP, NAP, NMP, DUM1(5), MTDF, MTVF, DUM2(4), MTDD,     PPRT0030
     1            MTVD, TXF, TXC, LMPDEF, LMBDEO, DUM3(18),              PPRT0040
     2            WDSSF, WDSSO, DUM4(19), NEPS, PAMB, AEXIT, ECFVAC,     PPRT0050
     3            NWALM, ECSTPI, PNSSS, PIESS, RVAPF, RVAPO              PPRT0060
      COMMON /CONVV/ JTAPE, NREC, ICRTSD, VCLC, AT, LCHAM, DCHAM,        PPRT0070
     1 AMCHAM, WGCHAM, ESISS, ECSSS, ECFSS, FSS, SIMPSS, CSTRSS,         PPRT0072
     2 CFSS                                                              PPRT0074
      COMMON /PULFLD/ TLF, TLO, VVALF, VVALO, NTVEF, NTVEO, NTVDEF,      PPRT0090
     * NTVDEO, TTVEF(9), TAVEF(9), TTVEO(9), TAVEO(9),                   PPRT0100
     1 TTVDEF(9), TAVDEF(9), TTVDEO(9), TAVDEO(9),                       PPRT0110
     2 AVEF, CEVF, AOVEF, AIVEF, AOVDEF, AIVDEF,                        PPRT0120
     3 AVEO, CEVO, AOVEO, AIVEO, AOVDEO, AIVDEO,                        PPRT0130
     4 ALF, LLF, RFLF, ALO, LLO, RFLO,                                  PPRT0140
     5 AMF, LMF, RFMF, AMO, LMO, RFMO,                                  PPRT0150
     6 SAIF,LIF, RFIF, SAIO,LIO, RFIO, CFIF, CFIO,                      PPRT0160
     7 SIMPF, SIMPO, VFSF, VFSO, IPOIL, EPS,                            PPRT0170
     8 VLF, VOLMF, VIF, VLO, VOLMO, VIO                                 PPRT0180
      COMMON /PULCOM/ N,      IIGN,   DTIMF,  TIME,   TAMB,   PBARSS,   PPRT0190
     1                RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,   PPRT0200
     2                NFIRST, INITS,  ISTART, TOFF,   TLAST,  COMB,     PPRT0210
     3                ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,    PPRT0220
     4                AVF,    AVO,    STDPW                             PPRT0230
      COMMON /PCOM1/  SUMIMP, TRISE, TIRISE, TRISE2, TDROP, TIDROP,     PPRT0240
     1 POWER, PWIDTH, OFFI, OFF2,  NS, THRUST, CXFRAC, TIA,             PPRT0250
     2 TWALL2, TWALLM, SUMPC, SUMPCA, TITAIL, TWALL, TAUICN             PPRT0260
      COMMON /PCYCOM/  PCMAT(36),      NSEC,   ISEQ,   NPS,    JPAGE,  PPRT0270
     1                 CFFA,   CFFP,   CFFC,   IP                       PPRT0272
      TVEF = AOVEF + AIVEF*VVALF                                         PPRT0310
      TVEO = AOVEO + AIVEO*VVALO                                         PPRT0320
      TTOEF = VOF(0.9994,TAVEF,TTVEF,NTVEF,2)                            PPRT0330
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      TTSEC = YSF(0.9999,TAVEC,TTVEC,NTVEC,2)                                  PPRT0340
      TVDEF = A0VDEF + A1VDEF*VVALF                                            PPRT0350
      TVDEC = A0VDEC + A1VDEC*VVALC                                            PPRT0360
      TTSDEF = YSF(0.0001,TAVDEF,TTVDEF,NTVDEF,2)                              PPRT0370
      TTSDEC = YSF(0.0001,TAVDEC,TTVDEC,NTVDEC,2)                              PPRT0380
      TLEADF = TVEC - TVEF                                                     PPRT0390
      TLEADC = -TLEADF                                                         PPRT0400
      TVEFF = TVEF + TTSEF                                                     PPRT0410
      TVEFC = TVEC + TTSEC                                                     PPRT0420
      WCUMV = WCUMVF + WCUMVC                                                  PPRT0430
      RMIX = WCUMVC/WCUMVF                                                     PPRT0440
      SPIMP = SUMIMP/WCUMV                                                     PPRT0450
      ESISS = AT*SUMPC*32.174/WCUMV                                            PPRT0452
      ESPIMP = ESISS*SPIMP/SIMPSS                                              PPRT0460
      EPULSE = SPIMP/SIMPSS                                                    PPRT0470
      IF(N.LE.0)  WRITE(6,90) ISEC, IP                                         PPRT0480
   90   FORMAT(1H1 45X 18HPULSE  PERFORMANCE / 42X 19HDUTY CYCLE SEQUENCPPRT0482
     1E  I6 / 50X  9HPULSE NO. I5 //)                                          PPRT0484
      IF(N.GT.0)  WRITE(6,100)                                                 PPRT0490
  100   FORMAT(1H1 45X 18HPULSE  PERFORMANCE / 43X 23HSTANDARD PULSE SEQPPRT0492
     1UENCE //)                                                                PPRT0494
      WRITE(6,110)  TSTART, PVALF, PWIDTH, PVALC, TLF                          PPRT0510
  110 FORMAT(                                                                  PPRT0520
     1 4X 17HTIME AT ON-SIGNAL 13X 4HMSEC3PF15.3,4X19HFUEL INLET PRESSURPPRT0530
     2F11.4 4HPSIA3PF15.2/  4X 28HDURATION (ON-SIG TO OFF-SIG) 2X 4HMSEC PPRT0540
     3 F15.1, 4X 19HOXID INLET PRESSURE11X 4HPSIA F15.2 / 57X 22HFUEL INPPRT0550
     4LET TEMPERATURE 8X 1HR F18.1 )                                           PPRT0560
      WRITE(6,120) TLC, PVSSS, AT, FSS, AEXIT, CSTRSS, PAMB, ECSSS, OFF1PPRT0580
  120 FORMAT(4X 12HSTEADY-STATE 39X 22HOXID INLET TEMPERATURE 8X 1HP    PPRT0590
     1 F16.1 / 4X 16HCHAMBER PRESSURE 14X 4HPSIA 1PE15.4,4X 11HTHROAT ARPPRT0600
     2EA 19X 5HSQ IN E14.4 / 4X 6HTHRUST 24X 3HLBF E16.4,4X 16HNOZZLE EXPPRT0610
     3IT AREA 14X 5HSQ IN E14.4 / 4X 6HC-STAR 24X 6HFT/SEC 0PF13.1, 4X  PPRT0620
     4 20HNOZZLE EXIT PRESSURE 10X 4HPSIA 1PE15.4 / 6X 10HEFFICIENCY 18XPPRT0622
     5 3HPCT 2PF16.2, 4X 34HOFF-PERIOD PRECEDING PULSE    MSEC 0PF15.1) PPRT0624
      WRITE(6,122) CFSS, OFF2, ECFSS, SIMPSS, TWALL2, ESISS                    PPRT0630
  122 FORMAT(4X 18HTHRUST COEFFICIENT 12X F19.4, 4X 34HOFF-PERIOD FOLLOWPPRT0640
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     1INC PULSE     MSEC  F15.1 / 6X 10HEFFICIENCY 18X 3HPCT 2PF16.2, 4X PPRT0642
     2 29HCHAMBER WALL TEMP AT OFF- / 4X 16HSPECIFIC IMPULSE 14X        PPRT0644
     3 11HLBF-SEC/LBM  OPF8.2, 6X 29HSIGNAL (80IL-OFF PARAMETER) R F18.0PPRT0646
     4 / 6X 10HEFFICIENCY  18X 3HPCT 2PF16.2 // )                       PPRT0648
      WRITE(6,130) VVALF, VVALO, TVEF, TVEO, TLEADF, TLEADO, TTREF,     PPRT0670
     1 TTREO, TVEFF, TVLFO, TVDEF, TVDEO, TTRDEF, TTRLEO,WCUMVF,WCUMVO  PPRT0680
130  FORMAT(4X 10HFUEL VALVE 43X 10HOXID VALVE /  2(4X15HAPPLIED VOLTAGPPRT0690
     1F 15X 5HVOLTS F14.2) / 2(4X 18HCOIL ENERGIZE TIME 12X 4HMSECF15.3)PPRT0700
     2 / 2(4X 19HLEAD (OR LAG) TIME 12X 4HMSEC F15.3) / 2(4X 19HOPENING PPRT0710
     3TRAVEL TIME 11X 4HMSEC F15.3) / 2(4X 22HON-SIGNAL TO FULL OPEN 8X PPRT0720
     4 4HMSEC F15.3) / 2(4X 21HCOIL DE-ENERGIZE TIME 9X 4HMSEC F15.3) / PPRT0730
     5 2(4X 19HCLOSING TRAVEL TIME 11X 4HMSEC F15.3)  /                 PPRT0740
     6 4X 15HTOTAL FUEL FLOW 15X 3HLBM 1PE16.4,4X 15HTOTAL OXID FLOW 15XPPRT0750
     7 3HLBM E16.4 ///)                                                 PPRT0760
      WRITE(6,140) TRISE,SUMIMP, TIRISE, WCUMV, TRISE2, RMIX            PPRT0770
140  FORMAT(4X 25HTRANSIENT CHARACTERISTICS 28X 19HOVERALL PERFORMANCE  PPRT0780
     1 / 4X 24HRISE (ON-SIG TO 90 PCT) TIME 2X 4HMSEC F15.3,4X 13HTOTAL PPRT0790
     2IMPULSE 17X 7HLBF-SEC 1PE12.4 / 4X 18HRISE TOTAL IMPULSE 12X 7HLBFPPRT0800
     3-SEC E12.4, 4X 21HTOTAL PROPELLANT FLOW 9X 3HLBM E16.4 / 4X       PPRT0810
     4 24HRISE (10 TO 90 PCT) TIME 6X 4HMSEC OPF15.3,4X 24HMEAN MIXTURE PPRT0820
     5RATIO (O/F) 6X F14.3 )                                            PPRT0830
      WRITE(6,150) TDROP, SPIMP, TIDROP, ESPIMP, POVER, EPULSE          PPRT0840
150  FORMAT(4X 30HDROP (OFF-SIG TO 10 PCT) TIME ,4HMSEC F15.3, 4X       PPRT0850
     1 21HMEAN SPECIFIC IMPULSE 9X11HLBF-SEC/LBM F8.2 / 4X 18HDROP TOTALPPRT0860
     2 IMPULSE 12X 7HLBF-SEC 1PE12.4, 4X 27HSPECIFIC IMPULSE EFFICIENCY PPRT0870
     3 3X 3HPCT 2PF16.3 / 4X 18HPRESSURE OVERSHOOT 12X 3HPCT F16.3, 4X  PPRT0880
     4 27HPULSING TO S-S EFFICIENCY 5X 3HPCT F16.3)                     PPRT0890
      WRITE(6,160)  TITAIL, PCSTAR, TWALLM                              PPRT0900
160  FORMAT(4X 22HTAIL-OFF TOTAL IMPULSE 8X 7HLBF-SEC  1PE12.4, 4X      PPRT0910
     1 11HMEAN C-STAR 19X 6HFT/SEC  0PF13.1 /                           PPRT0920
     2 47X 22HMEAN CHAMBER WALL TEMP 8X 1HR  F18.0)                     PPRT0930
        RETURN                                                          PPRT0970
      END                                                               PPRT0980
```

P U L S E SUBPROGRAM BLOCK

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      SUBROUTINE  PULPLT                                                        PPLT0010
      COMMON  /SAVEC/ TIMES(1000), PNSP(1000), THRUSP(1000), OXFRP(1000)PPLT0020
     1         ,WOFP(1000), WDOP(1000)                                          PPLT0022
      COMMON  /PULCOM/ MN,     IIGN,   DTIME,  TIME,   TAMB,   PBARSS,  PPLT0030
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,  PPLT0032
     2                 NFIRST, INITB,  TSTART, TOFF,   TLAST,  COMB,    PPLT0034
     3                 ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,   PPLT0036
     4                 AVF,    AVO,    STDPW,  IPPRT,  ICRTP            PPLT0038
C                                                                           PPLT0200
      YMAX = 0.                                                             PPLT0210
      N = MN+1 - NFIRST                                                     PPLT0220
        N = MIN0(1000,N)                                                    PPLT0230
        DO 10 I=1,N                                                         PPLT0250
   10   YMAX = AMAX1(YMAX,PNSP(I),THRUSP(I))                                PPLT0260
      CALL  LOGIC(0,TIMES(1),TIMES(N),0.,YMAX, 24,0,24,45, IR)              PPLT0320
      CALL  LINEG(N,TIMES,PNSP,1,1,1)                                       PPLT0330
      CALL  LINEG(N,TIMES,THRUSP,1,1,2)                                     PPLT0340
      J1 = MAX0(1,N/4)                                                      PPLT0350
      J2 = 2*J1                                                             PPLT0360
      CALL APLOTV(N,TIMES,PNSP,1,1,1,42,IR)                                 PPLT0362
      CALL APLOTV(N-J1,TIMES(J1),PNSP(J1),J2,J2,1,39,IR)                    PPLT0370
      CALL APLOTV(N-J2,TIMES(J2),THRUSP(J2),J2,J2,1,51,IR)                  PPLT0380
      CALL  PITE2V(469,4,1023,90,2,9,1,9HTIME (MS), IL)                     PPLT0390
      CALL  PITE2V(9,797,1023,180,2,27,1,27HREDUCED THRUST AND PRESSURE,PPLT0400
     * IL)                                                                  PPLT0410
      YMAX = 0.                                                             PPLT0420
        DO 40 I=1,N                                                         PPLT0430
   40   YMAX = AMAX1(YMAX,WOFP(I),WDOP(I),OXFRP(I))                         PPLT0440
      CALL  LOGIC(0,TIMES(1),TIMES(N),0.,YMAX, 24,0,24,45, IR)              PPLT0450
      CALL  LINEG(N,TIMES,WOFP,1,1,2)                                       PPLT0460
      CALL  LINEG(N,TIMES,WDOP,1,1,1)                                       PPLT0470
      CALL  LINEG(N,TIMES,OXFRP,1,1,2)                                      PPLT0480
      J3 = (J1+J2)/2                                                        PPLT0490
      CALL APLOTV(N,TIMES,WDOP,1,1,1,42,IR)                                 PPLT0492
      CALL APLOTV(N-J1,TIMES(J1),WOFP(J1),J2,J2,1,22,IR)                    PPLT0500
      CALL APLOTV(N-J2,TIMES(J2),WDOP(J2),J2,J2,1,38,IR)                    PPLT0510
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```
      CALL APLOTV(K-J3,TIMES(J3),OXFRP(J3),J2,J2,1,36,IR)                PPLT0520
      CALL  @ITE2V(469,9,1023,9C,2,9,1,9HTIME (MS), IL)                  PPLT0530
      CALL  @IT&2V(9,100,1023,180,2,45,1,                                PPLT0540
     1       45HREFERENCES INJECTION FLOWRATES AND OXID FRACTION, IL)    PPLT0550
C                                                                        PPLT0900
      @ETURN                                                             PPLT0910
      END                                                                PPLT0920



      SUBROUTINE  TCSAV(K)                                               TCSAV010
      COMMON  /SAVEC/ TIMES(1000), PNSP(1000), THRUSP(1000), OXFRP(1000)TCSAV020
     1       ,WOSP(1000), WOOP(1000)                                     TCSAV030
      COMMON  /CONS / JTAPL, NREC, ICPTSD, VOLC, AT, LCHAM, DCHAM,       TCSAV040
     1        AMCHAM, WCSCHAM, FSISS, FCSSS, ECFSS, FSS, SIMPSS, CSTRSS,TCSAV050
     2        CFSS, OXFSS,                                               TCSAV060
      COMMON  /PULCOM/ M,      IIGN,   DTIME,  TIME,   TAMB,   PRARSS,   TCSAV070
     1                 MPCIN,  RPCNS,  NSPACE, NTHALL, INITTC, INITCG,  TCSAV080
     2                 MFIRST, INITP,  TSTART, TOFF,   TLAST,  COMB,    TCSAV090
     3                 ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,   TCSAV100
     4                 AVF                                              TCSAV110
      COMMON  /PCOM1/  SUMIMP, TRISE, TIRISE, TRISE2, TDROP, TIDROP,     TCSAV120
     1        PCVFR, PWIDTH, OFF1, OFF2, PNS, THRUST, OXFRAC, TIA        TCSAV130
     2      , TWALL2, TWALLM, SUMPC, SUMPC4, TITAIL                      TCSAV140
      COMMON  /COMCOF/  WFNSF, VFNSF, TFNSF, SUMSPF, WOFCUM, WFSS,       TCSAV150
     1                  WFNSO, VFNSO, TFNSO, SUMSPO, WOOCUM, WFSO, TCSS TCSAV160
      COMMON  /SVV/ SVVD1(36), WDSSF, WDSSO, SVVD2(25), PNSSS            TCSAV170
C                                                                        TCSAV300
   10   K = K + 1                                                       TCSAV500
        IF(K.GT.1000)  RETURN                                           TCSAV504
      TIMES(K) = TIME*1000.                                             TCSAV510
      PNSP(K) = PNS/PNSSS                                               TCSAV520
      THRUSP(K) = THRUST/FSS                                            TCSAV530
      OXFRP(K) = OXFRAC/OXFRSS                                          TCSAV540
      WOFP(K) = WFNSF/(DTIME*WDSSF)                                     TCSAV550
      WOOP(K) = WFNSO/(DTIME*WDSSO)                                     TCSAV560
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      RETURN                                                                TCSAV950
      END                                                                   TCSAV960



      FUNCTION  PFNCTF(T)                                                   PVFU0020
C                                                                           PVFU0040
      COMMON  /SCRFEQ/ DUM1(6), NPVAPF, DUM2(49), TTPVF(12), TPVAPF(12)     PVFU0060
      DIMENSION  TLNPVF(12)                                                 PVFU0080
      REAL       LNPVF                                                      PVFU0100
      DATA  NLN / 0 /                                                       PVFU0120
C                                                                           PVFU0140
      IF(NLN.GT.0)  GO TO  40                                               PVFU0160
      NLN = 1                                                               PVFU0180
      DO 20  I=1,NPVAPF                                                     PVFU0200
   20 TLNPVF(I) = ALOG(TPVAPF(I))                                           PVFU0220
C                                                                           PVFU0240
   40 LNPVF = VDF(T,TTPVF,TLNPVF,NPVAPF,2)                                  PVFU0260
      PFNCTF = EXP(LNPVF)                                                   PVFU0280
C                                                                           PVFU0300
      RETURN                                                                PVFU0320
      END                                                                   PVFU0340



      FUNCTION  PFNCTC(T)                                                   PVCX0020
C                                                                           PVCX0040
      COMMON  /SCRFEQ/ DUM1(7), NPVAPC,DUM2(72), TTPVC(12), TPVAPC(12)      PVCX0060
      DIMENSION  TLNPVC(12)                                                 PVCX0080
      REAL       LNPVC                                                      PVCX0100
      DATA  NLN / 0 /                                                       PVCX0120
C                                                                           PVCX0140
      IF(NLN.GT.0)  GO TO 40                                                PVCX0160
      NLN = 1                                                               PVCX0180
      DO 20  I=1,NPVAPC                                                     PVCX0200
   20 TLNPVC(I) = ALOG(TPVAPC(I))                                           PVCX0220
```

```
C                                                                       PVOX0240
   40 LNPVO = YOR(T,TTPVO,TLNPVO,NPVAPO,2)                              PVOX0260
      PRNCIO = EXP(LNPVO)                                               PVOX0280
C                                                                       PVOX0300
      RETURN                                                            PVOX0320
      END                                                               PVOX0340


      SUBROUTINE  PUNDCX                                                PUND0010
      COMMON  /PUNIC/ NSEC, CIO                                         PUND0020
      COMMON  /SVV/ NP, NAP, NMP, DUM1(5), MTDF, MTVF, DUM2(4), MTDO,   PUND0030
     1              MTVO, TXF, TXO, LMBDEF, LMBDEO, DUM3(18),           PUND0040
     2              WDSSF, WDSSO, DUM4(19), NEPS, PAMB, AEXIT, ECFVAC,  PUND0050
     3              NMACH, FCSTR1, PNSSS, PIESS, RVAPF, RVAPO           PUND0060
      COMMON  /COMPM/ JTARE, NREC, ICRTSO, VOLC, AT, LCHAM, DCHAM,      PUND0070
     1         AWCHAM, WOCHAM, ESISS, FCSSS, ECFSS, FSS, STMPSS, CSTRSS,PUND0072
     2         CFSS, OXFRSS, HTLOSS                                     PUND0074
      COMMON  /PULFEO/ TLF, TLO, VVALF, VVALO, NTVEF, NTVEO, NTVDEF,    PUND0090
     1         NTVDEO, TTVEF(9), TAVEF(9), TTVEO(9), TAVEO(9),          PUND0092
     1         TTVDEF(9), TAVDEF(9), TTVDEO(9), TAVDEO(9),              PUND0094
     2         AVEF, CHVF, AOVEF, A1VEF, AOVDEF, A1VDEF,                PUND0096
     3         AVEO, CHVO, AOVEO, A1VEO, AOVDEO, A1VDEO                 PUND0098
      COMMON  /PULBYC/  COEHTH, COEHTC, TCWSS, QSBFSS, QSBOSS, TGASSS,  PUND0120
     1         PSPACE(12),  TTWALL(6),  TWF(12,6),  TWO(12,6),          PUND0122
     2         TTIA(12,6), TTIB(12,6), TTRISE(12,6), TTIRIS(12,6),      PUND0124
     3         TTRIS2(12,6), TTDROP(12,6), TTIDRP(12,6), TPOVER(12,6),  PUND0126
     4         TTITAL(12,6), TIPDTA(12,6), TIPDTB(12,6)                 PUND0128
      COMMON  /PULCOM/ N,       IIGN,    OTIME,   TIME,    TAMB,    PBARSS,  PUND0190
     1                 RPCIN,   RPCNB,   NSPACE, NTWALL, INITTC, INITGG,  PUND0200
     2                 NFIRST,  INITB,   TSTART, TOFF,    TLAST,   COMB,   PUND0210
     3                 ISPACE,  PIE,     WCUMVF, WCUMVO, PVALF,   PVALO,   PUND0220
     4                 AVF,     AVO,     STDPW                           PUND0230
      DATA   CIO1, BLANK/ 4HPUND, 0./                                   PUND0300
      CIO = CIO1                                                        PUND0310
      NSEO = 1000                                                       PUND0320
```

```
      WRITE(6,10)                                                          PUND0330
   10 FORMAT(1H1 27X 36HPUNCHED CARD OUTPUT FOR  D C Y C L E /)            PUND0340
      WRITE(6,20)  NSPACE, NTWALL, NTVEF,  NTVEO,  NTVDEF, NTVDEO,        PUND0350
     1             CID,    NSEQ                                          PUND0360
   20 FORMAT(10X 6I12, A4, I4)                                            PUND0370
        PUNCH 30,  NSPACE, NTWALL, NTVEF,  NTVEO,  NTVDEF, NTVDEO,        PUND0380
     1             CID,    NSEQ                                          PUND0390
   30   FORMAT(  6I12, A4, I4)                                            PUND0400
      CALL PUN1( STDPW,  HTLOSS, TGASSS, TCWSS,  COEHTH, COEHTC )        PUND0410
      CALL PUN1( TAMB,    PAMB,   TLO,    TLF,    PVALF,  PVALO )        PUND0420
      CALL PUN1( VVALF,  VVALO,  AT,     AEXIT,  ECSTR1, BLANK  )        PUND0430
      CALL PUN1( SIMPSS, CSTRSS, CFSS,   ESISS,  ECSSS,  ECFSS  )        PUND0440
      CALL PUN1( WDSSF,  WDSSO,  FSS,    PNSSS,  AOVEO,  A1VEO  )        PUND0450
      CALL PUN1( AOVEF,  A1VEF,  AOVDEF, A1VDEF, AOVDEO, A1VDEO )        PUND0460
      CALL PUN( TAVEF, NTVEF, CID, NSEQ )                                PUND0470
      CALL PUN( TTVEF, NTVEF, CID, NSEQ )                                PUND0480
      CALL PUN( TAVEO, NTVEO, CID, NSEQ )                                PUND0490
      CALL PUN( TTVEO, NTVEO, CID, NSEQ )                                PUND0500
      CALL PUN( TAVDEF,NTVDEF,CID, NSEQ )                                PUND0510
      CALL PUN( TTVDEF,NTVDEF,CID, NSEQ )                                PUND0520
      CALL PUN( TAVDEO,NTVDEO,CID, NSEQ )                                PUND0530
      CALL PUN( TTVDEO,NTVDEO,CID, NSEQ )                                PUND0540
      CALL PUN( PSPACE,NSPACE,CID, NSEQ )                                PUND0550
      CALL PUN( TTWALL,NTWALL,CID, NSEQ )                                PUND0560
      K = NSPACE                                                         PUND0600
        DO 80  J=1,NTWALL                                                PUND0610
        CALL  PUN(TWF   (1,J), K, CID, NSEQ )                            PUND0620
        CALL  PUN(TWO   (1,J), K, CID, NSEQ )                            PUND0630
        CALL  PUN(TTIA  (1,J), K, CID, NSEQ )                            PUND0640
        CALL  PUN(TTIP  (1,J), K, CID, NSEQ )                            PUND0650
        CALL  PUN(TTRISE(1,J), K, CID, NSEQ )                            PUND0660
        CALL  PUN(TTIRIS(1,J), K, CID, NSEQ )                            PUND0670
        CALL  PUN(TTRIS2(1,J), K, CID, NSEQ )                            PUND0680
        CALL  PUN(TTDROP(1,J), K, CID, NSEQ )                            PUND0690
        CALL  PUN(TTIDRP(1,J), K, CID, NSEQ )                            PUND0700
        CALL  PUN(TPOVER(1,J), K, CID, NSEQ )                            PUND0710
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      CALL  PUN(TTITAL(1,J), K, CID, NSEQ )                    PUND0720
      CALL  PUN(TIPDTA(1,J), K, CID, NSEQ )                    PUND0730
      CALL  PUN(TIPDTB(1,J), K, CID, NSEQ )                    PUND0740
80    CONTINUE                                                 PUND0760
      RETURN                                                   PUND0980
      END                                                      PUND0990


      SUBROUTINE  IGN(K)                                       DIGN0010
      I = 1                                                    DIGN0020
      RETURN                                                   DIGN0030
      END                                                      DIGN0040
```

D C Y C L E SUBPROGRAM BLOCK

```
      SUBROUTINE  DCYCLE                                                    DCYC0010
      COMMON  /PULDYC/  COEHTH, COEHTC, TCWSS, QSBFSS, QSBOSS, TGASSS,      DCYC0020
     1          PSPACE(12),  TTWALL(6),  TWF(12,6),  TWO(12,6),            DCYC0030
     2          TTIA(12,6), TTIB(12,6), TTRISE(12,6), TTIRIS(12,6),        DCYC0040
     3          TTRIS2(12,6), TTDROP(12,6), TTIDRP(12,6), TPOVER(12,6),    DCYC0050
     4          TTITAL(12,6), TIPDTA(12,6), TIPDTB(12,6)                   DCYC0052
      COMMON  /DCYCOM/  DCMAT(36),      NSEQ,   ISEQ,   NPS,    JPAGE,    DCYC0060
     1                  OFFA,   OFFB,   OFFC,   IP,     ECFQ               DCYC0062
      COMMON  /HEAD/    AMAT(72),       CDATE(2),                          DCYC0070
     1                  ILISP,  ISTC,   ITRANS, ITDK,   IPULSE, IDCYCL     DCYC0072
      COMMON  /PULCOM/  NN,     IIGN,   DTIME,  TIME,   TAMB,   PBARSS,    DCYC0080
     1                  RPCIN,  RPCNB,  NSPACE, NTWALL                     DCYC0082
      COMMON  /PCOM1/   SUMIMP, TRISE,  TIRISE, TRISE2, TDROP,  TIDROP,    DCYC0090
     1                  POVER,  PWIDTH, OFF1,   OFF2,   PNS,    THRUST,    DCYC0092
     2                  CXFRAC, TIA,    TWALL2, TWALLM, SUMPC,  SUMPCA,    DCYC0094
     3                  TITAIL, TWALL,  TAUIGN                             DCYC0096
C                                                                           DCYC0098
      WRITE(6,4)                                                            DCYC0100
    4 FORMAT(1H1 ///// 37X 37HD U T Y   C Y C L E   A N A L Y S I S ///     DCYC0102
     1 36X 38HWITH  P M P M  SUBPROGRAM  D C Y C L E /////                  DCYC0104
     2 47X 15HSEP 72 REVISION )                                             DCYC0106
C                                                                           DCYC0109
      IF(IPULSE.EQ.0)  CALL DPUNIN                                          DCYC0110
      NN = 0                                                                DCYC0114
      TIME = 0.                                                             DCYC0116
      OFFC = PSPACE(NSPACE)                                                 DCYC0120
      TWALL = TAMB                                                          DCYC0130
      READ(5,10)  DCMAT                                                     DCYC0140
   10 FORMAT(18A4)                                                          DCYC0150
      READ(5,20)  NSEQ,   ECFQ                                              DCYC0160
   20 FORMAT(I12,5F12.8)                                                    DCYC0170
      WRITE(6,30)                                                           DCYC0180
   30 FORMAT(1H1 26X 56HPULSE MODE PERFORMANCE MODEL DUTY CYCLE (DCYCLE)    DCYC0190
     1 PROGRAM )                                                            DCYC0200
      WRITE(6,40)  DCMAT, NSEQ, ECFQ                                        DCYC0210
   40 FORMAT(19X 18A4 / 19X 18A4 // 1X 8H NSEQ  = I10, 6X 8H ECFQ  =        DCYC0220
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     1        F7.4)                                                          DCYC0222
C                                                                           DCYC0230
      DO 100 ISEQ=1,NSEQ                                                    DCYC0240
      OFFA = OFFC                                                           DCYC0250
      READ(5,50)  NPS,  JPAGE,  PWIDTH,  OFFB,  OFFC                        DCYC0260
   50 FORMAT(2I12, 4E12.8)                                                  DCYC0270
      WRITE(6,60)  NPS, JPAGE, PWIDTH, OFFB, OFFC                           DCYC0280
   60 FORMAT(  9HI NPS   =      I10, 8H JPAGE =   I10, 8H PWIDTH=           DCYC0290
     1 1PE10.3,  8H OFFB  =   E10.3, 8H OFFC  = E10.3 )                     DCYC0300
        CALL  SYNTHE                                                        DCYC0310
  100 CONTINUE                                                              DCYC0320
      RETURN                                                                DCYC0900
      END                                                                   DCYC0910


      SUBROUTINE  DPUNIN                                                    DPUN0010
      COMMON  /SVV/ NP, NAP, NMR, DUM1(5), MTDF, MTVF, DUM2(4), MTDC,       DPUN0030
     1              MTVC, TXF, TXC, LMBDEF, LMBDEC, DUM3(18),               DPUN0040
     2              WDSSF, WDSSC, DUM4(19), NEPS, PAMB, AEXIT, ECFVAC,      DPUN0050
     3              NMACH, ECSTR1, PNSSS, PIESS, RVAPF, RVAPO               DPUN0060
      COMMON  /COMPM/ JTAPE, NREC, ICRTSD, VOLC, AT, LCHAM, DCHAM,          DPUN0070
     1          AWCHAM, WGCHAM, ESISS, ECSSS, ECFSS, FSS, SIMPSS, CSTRSS,DPUN0072
     2          CFSS, CXFRSS, HTLOSS                                        DPUN0074
      COMMON  /PULFED/ TLF, TLO, VVALF, VVALO, NTVEF, NTVEO, NTVDEF,        DPUN0090
     X          NTVDEO, TTVEF(9), TAVEF(9), TTVEO(9), TAVEO(9),           DPUN0092
     1          TTVDEF(9), TAVDEF(9), TTVDEO(9), TAVDEO(9),               DPUN0094
     2          AVEF, CFVF, AOVEF, A1VEF, AOVDEF, A1VDEF,                 DPUN0096
     3          AVEO, CFVO, AOVEO, A1VEO, AOVDEO, A1VDEO                  DPUN0098
      COMMON  /PULDYC/  CDEHTH, CDFHTC, TCWSS, QSBFSS, QSBOSS, TGASSS,      DPUN0120
     1          PSPACE(12),  TTWALL(6),  TWF(12,6),  TWO(12,6),           DPUN0122
     2          TTIA(12,6), TTIB(12,6), TTRISE(12,6), TTIRIS(12,6),       DPUN0124
     3          TTRIS2(12,6), TTDROP(12,6), TTIDRP(12,6), TPOVER(12,6),   DPUN0126
     4          TTITAL(12,6), TIPDTA(12,6), TIPDTB(12,6)                  DPUN0128
      COMMON  /PULCOM/ N,      IIGN,   DTIME,  TIME,   TAMB,   PBARSS,      DPUN0190
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITGG,    DPUN0200
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     2                NFIRST, INITB,  TSTART, TOFF,   TLAST,  COMB,     DPUN0210
     3                ISPACE, PIE,    WCUMVF, WCUMVO, PVALF,  PVALO,    DPUN0220
     4                AVF,    AVO,    STDPW                             DPUN0230
      READ(5,10)    NSPACE, NTWALL, NTVEF,  NTVEO,  NTVDEF, NTVDEO     DPUN0300
10  FORMAT(6I12)                                                        DPUN0310
      READ(5,20)    STDPW,  HTLOSS, TGASSS, TCWSS,  COFHTH, COFHTC,   DPUN0320
     1              TAMB,   PAMB,   TLO,    TLF,    PVALF,  PVALO,    DPUN0330
     2              VVALF,  VVALO,  AT,     AEXIT,  ECSTR1, BLANK,    DPUN0340
     3              SIMPSS, CSTRSS, CFSS,   ESISS,  ECSSS,  ECFSS,    DPUN0350
     4              WDSSF,  WDSSO,  FSS,    PNSSS,  AOVEO,  A1VEO,    DPUN0360
     5              AOVEF,  A1VEF,  AOVDEF, A1VDEF, AOVDEO, A1VDEO    DPUN0370
20  FORMAT(6F12.8)                                                      DPUN0380
      READ(5,20)  (TAVEF (I), I=1,NTVEF )                               DPUN0390
      READ(5,20)  (TTVEF (I), I=1,NTVEF )                               DPUN0400
      READ(5,20)  (TAVEO (I), I=1,NTVEO )                               DPUN0410
      READ(5,20)  (TTVEO (I), I=1,NTVEO )                               DPUN0420
      READ(5,20)  (TAVDEF(I), I=1,NTVDEF)                               DPUN0430
      READ(5,20)  (TTVDEF(I), I=1,NTVDEF)                               DPUN0440
      READ(5,20)  (TAVDEO(I), I=1,NTVDEO)                               DPUN0450
      READ(5,20)  (TTVDEO(I), I=1,NTVDEO)                               DPUN0460
      READ(5,20)  (PSPACE(I), I=1,NSPACE)                               DPUN0470
      READ(5,20)  (TTWALL(I), I=1,NTWALL)                               DPUN0480
      K = NSPACE                                                        DPUN0490
        DO 30  J=1,NTWALL                                               DPUN0500
        READ(5,20)  (TWF   (I,J), I=1,K)                                DPUN0510
        READ(5,20)  (TWC   (I,J), I=1,K)                                DPUN0520
        READ(5,20)  (TTIA  (I,J), I=1,K)                                DPUN0530
        READ(5,20)  (TTIF  (I,J), I=1,K)                                DPUN0540
        READ(5,20)  (TTRISF(I,J), I=1,K)                                DPUN0550
        READ(5,20)  (TTIRIS(I,J), I=1,K)                                DPUN0560
        READ(5,20)  (TTRIS2(I,J), I=1,K)                                DPUN0570
        READ(5,20)  (TTDRDP(I,J), I=1,K)                                DPUN0580
        READ(5,20)  (TTIDRP(I,J), I=1,K)                                DPUN0590
        READ(5,20)  (TPOVER(I,J), I=1,K)                                DPUN0600
        READ(5,20)  (TTITAL(I,J), I=1,K)                                DPUN0610
        READ(5,20)  (TIPDTA(I,J), I=1,K)                                DPUN0620
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      READ(5,20)  (TIPDTB(I,J), I=1,K)                                  DPUN0630
30    CONTINUE                                                          DPUN0640
      RETURN                                                            DPUN0980
      END                                                               DPUN0990


      SUBROUTINE  SYNTHE                                                SYNT0010
      COMMON  /DCYCOM/  DCMAT(36), NSEQ, ISEQ, NPS, JPAGE,             SYNT0020
     1                  OFFA,   OFFB,   OFFC,   IP,     ECFQ           SYNT0022
      COMMON  /PULSYC/  CCEHTH, CDEHTC, TCWSS, QSBFSS, QSBOSS, TGASSS,  SYNT0040
     1          BSPACE(12),  TIWALL(6),  TWF(12,6),  TWD(12,6),         SYNT0050
     2          TTIA(12,6), TTIB(12,6), TTRISE(12,6), TTIRIS(12,6),     SYNT0060
     3          TTRIS2(12,6), TTDROP(12,6), TTIDRP(12,6), TPOVER(12,6), SYNT0070
     4          TTITAL(12,6), TIPDTA(12,6), TIPDTB(12,6)                SYNT0072
      COMMON  /PULCOM/ NN,     IIGN,   DTIME,  TIME,   TAMB,   PBARSS,  SYNT0080
     1                 RPCIN,  RPCNB,  NSPACE, NTWALL, INITTC, INITCG,  SYNT0082
     2                 NFIRST, INITB,  TSTART, TOFF,   TLAST,  COME,    SYNT0084
     3                 ISPACE, PIE,    WF,     WD,     PVALF,  PVALD,   SYNT0096
     4                 AVF,    AVD,    STDPW,  IPPRT,  ICRTP            SYNT0088
      COMMON  /BCOM1/  TI, TRISE, TIRISE, TRISE2, TDROP, TIDROP,        SYNT0110
     1          POVER, PWIDTH, OFF1, OFF2, PNS, THRUST, OXFRAC, TIA,    SYNT0112
     2          TWALL2, TWALLM, SUMPC, SUMPCA, TITAIL, TWALL, TAUIGN    SYNT0114
      COMMON  /SVV/     SVVD1(39), WDSSF, WDSSO, SVVD2(25), PNSSS       SYNT0120
      COMMON  /COMPW/   CPWDUM(9), ESISS, ECSSS, ECFSS, FSS, SIMPSS,    SYNT0130
     1                  CPWDUX(3), HTLOSS, CR, ECSMIX, ECSENR           SYNT0132
      COMMON  /COMBIT/ JX1,JX2,NX,FX1,FX2                               SYNT0140
      DATA  JX1,JX2/1,1/                                                SYNT0160
      IF(ISEQ.GT.1)  GO TO 10                                           SYNT0200
        PSPACK = PSPACE(NSPACE)                                         SYNT0206
        SUMWF = 0.                                                      SYNT0210
        SUMWO = 0.                                                      SYNT0220
        SUMTI = 0.                                                      SYNT0230
        TWALL2 = TWALL                                                  SYNT0232
        FHL2 = ((1.-HTLOSS)*ECFQ)**2                                    SYNT0234
        CHT = (1.-FHL2)/(FHL2-TCWSS/TGASSS)                             SYNT0235
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      CHT1 = 1./(EML2*(1.+CHT))                                          SYNT0236
      CHT2 = CHT/(TGASSS*EML2*(1.+CHT))                                  SYNT0237
      NY = 12                                                            SYNT0240
      SIMPTM = SIMPSS/ESISS                                              SYNT0242
10    OFF1 = OFFA                                                        SYNT0250
      OFF2 = OFFB                                                        SYNT0260
      DELPW = (PWIDTH-STOPW)*1.E-3                                       SYNT0270
      PWSEC = PWIDTH*1.E-3                                               SYNT0280
      TLAST = TIME                                                       SYNT0290
      TWALL3 = TWALL                                                     SYNT0292
      NPS2 = (NPS+1)/2                                                   SYNT0294
      LINE = 50                                                          SYNT0296
      DO 63 IP=1,NPS                                                     SYNT0300
       IF(IP.EQ.2)  OFF1 = OFF2                                          SYNT0310
       IF(IP.EQ.NPS)  OFF2 = OFFC                                        SYNT0320
      OFF1X = AMIN1(OFF1,PSPACX)                                         SYNT0324
      OFF2X = AMIN1(OFF2,PSPACX)                                         SYNT0326
      TSTART = TLAST                                                     SYNT0330
      TOFF = TSTART + PWSEC                                              SYNT0350
      TLAST = TOFF + OFF2*1.E-3                                          SYNT0360
      TWALL1 = TWALL3                                                    SYNT0370
      TWAL2X = TWALL2                                                    SYNT0372
      TWALL2 = TWALL1 + (TCWSS-TWALL1)*(1.-EXP(-COEHTH*PWIDTH))          SYNT0380
      TWALLM = TWALL1 + (TCWSS-TWALL1)*(1.-EXP(-COEHTH*0.5*PWIDTH))      SYNT0390
      TIFACT = SQRT(CHT1+CHT2*TWALLM)                                    SYNT0400
      TWALL3 = TWALL2 - (TWALL2-TAMB)*(1.-EXP(-COEHTC*OFF2))             SYNT0410
      CALL  LOCFAC(JK1,OFF1X,PSPACE,NSPACE, JX1,FX1)                     SYNT0420
      CALL  LOCFAC(JX2,TWAL2X,TTWALL,NTWALL, JX2,FX2)                    SYNT0430
      WF = DINTRP(TWF,0) + DELPW*WDSSF                                   SYNT0440
      WO = DINTRP(TW2,1) + DELPW*WDSSO                                   SYNT0450
      TIA = DINTRP(TTIA,1)                                               SYNT0460
      TRISE = DINTRP(TTRISE,1)                                           SYNT0470
      TRISE2 = DINTRP(TTRIS2,1)                                          SYNT0480
      TIRISF = DINTRP(TTIRIS,1)*TIFACT                                   SYNT0490
      POVER = DINTRP(TPOVER,1)                                           SYNT0500
      SUMPO = DINTRP(TIPOTA,1)                                           SYNT0504
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      CALL  LOCFAC(JK1,OFF2X,PSPACE,NSPACE, JX1,FX1)                    SYNT0508
      CALL  LOCFAC(JK2,TWALL2,TTWALL,NTWALL, JX2,FX2)                   SYNT0510
      TORQP = DINTRP(TTORQP,C)                                          SYNT0520
      TIORQP = DINTRP(TTIDRP,I)*TIFACT                                  SYNT0530
      TIB = DINTRP(TTIB,1)                                              SYNT0534
      SUMPC = SUMPC + DINTRP(TIPDTB,1) + DELPW*PNSSS                    SYNT0536
      TI = TIFACT*(TIA+DELPW*FSS*TIB)                                   SYNT0540
      TITAIL = DINTRP(TTITAL,I)*TIFACT                                  SYNT0544
      SUMWF = SUMWF + WF                                                SYNT0550
      SUMWO = SUMWO + WO                                                SYNT0560
      SUMTI = SUMTI + TI                                                SYNT0570
      SIMFAV = SUMTI/(SUMWF+SUMWO)                                      SYNT0580
      XWOWF  = SUMWO/SUMWF                                              SYNT0590
      IF(JPAGE.EQ.0)  GO TO 30                                          SYNT0600
        IF(JPAGE.EQ.4)  GO TO 20                                        SYNT0602
        IF(IP.EQ.1)  GO TO 20                                           SYNT0620
        IF(JPAGE.GT.2 .AND. IP.EQ.NPS2)  GO TO 20                       SYNT0630
        IF(JPAGE.LT.2 .OR. IP.NE.NPS)  GO TO 30                         SYNT0640
20      CALL  PULPRT                                                    SYNT0650
        LINE = 42                                                       SYNT0652
      GO TO 44                                                          SYNT0654
30    IF(JPAGE.EQ.4)  GO TO 42                                          SYNT0656
      IF(LINE.LE.38)  GO TO 34                                          SYNT0658
      WRITE(6,32)                                                       SYNT0660
32    FORMAT(1H1 6X 6HTSTART 6X 6HPWIDTH 6X 4HOFF1 8X 4HOFF2 8X         SYNT0662
     1 6HTWALL1 6X 6HTWALLM 6X 6HTWALL2 6X 6HTWALL3 / 7X 6HTIFACT 6X    SYNT0663
     2 2HWF 10X 2HWO 10X 2HTI 10X 5HTRISE 7X 6HTRISE2 6X 5HTDROP 7X 5HPOVERSYNT0664
     3 / 7X 3HTIA 9X 3HTIB 9X 6HTIRISE 6X 6HTIDROP 6X 5HSPIMP 7X        SYNT0665
     4 6HFSPIMP / )                                                     SYNT0666
      LINE = 4                                                          SYNT0667
34    LINE = LINE + 4                                                   SYNT0668
      SPIMP = TI/(WO+WF)                                                SYNT0670
      FSPIMP = SPIMP/SIMPTH                                             SYNT0672
      WRITE(6,40) ISEC, IP, TSTART, PWIDTH, OFF1, OFF2, TWALL1,TWALLM,SYNT0678
     1            TWALL2, TWALL3, TIFACT, WF, WO, TI,  TRISE, TRISE2, SYNT0680
     2            TDROP, POVER, TIA, TIB, TIRISE, TIDROP, SPIMP,      SYNT0690
```

```
  3                ESPIMP                                                SYNT0692
40   FORMAT(4X 6HISEQ = I3,  6H, IP = I5 / (4X 1P8E12.3))                SYNT0700
42 IF(IP.LT.NPS)  GO TO 50                                               SYNT0702
44   WRITE(6,46) SUMWF, SUMWO, SUMTI, SIMEAN, XMRMN                      SYNT0710
46   FORMAT(28H0   CUM PERFORMANCE   SUMWF= 1PE10.3, 7H SUMWO= E10.3,SYNT0720
  1  7H SUMTI= E10.3, 8H SIMEAN= E10.3, 7H XMRMN= E10.3)                 SYNT0730
     LINE = LINE + 2                                                     SYNT0732
50   CONTINUE                                                            SYNT0740
   TIME = TLAST                                                          SYNT0760
   TWALL = TWALL3                                                        SYNT0770
   RETURN                                                                SYNT0980
   END                                                                   SYNT0990
```

```
      SUBROUTINE  IGN(IP)                                                    IGN00100
C                                                                            IGN00120
C   MAIN CONTROL SUBPROGRAM FOR  I G N  PROGRAM, ADAPTED FROM THE HYPER-     IGN00140
C   GOLIC IGNITION MODEL OF SEAMANS, AFRPL-TR-69-68.                         IGN00160
C                                                                            IGN00180
      COMMON  /IGN1/   C(3),  DELTN, LF,    LO,    LIF,   LIO,   TMAX      IGN00200
     1,                E1,    N                                             IGN00220
      COMMON   IGN4/   CPG,   CVG,   KCG,   MG,    MGN,   MTG,   MUG       IGN00240
     1,                TC,    PG,    MVI,   QVP,   QVW,   TIMEMS           IGN00260
      COMMON  /IGNT/   SIGN,  SIGNL, CTD,   KTP,   TGO,   MI               IGN00280
      COMMON  /PULCOM/ NN,    IIGN,  DTIME, TIME,  PCDUM(12),              IGN00300
     1                 TLAST, COMB                                         IGN00310
      COMMON  /PCOM1/  A(10), PNS,   B(9),  TAUIGN                         IGN00320
      REAL  KCG,   MG,    MGN,   MI,    MTG,   MUG,   MVI                  IGN00340
      LOGICAL  COMB                                                        IGN00350
C                                                                            IGN00360
      INERR = 0                                                            IGN00380
      TIME1 = TIME                                                         IGN00390
      IF(IP.GT.1)  GO TO 50                                                IGN00400
      CALL VACIN                                                           IGN00420
   50 IF(IP.GT.1)  CALL TRCOIN                                             IGN00440
      DO 150  I=1,400                                                      IGN00460
          IF(I.GT.1)  CALL  ICFEED                                         IGN00480
          CALL ICFUEL                                                      IGN00500
          CALL ICOXID                                                      IGN00520
          CALL NTRMDT(INERR)                                               IGN00540
          IF(INERR.GT.0)  GO TO 300                                        IGN00560
          IF(SIGNL.LT.1.0)  GO TO 100                                      IGN00580
  100     IF(SIGN.GE.1.0)  GO TO 200                                       IGN00600
          IF(TIME.GE.TLAST)  GO TO 300                                     IGN00610
  150 CONTINUE                                                             IGN00620
      GO TO 300                                                            IGN00630
C                                                                            IGN00640
  200 TIGN = TIMEMS - 1000.*DELTN*(SIGN - 1.)/(SIGN - SIGNL)               IGN00660
      TAUIGN = TIGN - TIME1*1000.                                          IGN00664
      COMB = .TRUE.                                                        IGN00670
```

```
      PNS = PG/144.                                                     IGN00680
      NN = NN * N -1                                                    IGN00700
      WRITE(6,210)  TIGN                                                IGN00720
  210 FORMAT(//// 7H TIGN = F10.4/ 1H1)                                 IGN00740
C                                                                       IGN00760
  300 RETURN                                                            IGN00780
      END                                                               IGN00800


      SUBROUTINE  TRCOIN                                                TCIN0020
C                                                                       TCIN0040
      COMMON  /IGN1/   C(3),  DELTN, LF,    LO,    LIF,   LIO,   TMAX   TCIN0060
     1,                C1,    N                                         TCIN0080
      COMMON  /IGN2/   DFINT, AIIMI, FINT,  AQIGN, EIGN,  DELHRC,DELHRV TCIN0100
     1,                TINT,  TCV,   QEXICN,DPRT                        TCIN0120
      COMMON  /IGN3/   VC,    ASTAR, TW,    L,     D,     ACC           TCIN0140
      COMMON  /IGN4/   CPG,   CVG,   KCG,   MG,    MGN,   MTG,   MUG    TCIN0160
     1,                TG,    PG,    MVI,   CVP,   CVW,   TIMFMS        TCIN0180
      COMMON  /IGN5/   NDF(3,401),   RDF(3,401),   UDF(3,401)           TCIN0200
     1,                TDF(3,401),   RHODF(3,401), VDF(401)             TCIN0220
     2,                JWALLF(401),  TIMPF(401)                         TCIN0240
      COMMON  /IGN5X/  MAXJF,        WDF(401),     JMAXF(401)           TCIN0250
      COMMON  /IGN5A/  LIWF,  LITF,  LIMPF, CPSF,  CPVF,  MUVF,  KCF    TCIN0260
     1,                LMBDSF,LMBDFF,ALPHAF,STENF, THTF,  FMAXF, FMINF  TCIN0280
     2,                EVF,   EDVF,  CVVF,  PVF,   DELTNF,THETAF,NF     TCIN0300
     3,                MVF,   MDVF,  MWALLF,KDF,   NIF                  TCIN0320
      COMMON  /IGN6/   NDO(3,401),   RDO(3,401),   UDO(3,401)           TCIN0340
     1,                TDO(3,401),   RHODO(3,401), VDO(401)             TCIN0360
     2,                JWALLO(401),  TIMPO(401)                         TCIN0380
      COMMON  /IGN6X/  MAXJO,        WDO(401),     JMAXO(401)           TCIN0390
      COMMON  /IGN6A/  LIWO,  LITO,  LIMPO, CPSO,  CPVO,  MUVO,  KCO    TCIN0400
     1,                LMBDSO,LMBDFO,ALPHAO,STENO, THTO,  FMAXO, FMINO  TCIN0420
     2,                EVO,   EDVO,  CVVO,  PVO,   DELTNO,THETAO,NO     TCIN0440
     3,                MVO,   MDVO,  MWALLO,KDO,   NIO                  TCIN0460
      COMMON  /IGN7/   SIGN,  SIGNL, CTD,   KTP,   TGO,   MI            TCIN0480
```

```
      COMMON  /SVV/    DV1(6),MTDF,  MTVF,  DV2(4),MTDO,  MTVO,  DV3(2)  TCIN0500
     1,                LMBDEF,LMBDEO                                     TCIN0520
      COMMON  /PCOM1/   PC1DUM(19), TWALL                                TCIN0530
      COMMON  /IGNFED/ TDFPF,CPLF,  TDFPO,CPLO                           TCIN0540
      COMMON  /PULCOM/ DV4(3),TIMF                                       TCIN0550
      COMMON  /IGNCOF/ WJF,   VJF,   TJF,   SUMSPF,WGFCUM,WFSF,         TCIN0560
     1                 WJO,   VJO,   TJO,   SUMSPO,WGOCUM,WFSO,  TCAS   TCIN0580
     2,                TRFSF, TRFSO                                     TCIN0590
      DATA GC,RFPS,RCOS,JC,PI/32.174,1545.3,1.9872,777.65,3.14159/       TCIN0600
C                                                                        TCIN0618
      REAL   JC,    JWALLF,JWALLO,KCF,   KCO,   KCC,   KG,    LIWF     TCIN0620
     1,      LIWO,  LITF,  LITO,  LIMPF, LIMPO, LMBD,  LMBDEF,LMBDFF    TCIN0640
     2,      LMBDSF,LMBDIO,LMBDFO,LMBDSO,MD,    MDV,   MDVF,  MDVO      TCIN0660
     3,      MFR,   MG,    MGN,   MI,    MWD,   MTDF,  MTDO,  MTG       TCIN0680
     4,      MTVF,  MTVO,  MUG,   MUVF,  MUVO,  MVI,   MVF,   MVO       TCIN0700
     5,      MVWF,  MVWO,  MWALLF,MWALLO,ND,    NU,    NDF,   NDO,   L  TCIN0720
C                                                                        TCIN0740
      WVF = AMAX1(0.0,WGFCUM)                                            TCIN0960
      WVO = AMAX1(0.0,WGOCUM)                                            TCIN0980
      TW = TWALL                                                         TCIN0990
      GC = 0                                                             TCIN1000
      IF(SUMSPF.LE.0.0)  GO TO 40                                        TCIN1020
          WF = 0                                                         TCIN1040
          DELWO = SUMSPF/6.                                              TCIN1060
          VELO = (LITF - LIMPF)/TRESF                                    TCIN1070
          IJ = INT(TRESF/(9.*DELTN))                                     TCIN1075
        DO 20  J=3,9                                                     TCIN1080
          WOF(J) = DELWO                                                 TCIN1100
          VOF(J) = VELO                                                  TCIN1120
          TIMPF(J) = 0.0                                                 TCIN1140
          JWALLF(J) = 400.                                               TCIN1150
          JWAYF(J) = IJ*(10-J)                                           TCIN1160
          ROF(2,J) = RDENCF(VELO)                                        TCIN1200
C                                                                        TCIN1220
        DO 20  I=1,3                                                     TCIN1240
          IF(I.EQ.1)  ROF(1,J) = ROF(2,J)/2.37                           TCIN1260
```

```
      IF(I.EQ.3)  RDF(3,J) = RDF(2,J)*2.37                                  TCIN1280
      TDF(I,J) = TJF                                                        TCIN1300
      RHODF(I,J) = DENF(TDF(I,J))                                           TCIN1320
      WPD = 4./3.*PI*RHODF(I,J)*RDF(I,J)**3                                 TCIN1340
      WDF(I,J) = C(I)*WDF(J)/WPD                                            TCIN1360
      UDF(I,J) = WPD*(CPSF*TDFPF + LMBDFF + CPLF*(TDF(I,J)-TDFPF))          TCIN1380
70    CONTINUE                                                              TCIN1400
C                                                                           TCIN1420
40  NO = 0                                                                  TCIN1440
    IF(SUMSPC.LE.0.0)  GO TO 80                                             TCIN1450
      DELWO = SUMSPC/6.                                                     TCIN1460
      VELO = (LIMO - LIMPC)/TMESO                                           TCIN1470
      IJ = INT(TMESO/(9.*DELTN))                                            TCIN1475
      DO 60  J=2,9                                                          TCIN1480
        WDO(J) = DELWO                                                      TCIN1500
        VDO(J) = VELO                                                       TCIN1520
        TIMPO(J) = 0.0                                                      TCIN1540
        JWALLO(J) = 400.                                                    TCIN1560
        JWAXO(J) = IJ*(10-J)                                                TCIN1580
        RDO(3,J) = RLFNCO(VELO)                                             TCIN1600
C                                                                           TCIN1620
      DO 60  I=1,3                                                          TCIN1640
        IF(I.EQ.1)  RDO(1,J) = RDO(2,J)/2.37                                TCIN1660
        IF(I.EQ.3)  RDO(3,J) = RDO(2,J)/2.37                                TCIN1680
        TDO(I,J) = TJO                                                      TCIN1700
        RHODO(I,J) = DENO(TDO(I,J))                                         TCIN1720
        WPO = 4./3.*PI*RHODO(I,J)*RDO(I,J)**3                               TCIN1740
        WDO(I,J) = C(I)*WDO(J)/WPO                                          TCIN1760
        UDO(I,J) = WPO*(CPSO*TDFPO + LMBDFO + CPLO*(TDO(I,J)-TDFPO))        TCIN1780
60    CONTINUE                                                              TCIN1800
C                                                                           TCIN1820
    DO DELTNF = DELTN/FLOAT(LF)                                             TCIN1840
      DELTNO = DELTN/FLOAT(LO)                                              TCIN1860
      D1 = SQRT(3C/(2.*PI*RFPS))                                            TCIN1880
      CVVF = CPVF-RFPS/(JC*WTVF)                                            TCIN1900
      CVVO = CPVO-RFPO/(JC*WTVO)                                            TCIN1920
```

```
      MC = MVF + MVO                                                    TCIN1940
      CVG = (CVVF*MVF + CVVC*MVO)/MC                                    TCIN1960
      CPG = (MVF*CPVF + MVO*CPVC)/MC                                    TCIN1970
      MTG = MC/(MVF/MTVF + MVO/MTVO)                                    TCIN1980
      KG = CPG/CVG                                                      TCIN1990
      TC = TG*T                                                         TCIN2000
      PVF = MVF*RFPS*TC/(MTVF*VC)                                       TCIN2020
      PVO = MVO*RFPS*TG/(MTVO*VC)                                       TCIN2040
      PC = PVF + PVO                                                    TCIN2050
      MUG = (MUVF+MUVO)/2.0                                             TCIN2060
      KEG = (KCF + KCO)/2.0                                             TCIN2080
      EVF = MVF*(CPSF*TDFPF + LMBDFF + CPLF*(TDF(2,2) - TDFPF) + LMBDFF TCIN2100
     1      + CPVF*(TG - TDF(2,2)))                                     TCIN2110
      EVO = MVO*(CPSO*TDFPO + LMBDFO + CPLO*(TDO(2,2) - TDFPO) + LMBDFO TCIN2120
     1      + CPVO*(TG - TDF(2,2)))                                     TCIN2130
C                                                                       TCIN2140
      N = 1                                                             TCIN2160
      NIF = 1                                                           TCIN2180
      NIO = 1                                                           TCIN2200
      MMALLF = 0.0                                                      TCIN2220
      MMALLO = 0.0                                                      TCIN2240
      MI = 0.0                                                          TCIN2260
      MVI = 0.0                                                         TCIN2280
      QVF = 0.0                                                         TCIN2300
      QVO = 0.0                                                         TCIN2320
      THETAF = 1.0/(1.0+CFINT)                                          TCIN2340
      THETAO = CFINT/(1.0+CFINT)                                        TCIN2360
      MDN = ASTAR*SQRT(GC*KG*MTG/RFPS*(2.0/(KG+1.0))**((KG+1.0)/(KG-1.0TCIN2380
     1))*PC*DELTN/SQRT(TC)                                              TCIN2382
      TIMEMV = 1000.*TIME                                               TCIN2400
      MDVS = 0.0                                                        TCIN2420
      MDVO = 0.0                                                        TCIN2440
      FOVF = 0.0                                                        TCIN2460
      FOVO = 0.0                                                        TCIN2480
      KTP = 0                                                           TCIN2500
      CTO = 0.0                                                         TCIN2520
```

```
C                                                                       TCIN2540
      CALL  IGFEFD                                                      TCIN2560
C                                                                       TCIN2580
      IF(TGO.GT.TG .OR. TGO.LE.0.0)  TGO = TG                           TCIN2600
C                                                                       TCIN2620
      RETURN                                                            TCIN2640
      END                                                               TCIN2660


      FUNCTION  DENF(T)                                                 DENFU020
C                                                                       DENFU040
      COMMON  /IGNFED/DUM1(4),NRHOF,DUM2(3),TTRLF(12),TRHOF(12)         DENFU060
C                                                                       DENFU080
      DENF = YOF(T,TTRLF,TRHOF,NRHOF,2)                                 DENFU100
C                                                                       DENFU120
      RETURN                                                            DENFU140
      END                                                               DENFU160


      FUNCTION  DENO(T)                                                 DENOX020
C                                                                       DENOX040
      COMMON  /IGNFED/DUM1(5),NRHOO,DUM2(26),TTRLO(12),TRHOO(12)        DENOX060
C                                                                       DENOX080
      DENO = YOF(T,TTRLO,TRHOO,NRHOO,2)                                 DENOX100
C                                                                       DENOX120
      RETURN                                                            DENOX140
      END                                                               DENOX160
```

```
C                                                                       TCIN2540
      CALL  IGFEED                                                      TCIN2560
C                                                                       TCIN2580
      IF(TGO.GT.TG .OR. TGO.LE.0.0)  TGO = TG                           TCIN2600
C                                                                       TCIN2620
      RETURN                                                            TCIN2640
      END                                                               TCIN2660


      FUNCTION  DENF(T)                                                 DENFU020
C                                                                       DENFU040
      COMMON  /IGNFED/DUM1(4),NRHOF,DUM2(3),TTRLF(12),TRHOF(12)         DENFU060
C                                                                       DENFU080
      DENF = YOF(T,TTRLF,TRHOF,NRHOF,2)                                 DENFU100
C                                                                       DENFU120
      RETURN                                                            DENFU140
      END                                                               DENFU160


      FUNCTION  DENO(T)                                                 DENOX020
C                                                                       DENOX040
      COMMON  /IGNFED/DUM1(5),NRHOO,DUM2(26),TTRLO(12),TRHOO(12)        DENOX060
C                                                                       DENOX080
      DENO = YOF(T,TTRLO,TRHOO,NRHOO,2)                                 DENOX100
C                                                                       DENOX120
      RETURN                                                            DENOX140
      END                                                               DENOX160
```

```
      SUBROUTINE  VACIN                                                                 VACI0100
C                                                                                       VACI0150
      COMMON  /IGN1/    C(3),   DELTN,  LF,     LO,     L1F,    L1O,    TMAX        VACI0300
     1,                 D1,     N                                                      VACI0310
      COMMON  /IGN2/    DFINT,  AIIMI,  EINT,   AQIGN,  EIGN,   DELHRC, DELHRV      VACI0350
     1,                 TINT,   TCV,    QEXIGN, DPRT                                VACI0360
      COMMON  /IGN3/    VC,     ASTAR,  TW,     L,      D,      ACC                 VACI0400
      COMMON  /IGN4/    CPG,    CVG,    KCG,    MG,     MGN,    MTG,    MUG         VACI0450
     1,                 TG,     PG,     MVI,    QVP,    QVW,    TIMEMS              VACI0460
      COMMON  /IGN5/    NDF(3,401),     RDF(3,401),     UDF(3,401)                  VACI0500
     1,                 TDF(3,401),     RHODF(3,401),   VDF(401)                    VACI0510
     2,                 JWALLF(401),    TIMPF(401)                                  VACI0520
      COMMON  /IGN5X/   MAXJF,          WDF(401),       JMAXF(401)                  VACI0530
      COMMON  /IGN5A/   LIWF,   LITF,   LIMPF,  CPSF,   CPVF,   MUVF,   KCF        VACI0550
     1,                 LMBDSF,LMBDEF,ALPHAF,STENF,    THTF,   FMAXF,  FMINF       VACI0560
     2,                 EVF,    EDVF,   CVVF,   PVF,    DELTNF,THETAF,NF           VACI0570
     3,                 MVF,    MDVF,   MWALLF,KDF,     N1F                        VACI0580
      COMMON  /IGN6/    NDO(3,401),     RDO(3,401),     UDO(3,401)                  VACI0600
     1,                 TDO(3,401),     RHODO(3,401),   VDO(401)                    VACI0610
     2,                 JWALLO(401),    TIMPO(401)                                  VACI0620
      COMMON  /IGN6X/   MAXJO,          WDO(401),       JMAXO(401)                  VACI0630
      COMMON  /IGN6A/   LIWO,   LITO,   LIMPO,  CPSO,   CPVO,   MUVO,   KCO        VACI0650
     1,                 LMBDSO,LMBDEO,ALPHAO,STENO,    THTO,   FMAXO,  FMINO       VACI0660
     2,                 EVO,    EDVO,   CVVO,   PVO,    DELTNO,THETAO,NO           VACI0670
     3,                 MVO,    MDVO,   MWALLO,KDO,     N1O                        VACI0680
      COMMON  /SVW/     DVI(8),MTDF,    MTVF,   DV2(4),MTDO,    MTVO,   DV3(2)      VACI0692
     1,                 LMBDEF,LMBDEO                                               VACI0694
      COMMON  /IGNFED/  TDFPF,CPLF,   TDFPO,CPLO                                    VACI0696
      COMMON  /IGNGGF/  WJF,    VJF,    TJF,    DV4(3),WJO,     VJO,    TJO       VACI0698
      COMMON  /IGN7/    SIGN,   SIGNL,  CTD,    KTP,    TGO,    MI                  VACI0699
      REAL    JC,     JWALLF,JWALLO,KCF,    KCG,    KCO,    KG,     LIWF          VACI0700
     1,       LIWO,   LITF,   LITO,   LIMPF,  LIMPO,  LMBD,   LMBDEF,LMBDFF       VACI0710
     2,       LMBDSF,LMBDEO,LMBDFO,LMBDSO,MD,     MDV,    MDVF,   MDVO           VACI0720
     3,       MFR,    MG,     MGN,    MI,     MMD,    MTDF,   MTDO,   MTG        VACI0730
     4,       MTVF,   MTVO,   MUG,    MUVF,   MUVO,   MVI,    MVF,    MVO        VACI0740
     5,       MVWF,   MVWO,   MWALLF,MWALLO,NO,     NU,     NDF,    NDO,    L  VACI0750
```

```
      DATA GC,RFPS,RCGS,JC,PI/32.174,1545.3,1.9872,777.65,3.14159/      VACI0800
C     PRELIMINARY CALCULATIONS                                          VACI1350
      PG = 0.0                                                          VACI1360
      DO 190 I=1,3                                                      VACI1400
      NDF(I,1) = 0.0                                                    VACI1450
      NDO(I,1) = 0.0                                                    VACI1500
      RDF(I,1) = 0.0                                                    VACI1550
      RDO(I,1) = 0.0                                                    VACI1600
      UDF(I,1) = 0.0                                                    VACI1650
      TDF(I,1) = 0.0                                                    VACI1700
      TDO(I,1) = 0.0                                                    VACI1750
  190 UDO(I,1) = 0.0                                                    VACI1800
C                                                                       VACI1850
      DELTNF = DELTN/FLOAT(LF)                                          VACI2000
      DELTNO = DELTN/FLOAT(LO)                                          VACI2450
      D1 = SQRT(GC/(2.*PI*RFPS))                                        VACI2950
      CVVF = CPVF-RFPS/(JC*MTVF)                                        VACI3000
      CVVO = CPVO-RFPS/(JC*MTVO)                                        VACI3050
      MUG = (MUVF+MUVO)/2.0                                             VACI3100
      KCG = (KCF+KCO)/2.0                                               VACI3150
      THETAF = 1.0/(OFINT+1.0)                                          VACI3200
      THETAO = OFINT/(OFINT+1.0)                                        VACI3250
C     INITIALIZE                                                        VACI3300
      N = 1                                                             VACI3350
      NF = 0                                                            VACI3400
      NO = 0                                                            VACI3450
      N1F = 1                                                           VACI3500
      N1O = 1                                                           VACI3550
      MWALLF = 0.0                                                      VACI3600
      MWALLO = 0.0                                                      VACI3650
      MVF = 0.0                                                         VACI3700
      MVO = 0.0                                                         VACI3750
      FVF = 0.0                                                         VACI3800
      FVO = 0.0                                                         VACI3850
      MI = 0.0                                                          VACI3900
      CVG = (CVVO+CVVF)/2.0                                             VACI3950
```

```
      CPG = (CPVO + CPVF)/2.                                                    VACI3960
      MTG = (MTVO+MTVF)/2.0                                                     VACI4000
      MVI = 0.0                                                                 VACI4050
      QVP = 0.0                                                                 VACI4100
      QVW = 0.0                                                                 VACI4120
      MGN = 0.0                                                                 VACI4150
      PVF = 0.0                                                                 VACI4250
      PVO = 0.0                                                                 VACI4300
      MG = 0.0                                                                  VACI4350
      TG = 0.0                                                                  VACI4400
      TIMEMS = 0.0                                                              VACI4500
      MDVO = 0.0                                                                VACI4550
      MDVF = 0.0                                                                VACI4600
      EDVO = 0.0                                                                VACI4650
      EDVF = 0.0                                                                VACI4700
      KTP = 0                                                                   VACI4750
      CTD = 0.0                                                                 VACI4800
      SIGN = 0.0                                                                VACI4850
C                                                                               VACI4900
      CALL  IGFEED                                                              VACI4920
C                                                                               VACI4940
      IF(TG.EQ.0.0)  TG = (CVVF*TDF(1,1)+CVVO*TDO(1,1))/(CVVF+CVVO)             VACI4960
      TGO = TG                                                                  VACI4980
C                                                                               VACI5000
      RETURN                                                                    VACI5050
      END                                                                       VACI5100


      SUBROUTINE  NTRMDT(INERR)                                                 NTRM0100
C                                                                               NTRM0150
      COMMON  /IGN1/   C(3),  DELTN, LF,    LO,    L1F,   L1O,   TMAX         NTRM0300
     1,                D1,    N                                                NTRM0310
      COMMON  /IGN2/   DFINT, AIIMI, EINT,  AQIGN, EIGN,  DELHRC,DELHRV        NTRM0350
     1,                TINT,  TCV,   QEXIGN,DPRT                               NTRM0360
      COMMON  /IGN3/   VC,    ASTAR, TW,    L,     D,     ACC                  NTRM0400
```

```
      COMMON  /IGN4/   CPG,    CVG,    KCG,    MG,     MGN,    MTG,    MUG     NTRM0450
     1,                TG,     PG,     MVI,    QVP,    QVW,    TIMEMS          NTRM0460
      COMMON  /IGN5/   NDF(3,401),     RDF(3,401),     UDF(3,401)              NTRM0500
     1,                TDF(3,401),     RHODF(3,401),   VDF(401)                NTRM0510
     2,                JWALLF(401),    TIMPF(401)                              NTRM0520
      COMMON  /IGN5X/  MAXJF,          WDF(401),       JMAXF(401)              NTRM0530
      COMMON  /IGN5A/  LIWF,   LITF,   LIMPF,  CPSF,   CPVF,   MUVF,   KCF     NTRM0550
     1,                LMBDSF,LMBDFF,ALPHAF,STENF,    THTF,   FMAXF,  FMINF   NTRM0560
     2,                EVF,    EDVF,   CVVF,   PVF,    DELTNF,THETAF,NF        NTRM0570
     3,                MVF,    MDVF,   MWALLF,KDF,     N1F                     NTRM0580
      COMMON  /IGN6/   NDO(3,401),     RDO(3,401),     UDO(3,401)              NTRM0600
     1,                TDO(3,401),     RHODO(3,401),   VDO(401)                NTRM0610
     2,                JWALLO(401),    TIMPO(401)                              NTRM0620
      COMMON  /IGN6X/  MAXJO,          WDO(401),       JMAXO(401)              NTRM0630
      COMMON  /IGN6A/  LIWO,   LITO,   LIMPO,  CPSO,   CPVO,   MUVO,   KCO     NTRM0650
     1,                LMBDSO,LMBDFO,ALPHAO,STENO,    THTO,   FMAXO,  FMINO   NTRM0660
     2,                EVO,    EDVO,   CVVO,   PVO,    DELTNO,THETAO,NO        NTRM0670
     3,                MVO,    MDVO,   MWALLO,KDO,     N1O                     NTRM0680
      COMMON  /IGN7/   SIGN,   SIGNL,  CTD,    KTP,    TGO,    MI              NTRM0690
      COMMON  /SVV/    DV1(9),MTDF,    MTVF,   DV2(4),MTDO,    MTVO,   DV3(2) NTRM0692
     1,                LMBDEF,LMBDEO                                           NTRM0694
      COMMON  /PULCOM/ DV5(3),TIME                                             NTRM0695
      COMMON  /IGNFED/ TDFPF,CPLF,    TDFPO,CPLO                               NTRM0696
      COMMON  /IGNGOF/ WJF,    VJF,    TJF,    DV4(3),WJO,     VJO,    TJO    NTRM0698
                                                                               NTRM0699
      REAL    JC,     JWALLF,JWALLO,KCF,    KCG,    KCO,    KG,     LIWF     NTRM0700
     1,       LIWO,   LITF,   LITO,   LIMPF,  LIMPO,  LMBD,   LMBDEF,LMBDFF  NTRM0710
     2,       LMBDSF,LMBDEO,LMBDFO,LMBDSO,MD,     MDV,    MDVF,   MDVO       NTRM0720
     3,       MFP,    MG,     MGN,    MI,     MMD,    MTDF,   MTDO,   MTG    NTRM0730
     4,       MTVF,   MTVO,   MUG,    MUVF,   MUVO,   MVI,    MVF,    MVO    NTRM0740
     5,       MVWF,   MVWO,   MWALLF,MWALLO,ND,     NU,     NDF,    NDO,    L NTRM0750
      DATA GC,REPS,RCGS,JC,PI/ 32.174,1545.3,1.9872,777.65,3.14159/            NTRM0850
C                                                                              NTRM0900
      IF(N.GT.1)  GO TO 2000                                                   NTRM0940
      UINVF = CPSF*TDFPF + LMBDFF + LMBDEF + CPLF*(TJF-TDFPF) - CPVF*TJFNTRM0960
      UINVO = CPSO*TDFPO + LMBDFO + LMBDEO + CPLO*(TJO-TDFPO) - CPVO*TJONTRM0980
```

```
      TMAXI = TIME*1000. + TMAX                                                 NTRM0990
C     MASS BALANCE ON INTERMEDIATE                                              NTRM1000
 2000 MI = MI+MVI                                                               NTRM1050
C     INCREMENT TIME                                                            NTRM1100
      TIME = TIME + DELTN                                                       NTRM1140
      TIMEMS = TIMEMS+1000.0*DELTN                                              NTRM1150
      TIMEMS = 1000.*TIME                                                       NTRM1180
C     GAS PROPERTIES                                                            NTRM1200
      TG = (EVF - MVF*UINVF + EVO - MVO*UINVO)/(CPVF*MVF + CPVO*MVO)            NTRM1250
      PVF = MVF*RBAR*TG/(MTVF*VC)                                               NTRM1300
      PVO = MVO*RBAR*TG/(MTVO*VC)                                               NTRM1350
      PG = PVF+PVO                                                              NTRM1400
      MG = MVF+MVO                                                              NTRM1450
      MTG = MG/(MVF/MTVF+MVO/MTVO)                                              NTRM1500
      CVG = (MVF*CVVF+MVO*CVVO)/MG                                              NTRM1550
      CPG = CVG+RBAR/(JC*MTG)                                                   NTRM1600
      KG = CPG/CVG                                                              NTRM1650
C     IGNITION CALCULATION                                                      NTRM1700
      SIGNL = SIGN                                                              NTRM1750
      SIGN = (TG-TGO)/(RCGS*TGO**2/EIGN)                                        NTRM1800
C     OUTPUT                                                                    NTRM1850
      PGMMHG = 0.359131*PG                                                      NTRM1900
      IF(KTP.EQ.0)  WRITE(6,118)                                                NTRM1920
      KTP = KTP+1                                                               NTRM1950
      IF(KTP-36)2098,2096,2098                                                  NTRM2000
 2096 KTP = 1                                                                   NTRM2050
      WRITE(6,118)                                                              NTRM2100
  118 FORMAT(1H1//,4X,'N',2X,'TIME,MS',3X,'PG,MMHG',4X,'TG,R',5X,               NTRM2110
     1'MGN,LB',5X,'MVO,LB',5X,'MVF,LB',4X,'MDVO,LB',4X,'MDVF,LB',6X,            NTRM2120
     2'MI,LB',2X,'PVO,PSF',2X,'PVF,PSF',5X,'SIGN'//)                            NTRM2130
 2098 WRITE(6,150) N,TIMEMS,PGMMHG,TG,MGN,MVO,MVF,MDVO,MDVF,MI,PVO,PVF,         NTRM2150
     1SIGN                                                                      NTRM2200
  150 FORMAT(1X,I4,F9.3,F10.3,F8.1,1P6E11.3,0PF9.2,F9.2,F9.4)                   NTRM2250
      CTD = CTD+1.0                                                             NTRM2300
      IF(DPRT-CTD*1000.1*DELTN)2100,2100,2106                                   NTRM2350
 2100 CTD = 0.0                                                                 NTRM2400
```

```
      NUP = NF + 1                                                          NTRM2450
      WRITE(6,152)                                                          NTRM2500
  152 FORMAT(///11X,'J',5X,'NDF(1,J)',2X,'NDF(2,J)',2X,'NDF(3,J)',4X,'RDNTRM2550
     1F(1,J),FT',4X,'RDF(2,J),FT',4X,                                       NTRM2600
     2'RDF(3,J),FT',3X,'TDF(1,J)',2X,'TDF(2,J)',2X,'TDF(3,J)'//)            NTRM2650
      DO 2102 J=1,NUP                                                       NTRM2700
      IF(J.GT.JMAXF(J))  GO TO 2102                                         NTRM2720
      WRITE(6,154) J,(NDF(I,J),I=1,3),(RDF(I,J),I=1,3),(TDF(I,J),I=1,3)     NTRM2740
 2102 CONTINUE                                                              NTRM2760
  154 FORMAT(I12,2X,3F10.1,1P3E15.3,0P1F10.1,2F10.1)                        NTRM2800
      NUP = NO + 1                                                          NTRM2850
      WRITE(6,1118)                                                         NTRM2900
 1118 FORMAT(///11X,'J',5X,'NDO(1,J)',2X,'NDO(2,J)',2X,'NDO(3,J)',4X,'RDNTRM2950
     1O(1,J),FT',4X,'RDO(2,J),FT',4X,                                       NTRM3000
     2'RDO(3,J),FT',3X,'TDO(1,J)',2X,'TDO(2,J)',2X,'TDO(3,J)'//)            NTRM3050
      DO 2104 J=1,NUP                                                       NTRM3100
      IF(J.GT.JMAXO(J))  GO TO 2104                                         NTRM3120
      WRITE(6,154) J,(NDO(I,J),I=1,3),(RDO(I,J),I=1,3),(TDO(I,J),I=1,3)     NTRM3140
 2104 CONTINUE                                                              NTRM3160
      WRITE(6,2105)                                                         NTRM3200
 2105 FORMAT(////3X,'N',2X,'TIME,MS',3X,'PG,MMHG',4X,'TG,R',5X,'MGN,LB',NTRM3250
     1 5X,'MVO,LB',5X,'MVF,LB',4X,'MDVO,LB',4X,'MDVF,LB',6X,'MI,LB',2X,     NTRM3300
     2'PVO,PSF',2X,'PVF,PSF',4X,'SIGN'//)                                   NTRM3350
 2106 IF(402-N)2108,2108,2112                                               NTRM3400
 2108 WRITE(6,2110)N                                                        NTRM3450
 2110 FORMAT(/,' CALCULATION TERMINATED DUE TO N =',I10/1H1)                NTRM3500
      INERR = 1                                                             NTRM3550
      RETURN                                                                NTRM3600
 2112 IF(MVF) 2002,2004,2004                                                NTRM3650
 2002 WRITE(6,156) MVF                                                      NTRM3700
  156 FORMAT(/,' CALCULATION TERMINATED DUE TO MVF =',E15.7/1H1)            NTRM3750
      INERR = 2                                                             NTRM3800
      RETURN                                                                NTRM3850
 2004 IF(MVO) 2006,2008,2008                                                NTRM3900
 2006 WRITE(6,158) MVO                                                      NTRM3950
  158 FORMAT(/,' CALCULATION TERMINATED DUE TO MVO =',E15.7/1H1)            NTRM4000
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```
      INERR = 3                                                          NTRM4050
      RETURN                                                             NTRM4100
 2008 IF(TG) 2010,2011,2011                                              NTRM4150
 2010 WRITE(6,160) TG                                                    NTRM4200
  160 FORMAT(/,' CALCULATION TERMINATED DUE TO TG =',E15.7/1H1)          NTRM4250
      INERR = 4                                                          NTRM4300
      RETURN                                                             NTRM4350
 2011 IF(TIMEMS.LT.TMAXI)  GO TO 2016                                    NTRM4400
 2012 WRITE(6,162)TIMEMS                                                 NTRM4450
  162 FORMAT(////,' CALCULATION TERMINATED DUE TO TIMEMS =',F9.3,' MILLINTRM4500
     1SECONDS'/1H1)                                                      NTRM4550
      INERR = 5                                                          NTRM4600
      RETURN                                                             NTRM4650
C                                                                        NTRM4700
 2016 N = N+1                                                            NTRM4750
C     COMBINED VAPOR CALCULATIONS                                        NTRM4800
  203 MVI = 0.016018463*AIIMI/VC*MVF/MTVF*MVO/MTVO*DELTN*                NTRM4850
     1EXP(-1.8*EINT/(RGGS*TG))                                           NTRM4900
      IF(TINT-TG)206,206,208                                             NTRM4950
  206 MVI = 0.0                                                          NTRM5000
  208 DELMR=DELMRC                                                       NTRM5050
      IF(TCV-TG)210,210,212                                              NTRM5100
  210 DELMR=DELMRV                                                       NTRM5150
  212 CVP = 0.020833335*AIGN/VC*MVF/MTVF*MVO/MTVO*DELTN*                 NTRM5200
     1EXP(-1.8*EIGN/(RGGS*TG))-DELMR*MVI                                 NTRM5250
      MGN = ASTAR*SQRT(GC*KG*MTG/RFPS*(2.0/(KG+1.0))**((KG+1.0)/(KG-1.0)NTRM5300
     1))*PG*DELTN/SQRT(TG)                                               NTRM5350
C     GAS WALL HEAT TRANSFER                                             NTRM5400
      PR = CPG*MUG/RGG                                                   NTRM5450
      REY = 4.0*MGN/(PI*D*MUG*DELTN)                                     NTRM5500
      HC = 0.023*RGG/D*REY**0.8*PR**0.33                                 NTRM5550
      AC = PI*DL                                                         NTRM5600
      CVW = HC*AC*(TG-TW)*DELTN                                          NTRM5650
      RETURN                                                             NTRM5700
      END                                                                NTRM5750
```

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      SUBROUTINE  IGFUEL                                                        IGFU0100
C                                                                               IGFU0150
      COMMON  /IGN1/   C(3),  DELTN, LF,    LC,    L1F,   L1D,   TMAX         IGFU0300
     1,                D1,    N                                                IGFU0310
      COMMON  /IGN2/   EFINT, AIIMI, EINT,  AQIGN, EIGN,  DELHRC, DELHRV       IGFU0350
     1,                TINT,  TCV,   QEXICN,DPRT                               IGFU0360
      COMMON  /IGN3/   VC,    ASTAR, TW,    L,     D,     ACC                  IGFU0400
      COMMON  /IGN4/   CPC,   CVC,   KCG,   MG,    MGN,   MTG,   MUG          IGFU0450
     1,                TG,    PG,    MVI,   QVP,   QVW,   TIMEMS              IGFU0460
      COMMON  /IGN5/   NDF(3,401),   RDF(3,401),   UDF(3,401)                 IGFU0500
     1,                TDF(3,401),   RMODF(3,401), VDF(401)                    IGFU0510
     2,                JWALLF(401),  TIMPF(401)                                IGFU0520
      COMMON  /IGN5X/  MAXJF,        WDF(401),     JMAXF(401)                  IGFU0530
      COMMON  /IGN5A/  LIWF,  LITF,  LIMPF, CPSF,  CPVF,  MUVF,  KCF          IGFU0550
     1,                LMBDSF,LMBDFF,ALPMAF,STENF, THTF,  FMAXF, FMINF        IGFU0560
     2,                IVF,   EDVF,  CVVF,  PVF,   DELTNF,THETAF,NF           IGFU0570
     3,                MVF,   MDVF,  MWALLF,KDF,   NIF                        IGFU0580
      COMMON  /SVV/    DVI(9),MTDF,  MTVF,  DV2(4),MTDO,  MTVO,  DV3(2)       IGFU0692
     1,                LMBDFF,LMBDEO                                          IGFU0694
      COMMON  /IGNFIO/ TDFPF,CPLF,  TDFPO,CPLO                                IGFU0696
      COMMON  /IGNSCF/ WJF,   VJF,   TJF,   DV4(3),WJO,   VJO,   TJO          IGFU0698
      REAL    JC,    JWALLF,KCF,   KCG,   KG,    LIMF,  LITF,  LIMPF         IGFU0700
     1,       LMBO,  LMBDFF,LMBDSF,LMBDFF,MD,    MDV,   MDVF,  MFR           IGFU0710
     2,       MC,    MGN,   MI,    MMD,   MTDF,  MTG,   MTVF,  MUG           IGFU0720
     3,       MUVF,  MVI,   MVF,   MVWF,  MWALLF,ND,    NU,    NDF           IGFU0730
     4,       JWALL                                                          IGFU0740
      DATA GC,GFPS,RGGS,JC,PI/ 32.174,1545.3,1.9872,777.65,3.14159/           IGFU0800
C                                                                               IGFU0850
      IF(N.GE.1)  GO TO 2                                                     IGFU0860
      MAXJ = JMAXF(1)                                                         IGFU0870
    2 MAXJ = MAXO(MAXJ,JMAXF(1))                                              IGFU0890
C                                                                               IGFU1000
C     BEGIN FUEL CALCULATIONS                                                   IGFU1050
    3 IF(LF*N-NF)1003,1003,300                                                IGFU1100
  300 NF = NF+1                                                               IGFU1150
      MDVF = 0.0                                                              IGFU1400
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```
      EOVF = 0.0                                                        IGFU1450
C     INJECTED MASS                                                     IGFU1800
  303 MMD = WJF                                                         IGFU1900
C     NUMBER OF DROPS                                                   IGFU2000
  305 DO 510 I=1,3                                                      IGFU2050
      NDF(I,1) = C(I)*MMD/(4.*PI*RDF(I,1)**3*RHODF(I,1)/3.)            IGFU2100
       J = 1 + MINO(NF,MAXJ)                                            IGFU2150
      JJ = J                                                            IGFU2160
  500 J = J-1                                                           IGFU2200
      NDF(I,J+1) = NDF(I,J)                                             IGFU2250
      IF(I.GT.1)  GO TO 505                                             IGFU2260
      JWALLF(J+1) = JWALLF(J)                                           IGFU2270
      JMAXF(J+1) = JMAXF(J)                                             IGFU2280
      TIMDF(J+1) = TIMDF(J)                                             IGFU2284
      VDF(J+1) = VDF(J)                                                 IGFU2286
  505 IF(J.GT.1)  GO TO 500                                             IGFU2300
  510 CONTINUE                                                          IGFU2350
      J = JJ                                                            IGFU2400
    4 J = J-1                                                           IGFU2450
C     BEGIN DROP CALCULATIONS - I LOOP                                  IGFU2500
      I = 0                                                             IGFU2550
    5 I = I+1                                                           IGFU2600
      IF(J.GT.JMAXF(J+1))  GO TO 307                                    IGFU2620
      JWALL = JWALLF(J+1)                                               IGFU2630
      ND = NDF(I,J+1)                                                   IGFU2650
      VD = VDF(J+1)                                                     IGFU2670
      RD = RDF(I,J)                                                     IGFU2700
      TD = TDF(I,J)                                                     IGFU2720
      UD = UDF(I,J)                                                     IGFU2750
      RHOD = RHODF(I,J)                                                 IGFU2760
      LMBD = LMBDSF                                                     IGFU2770
      IF(TD.LE.TDFPF)  LMBD = LMBDSF                                    IGFU2780
      IF(RD-1.0E-10)307,307,308                                         IGFU2800
  307 RDF(I,J+1) = 0.0                                                  IGFU2850
      UDF(I,J+1) = 0.0                                                  IGFU2900
      VDF(I,J+1) = 0.0                                                  IGFU2950
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```
      GO TO 331                                                          IGFU3000
C     MASS AND SURFACE AREA OF A DROP                                    IGFU3050
  308 MD = 4.*PI*RD**3*RHOD/3.                                           IGFU3100
      AD = 4.0*PI*RD**2                                                  IGFU3150
C     DROP QUALITY (FRACTION FROZEN).                                    IGFU3450
      XD = 0.0                                                           IGFU3500
      IF(TD.GT.TDFPF)  GO TO 316                                         IGFU3550
      XD = 1. - (MD/MO - CPSF*TDFPF)/LMBDFF                              IGFU3600
      IF(XD.GT.1.)  XD = 1.0                                             IGFU3650
C     EVAPORATION                                                        IGFU3900
  316 MDV = 0.0                                                          IGFU3920
      IF(TIMEMS.GE.TIMPF(J+1))  MDV = ALPHAF*AD*(PFNCTF(TD)*SQRT(MTDF)   IGFU3940
     1                          *144. - PVF*SQRT(MTVF))*DELTNF*DI/SQRT(TD)  IGFU3960
      IF(MDV.LE.0.0)  GO TO 320                                          IGFU3980
C     DROPLET ENERGY IS PREVENTED FROM FALLING BELOW 0.5*CPS*TDFP        IGFU4000
        XMDV = (UD-MD*CPSF*TDFPF/2.)/(UD/MD+LMBD-CPSF*TDFPF/2.)          IGFU4020
        MDV = AMIN1(MDV,XMDV)                                            IGFU4040
C     GAS HEAT TRANSFER                                                  IGFU4250
  320 QGD = 0.0                                                          IGFU4300
      IF(0.0-MG)322,6,6                                                  IGFU4350
  322 REO = 2.*VD*RD*MG/(VG*MUG)                                         IGFU4400
      NU = 2.0+.6*(CPG*MUG/KCG)**(1.0/3.0)*REO**0.5                      IGFU4450
      Z = CPG*MDV/(2.0*PI*KCG*RD*NU*DELTNF)                              IGFU4500
      IF(20.0-Z)16,324,324                                               IGFU4550
  324 ZZ = 1.0                                                           IGFU4600
      IF(0.001-Z)326,327,327                                             IGFU4650
  326 ZZ = Z/(EXP(Z)-1.0)                                                IGFU4700
  327 QGD = ZZ*(NU*KCG/(2.0*RD))*AD*(TG-TD)*DELTNF                       IGFU4750
C     WALL HEAT TRANSFER                                                 IGFU4800
    6 QWD = 0.0                                                          IGFU4850
      F = 0.0                                                            IGFU4856
      IF(JWALL.GT.J)  GO TO 7                                            IGFU4860
C     CALCULATE WALL HEAT TRANSFER FACTOR.                               IGFU4870
      F = FMINF*DELTNF/DELTN                                             IGFU4880
      IF(NF .GE. JWALL*THTF/DELTNF)  GO TO 328                           IGFU4890
      F = (FMAXF-(NF-JWALL)*DELTNF*(FMAXF-FMINF)/THTF)*DELTNF/DELTN      IGFU4900
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  328 IF(TD.LT.0.8)  QMD = F*(TW-TD)**MD*CPLF                              IGFU5000
    7 CONTINUE                                                             IGFU5100
      EDV = MCV*(UD/MD + LMBD) - QGD                                       IGFU5160
        UDF(I,J+1) = UD + QMD - EDV                                        IGFU5200
      UD = UDF(I,J+1)                                                      IGFU5250
      MD = MD -MCV                                                         IGFU5300
C     DROP TEMPERATURE, DENSITY & RADIUS                                   IGFU5320
      IF((CPSF*TDFPF + LMBDFF)-UD/MD)  408,410,410                         IGFU5350
  408 TDF(I,J+1) = TDFPF + (UD/MD - CPSF*TDFPF - LMBDFF)/CPLF              IGFU5400
      GO TO 412                                                            IGFU5450
  410 IF(CPSF*TDFPF - UD/MD)  412,412,414                                  IGFU5500
  412 TDF(I,J+1) = TDFPF                                                   IGFU5550
      GO TO 416                                                            IGFU5600
  414 TDF(I,J+1) = UD/(MD*CPSF)                                            IGFU5650
  416 RHODF(I,J+1) = DENF(TDF(I,J+1))                                      IGFU5700
      RDF(I,J+1) = (MD/(4.*PI*RHODF(I,J+1)/3.))**0.33333                   IGFU5750
C     SUM MASS AND ENERGY TRANSFERRED FROM ALL DROPS                       IGFU5850
      MCVF = MCVF + MD*MCV                                                 IGFU5900
      ECVF = ECVF + MD*ECV                                                 IGFU5950
  331 IF(J-I)332,332,5                                                     IGFU6000
  332 IF(J.GT.1)  GO TO 4                                                  IGFU6050
C     END DROP CALCULATIONS                                                IGFU6100
C     ********** ** ********** ********** ********** **********           IGFU6150
C     BEGIN VAPOR CALCULATIONS                                             IGFU6200
C     CONDENSATION                                                         IGFU6250
  336 MVWF = ALPHAF*4CC*(PVF-144.*PFNCTF(TW))*D1*SQRT(MTDF/TW)*DELTNF      IGFU6300
  338 MVWF = AMAX1(MVWF,-MWALLF)                                           IGFU6500
C     MASS BALANCE ON CONDENSATION                                         IGFU6550
      MWALLF = MWALLF+MVWF                                                 IGFU6600
      MFR = 0.0                                                            IGFU6650
      IF(MG.GT.0.0)  MFR = MVF/MG                                          IGFU6700
        EVWF = 0.                                                          IGFU6750
      IF(MVF.GT.0.)  EVWF = EVF*MVWF/MVF                                   IGFU6760
      IF(MVWF.LT.0.0)  EVWF = EVWF + MVWF*CPVF*(TW-TC)                     IGFU6800
C     MASS BALANCE ON VAPOR                                                IGFU6850
  342 MVF = MVF+MCVF-MVWF-THETAF*MVI/LF-MFR*MGN/LF                         IGFU6900
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C     ENERGY BALANCE ON VAPOR                                                IGFU6950
      EVF = EVF*(1. - MGN/(LF*MG) - THETAF*MVI/(LF*MVF)) + MFR*CPVF/CPG*IGFU7000
     1          ((QVP - QVW + QEXIGN*DELTN)/LF - MGN*RFPS*TG/(JC*MTG)) IGFU7020
     2        + EDVF - EVWF                                                IGFU7040
      GO TO 3                                                               IGFU7100
C     END FUEL CALCULATIONS                                                 IGFU7150
 1003 RETURN                                                                IGFU7200
      END                                                                   IGFU7250


      SUBROUTINE  IGFEEL                                                    IGFE0100
C                                                                           IGFE0150
      COMMON  /IGN1/   C(3),  DELTN, LF,    LO,    LIF,   LIO,   TMAX      IGFE0300
     1,                D1,    N                                             IGFE0310
      COMMON  /IGN2/   QFINT, AIIMI, EINT,  AQIGN, EIGN,  DELHRC,DELHRV    IGFE0350
     1,                TINT,  TCV,   QEXIGN,DPRT                            IGFE0360
      COMMON  /IGN3/   VC,    ASTAR, TW,    L,     D,     ACC              IGFE0400
      COMMON  /IGN4/   CPG,   CVG,   KCG,   MG,    MGN,   MTG,   MUG       IGFE0450
     1,                TG,    PG,    MVI,   QVP,   QVW,   TIMEMS           IGFE0460
      COMMON  /IGN5/   NDF(3,401),   RDF(3,401),   UDF(3,401)              IGFE0500
     1,                TDF(3,401),   RHODF(     ), VDF(401)                IGFE0510
     2,                JWALLF(401),  TIMPF(                                IGFE0520
      COMMON  /IGN5K/  MAXJF,        WDF(40  ,     JMAXF(401)              IGFE0530
      COMMON  /IGN5A/  LIWF,  LITF,  LIMPF, CPSF,  CPVF,  MUVF,  KCF       IGFE0550
     1,                LMBDSF,LMBDFF,ALPHAF,STENF, THTF,  FMAXF, FMINF     IGFE0560
     2,                EVF,   EDVF,  CVVF,  PVF,   DELTNF,THETAF,NF        IGFE0570
     3,                MVF,   MDVF,  MWALLF,KDF,   NIF                     IGFE0580
      COMMON  /IGN6/   NDO(3,401),   RDO(3,401),   UDO(3,401)              IGFE0600
     1,                TDO(3,401),   RHODO(3,401), VDO(401)                IGFE0610
     2,                JWALLO(401),  TIMPO(401)                            IGFE0620
      COMMON  /IGN6K/  MAXJO,        WDO(401),     JMAXO(401)              IGFE0630
      COMMON  /IGN6A/  LIWO,  LITO,  LIMPO, CPSO,  CPVO,  MUVO,  KCO       IGFE0650
     1,                LMBDSO,LMBDFO,ALPHAO,STENO, THTO,  FMAXO, FMINO     IGFE0660
     2,                EVO,   EDVO,  CVVO,  PVO,   DELTNO,THETAO,NO        IGFE0670
     3,                MVO,   MDVO,  MWALLO,KDO,   NIO                     IGFE0680
```

```
      COMMON  /SVV/     DV1(8),MTDF,  MTVF,  DV2(4),MTDO,  MTVO,  DV3(2) IGFE0692
     1,                 LMBDEF,LMBDEO                                    IGFE0694
      COMMON  /IGNFED/ TDFPF,CPLF,  TDFPO,CPLO                           IGFE0696
      COMMON  /IGNGGF/ WJF,   VJF,   TJF,   DV4(3),WJO,   VJO,   TJO    IGFE0698
      REAL  JC,    JWALLF,JWALLO,KCF,   KCG,   KCO,   KG,    LIWF      IGFE0700
     1,     LIWO,  LITF,  LITO,  LIMPF, LIMPO, LMBD,  LMBDEF,LMBDFF    IGFE0710
     2,     LMBDSF,LMBDFO,LMBDFO,LMBDSO,MD,    MDV,   MDVF,  MDVO      IGFE0720
     3,     MFR,   MG,    MGN,   MI,    MMD,   MTDF,  MTDO,  MTG       IGFE0730
     4,     MTVF,  MTVO,  MUG,   MUVF,  MUVO,  MVI,   MVF,   MVO       IGFE0740
     5,     MVWF,  MVWO,  MWALLF,MWALLO,ND,    NU,    NDF,   NDO,   L  IGFE0750
     6,     KDF,   KDO                                                  IGFE0760
C                                                                       IGFE0900
      DATA  FACT,PI / 2.37,3.14159 /                                    IGFE1000
C                                                                       IGFE1050
      CALL  FEEDS                                                       IGFE1100
C                                                                       IGFE1120
      DELPVF = 144.*PFNCTF(TJF) - PG                                    IGFE1130
      DELPVO = 144.*PFNCTO(TJO) - PG                                    IGFE1140
C                                                                       IGFE1142
      VDF(1) = VJF                                                      IGFE1150
      VDO(1) = VJO                                                      IGFE1200
      TIMPF(1) = TIMEMS                                                 IGFE1420
      IF(DELPVF.LE.0.0)  TIMPF(1) = TIMEMS + 1000.*LIMPF/VJF            IGFE1440
      TIMPO(1) = TIMEMS                                                 IGFE1460
      IF(DELPVO.LE.0.0)  TIMPO(1) = TIMEMS + 1000.*LIMPO/VJO            IGFE1480
        VDTF = AMAX1(VJF,0.1)*DELTNF                                    IGFE1500
        VDTO = AMAX1(VJO,0.1)*DELTNO                                    IGFE1520
      JWALLF(1) = LIWF/VDTF                                             IGFE1540
      JWALLO(1) = LIWO/VDTO                                             IGFE1560
      JMAXF(1)  = LITF/VDTF                                             IGFE1580
      JMAXO(1)  = LITO/VDTO                                             IGFE1600
C                                                                       IGFE1950
   20 RDF(2,1) = RDFNCF(VJF)                                            IGFE2060
      RDF(1,1) = RDF(2,1)/FACT                                          IGFE2100
      RDF(3,1) = RDF(2,1)*FACT                                          IGFE2150
C                                                                       IGFE2152
```

```
   40 RDO(2,1) = RDFNCO(VJO)                                              IGFE2260
      RDO(1,1) = RDO(2,1)/FACT                                            IGFE2300
      RDO(3,1) = RDO(2,1)*FACT                                            IGFE2350
C                                                                         IGFE2400
      RHOF = DENF(TJF)                                                    IGFE2450
      RHOO = DENO(TJO)                                                    IGFE2500
C                                                                         IGFE2550
      DO 100  I=1,3                                                       IGFE2600
      TDF(I,1) = TJF                                                      IGFE2650
      RHODF(I,1) = RHOF                                                   IGFE2700
      UDF(I,1) = 4./3.*PI*RDF(I,1)**3*RHOF*(CPSF*TDFPF + LMBDFF           IGFE2750
     1           + CPLF*(TJF - TDFPF))                                    IGFE2760
      TDO(I,1) = TJO                                                      IGFE2800
      RHODO(I,1) = RHOO                                                   IGFE2850
      UDO(I,1) = 4./3.*PI*RDO(I,1)**3*RHOO*(CPSO*TDFPO + LMBDFO           IGFE2900
     1           + CPLO*(TJO - TDFPO))                                    IGFE2910
  100 CONTINUE                                                            IGFE2950
C                                                                         IGFE3000
      RETURN                                                              IGFE3050
      END                                                                 IGFE3100



      SUBROUTINE  IGOXID                                                  IGOX0100
C                                                                         IGOX0150
      COMMON  /IGN1/   C(3),  DELTN, LF,    LO,    L1F,   L1O,   TMAX   IGOX0300
     1,                D1,    N                                          IGOX0310
      COMMON  /IGN2/   QFINT, AIIMI, EINT,  AQIGN, EIGN,  DELHRC,DELHRV IGOX0350
     1,                TINT,  TCV,   QEXIGN,DPRT                        IGOX0360
      COMMON  /IGN3/   VC,    ASTAR, TW,    L,     D,     ACC           IGOX0400
      COMMON  /IGN4/   CPG,   CVG,   KCG,   MG,    MGN,   MTG,   MUG   IGOX0450
     1,                TG,    PG,    MVI,   QVP,   QVW,   TIMEMS       IGOX0460
      COMMON  /IGN6/   NDO(3,401),    RDO(3,401),    UDO(3,401)         IGOX0600
     1,                TDO(3,401),    RHODO(3,401), VDO(401)           IGOX0610
     2,                JWALLO(401),   TIMPO(401)                       IGOX0620
      COMMON  /IGN6X/  MAXJO,         WDO(401),     JMAXO(401)          IGOX0630
```

```
      COMMON  /IGN6A/  LIWO,  LITO,  LIMPO, CPSO,  CPVO,  MUVO,  KCO     IGOX0650
     1,                LMBDSO,LMBDFO,ALPHAO,STENO, TMTO,  FMAXO, FMINO  IGOX0660
     2,                EVO,   EDVO,  CVVO,  PVO,   DELTNO,THETAO,NO     IGOX0670
     3,                MVO,   MDVO,  MWALLO,KDO,   N1O                  IGOX0680
      COMMON  /SVV/    DV1(8),MTDF,  MTVF,  DV2(4),MTDO,  MTVO,  DV3(2) IGOX0692
     1,                LMBDEF,LMBDEO                                    IGOX0694
      COMMON  /IGNFED/ TDFPF,CPLF,  TDFPO,CPLO                          IGOX0696
      COMMON  /IGNGGF/ WJF,   VJF,   TJF,   DV4(3),WJO,   VJO,   TJO   IGOX0698
      REAL  JC,     JWALLO,KCO,   KCG,   KG,    LIWO,  LITO,  LIMPO   IGOX0700
     1,     LMBD,   LMBDEO,LMBDSO,LMBDFO,MD,    MDV,   MDVO,  MFR     IGOX0710
     2,     MG,     MGN,   MI,    MMD,   MTDO,  MTG,   MTVO,  MUG     IGOX0720
     3,     MUVO,   MVI,   MVO,   MVWO,  MWALLO,ND,    NU,    NDO     IGOX0730
     4,     JWALL                                                      IGOX0740
      DATA GC,RFPS,RCGS,JC,PI/ 32.174,1545.3,1.9872,777.65,3.14159/     IGOX0800
C                                                                       IGOX0850
      IF(N.GT.1)  GO TO 1002                                            IGOX0860
      MAXJ = JMAXO(1)                                                   IGOX0870
 1002 MAXJ = MAXO(MAXJ,JMAXO(1))                                        IGOX0890
C                                                                       IGOX1000
C     BEGIN OXIDIZER CALCULATIONS                                       IGOX1050
 1003 IF(LO*N-NO)2000,2000,1300                                         IGOX1100
 1300 NC = NO+1                                                         IGOX1150
      MDVO = 0.0                                                        IGOX1400
      EDVO = 0.0                                                        IGOX1450
C     INJECTED MASS                                                     IGOX1800
 1303 MMD = WJO                                                         IGOX1900
C     NUMBER OF DROPS                                                   IGOX2000
 1305 DO 1510 I=1,3                                                     IGOX2050
      NDO(I,1) = C(I)*MMD/(4.*PI*RDO(I,1)**3*RHODO(I,1)/3.)             IGOX2100
       J = 1 + MINO(NO,MAXJ)                                            IGOX2150
      JJ = J                                                            IGOX2160
 1500 J = J-1                                                           IGOX2200
      NDO(I,J+1) = NDO(I,J)                                             IGOX2250
      IF(I.GT.1)  GO TO 1505                                            IGOX2260
      JWALLO(J+1) = JWALLO(J)                                           IGOX2270
      JMAXO(J+1) = JMAXO(J)                                             IGOX2280
```

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      TIMPO(J+1) = TIMPO(J)                                                  IGOX2284
      VDO(J+1) = VDO(J)                                                      IGOX2286
 1505 IF(J.GT.1)  GO TO 1500                                                 IGOX2300
 1510 CONTINUE                                                               IGOX2350
      J = JJ                                                                 IGOX2400
 1004 J = J-1                                                                IGOX2450
C     BEGIN DROP CALCULATIONS - I LOOP                                       IGOX2500
      I = 0                                                                  IGOX2550
 1005 I = I+1                                                                IGOX2600
      IF(J.GT.JMAXO(J+1))  GO TO 1307                                        IGOX2620
      JWALL = JWALLO(J+1)                                                    IGOX2630
      ND = NDO(I,J+1)                                                        IGOX2650
      VD = VDO(J+1)                                                          IGOX2670
      RD = RDO(I,J)                                                          IGOX2700
      TD = TDO(I,J)                                                          IGOX2730
      UD = UDO(I,J)                                                          IGOX2750
      RHOD = RHODO(I,J)                                                      IGOX2760
      LMBD = LMBDEO                                                          IGOX2770
      IF(TD.LE.TDFPO)  LMBD = LMBDSO                                         IGOX2780
      IF(RD-1.0E-10)1307,1307,1308                                           IGOX2800
 1307 RDO(I,J+1) = 0.0                                                       IGOX2850
      UDO(I,J+1) = 0.0                                                       IGOX2900
      TDO(I,J+1) = 0.0                                                       IGOX2950
      GO TO 1331                                                             IGOX3000
C     MASS AND SURFACE AREA OF A DROP                                        IGOX3050
 1308 MD = 4.*PI*RD**3*RHOD/3.                                               IGOX3100
      AD = 4.0*PI*RD**2                                                      IGOX3150
C     DROP QUALITY (FRACTION FROZEN).                                        IGOX3450
      XD = 0.0                                                               IGOX3500
      IF(TD.GT.TDFPO)  GO TO 1316                                            IGOX3550
      XD = 1. - (UD/MD - CPSO*TDFPO)/LMBDFO                                  IGOX3600
      IF(XD.GT.1.)  XD = 1.0                                                 IGOX3650
C     EVAPORATION                                                            IGOX3900
 1316 MDV = 0.0                                                              IGOX3920
      IF(TIMEMS.GE.TIMPO(J+1))  MDV = ALPHAO*AD*(PFNCTO(TD)*SQRT(MTDO)       IGOX3940
     1                          *144. - PVO*SQRT(MTVO))*DELTNO*D1/SQRT(TD)   IGOX3960
```

```
      IF(MDV.LE.0.0)  GO TO 1320                                          IGOX3980
C     DROPLET ENERGY IS PREVENTED FROM FALLING BELOW 0.5*CPS*TDFP         IGOX4000
        XMDV = (UD-MD*CPSO*TDFPO/2.)/(UD/MD+LMBD-CPSO*TDFPO/2.)           IGOX4020
        MDV = AMIN1(MDV,XMDV)                                             IGOX4040
C     GAS HEAT TRANSFER                                                   IGOX4250
 1320 QGD = 0.0                                                           IGOX4300
      IF(0.0-MG)1322,1006,1006                                            IGOX4350
 1322 RED = 2.*VD*RD*MG/(VC*MUG)                                          IGOX4400
      NU = 2.0+0.6*(CPG*MUG/KCG)**(1.0/3.0)*RED**0.5                      IGOX4450
      Z = CPG*MDV/(2.0*PI*KCG*RD*NU*DELTNO)                               IGOX4500
      IF(30.0-Z)1006,1324,1324                                            IGOX4550
 1324 ZZ = 1.0                                                            IGOX4600
      IF(0.001-Z)1326,1327,1327                                           IGOX4650
 1326 ZZ = Z/(EXP(Z)-1.0)                                                 IGOX4700
 1327 QGD = ZZ*(NU*KCG/(2.0*RD))*AD*(TG-TD)*DELTNO                        IGOX4750
C     WALL HEAT TRANSFER                                                  IGOX4800
 1006 QWD = 0.0                                                           IGOX4850
      F = 0.0                                                             IGOX4856
      IF(JWALL.GT.J)  GO TO 1007                                          IGOX4860
C     CALCULATE WALL HEAT TRANSFER FACTOR.                                IGOX4870
      F = FMINO*DELTNO/DELTN                                              IGOX4880
      IF(NO .GE. JWALL+THTO/DELTNO)  GO TO 1328                           IGOX4890
      F = (FMAXO-(NO-JWALL)*DELTNO*(FMAXO-FMINO)/THTO)*DELTNO/DELTN       IGOX4900
 1328 IF(XD.LT.0.8)  QWD = F*(TW-TD)*MD*CPLO                              IGOX5000
 1007 CONTINUE                                                            IGOX5100
C     ENERGY BALANCE ON DROP                                              IGOX5150
      EDV = MDV*(UD/MD + LMBD) - QGD                                      IGOX5160
        UDO(I,J+1) = UD + QWD - EDV                                       IGOX5200
      UD = UDO(I,J+1)                                                     IGOX5250
      MD = MD - MDV                                                       IGOX5300
C     DROP TEMPERATURE, DENSITY & RADIUS                                  IGOX5320
      IF((CPSO*TDFPO + LMBDFO)-UD/MD)  1408,1410,1410                     IGOX5350
 1408 TDO(I,J+1) = TDFPO + (UD/MD - CPSO*TDFPO - LMBDFO)/CPLO             IGOX5400
      GO TO 1416                                                          IGOX5450
 1410 IF(CPSO*TDFPO - UD/MD)  1412,1412,1414                              IGOX5500
 1412 TDO(I,J+1) = TDFPO                                                  IGOX5550
```

```
      GO TO 1416                                                                IGOX5600
 1414 TDO(I,J+1) = UD/(MD*CPSO)                                                 IGOX5650
 1416 RHODO(I,J+1) = DENO(TDO(I,J+1))                                           IGOX5700
      RDO(I,J+1) = (MD/(4.*PI*RHODO(I,J+1)/3.))**0.33333                        IGOX5750
C     SUM MASS AND ENERGY TRANSFERRED FROM ALL DROPS                            IGOX5850
      MDVO = MDVO + ND*MDV                                                      IGOX5900
      EDVO = EDVO + ND*EDV                                                      IGOX5950
 1331 IF(3-I)1332,1332,1005                                                     IGOX6000
 1332 IF(J.GT.1)  GO TO 1004                                                    IGOX6050
C     END DROP CALCULATIONS                                                     IGOX6100
C     ***********************************************************************IGOX6150
C     BEGIN VAPOR CALCULATIONS                                                  IGOX6200
C     CONDENSATION                                                              IGOX6250
 1334 MVWO = ALPHAO*ACC*(PVO-144.*PFNCTO(TW))*D1*SQRT(MTDO/TW)*DELTNO           IGOX6300
 1338 MVWO = AMAX1(MVWO,-MWALLO)                                                IGOX6500
C     MASS BALANCE ON CONDENSATION                                              IGOX6550
      MWALLO = MWALLO+MVWO                                                      IGOX6600
      MFR = 0.0                                                                 IGOX6650
      IF(MG.GT.0.0)  MFR = MVO/MG                                               IGOX6700
        EVWO = 0.                                                               IGOX6750
      IF(MVO.GT.0.)  EVWO = EVO*MVWO/MVO                                        IGOX6760
      IF(MVWO.LT.0.0)  EVWO = EVWO + MVWO*CPVO*(TW-TG)                          IGOX6800
C     MASS BALANCE ON VAPOR                                                     IGOX6850
 1342 MVO = MVO+MDVO-MVWO-THETAO*MVI/LO-MFR*MGN/LO                              IGOX6900
C     ENERGY BALANCE ON VAPOR                                                   IGOX6950
      EVO = EVO*(1. - MGN/(LO*MG) - THETAO*MVI/(LO*MVO)) + MFR*CPVO/CPG*        IGOX7000
     1           ((QVP - QVW + QEXIGN*DELTN)/LO - MGN*RFPS*TG/(JC*MTG))         IGOX7020
     2         + EDVO - EVWO                                                    IGOX7040
      GO TO 1003                                                                IGOX7100
C     END OXIDIZER CALCULATIONS                                                 IGOX7150
 2000 RETURN                                                                    IGOX7200
      END                                                                       IGOX7250
```

PULSE / IGN SUBPROGRAM BLOCK

```
      FUNCTION  RDFNCF(V)                                          00000400
      RDFNCF = 9.84E-5                                             00000410
      RETURN                                                       00000420
      END                                                          00000430


      FUNCTION  RDFNCO(V)                                          00000500
      RDFNCO = 9.84E-5                                             00000510
      RETURN                                                       00000520
      END                                                          00000530
```

APPENDIX B

CARD CHANGES FOR SPECIAL DECK SETUP

```
      DATA CLBL/    21CH1     2     3     4     5     6     7     8      CNTRP110
     1*     A     B     C     D     E     F     G     H     I     J      CNTRP120
     2*     L     M     N     O     P     Q     R     S     T     U      CNTRP130
     3V     W     X     Y     Z     /                                    CNTRP132



      SUBROUTINE  S4MAT (L,F,KL)                                        S4MAT020
C                                                                       S4MAT030
C       FORTRAN IV VERSION                                              S4MAT040
C                                                                       S4MAT050
      DIMENSION  B(12), F(4)                                            S4MAT060
      DATA  A,B / 6HA4,I4), 72H1E12.5,60X  2E12.5,48X  3E12.5,36X  4E12.S4MAT070
     15,24X  5E12.5,12X  6E12.5      /                                  S4MAT080
C                                                                       S4MAT090
      IF(KL.GT.-1)  GO TO 10                                            S4MAT100
      INIT = 1                                                          S4MAT110
      F(4) = A                                                          S4MAT120
      KL = L                                                            S4MAT130
C                                                                       S4MAT140
   10 J = 2*L - 1                                                       S4MAT150
      F(2) = B(J)                                                       S4MAT160
      F(3) = B(J+1)                                                     S4MAT170
C                                                                       S4MAT180
      RETURN                                                            S4MAT190
      END                                                               S4MAT200



      SUBROUTINE  PUN(A,N,AID,NSEQ)                                     PUN00010
C                                                                       PUN00020
C       LIST  &  PUNCH  ARRAY  A  USING  1PE12.5  FORMAT                PUN00030
C          WITH  ID (AID) IN COL 73-76,  SEQUENCE (NSEQ+I) IN COL 77-80 PUN00040
C       FORTRAN IV VERSION                                              PUN00042
C                                                                       PUN00044
```

```
      DIMENSION  A(1), F(4)                                              PUN00050
      DATA  KL,BLANK,SPACE /-1, 6H(   1P, 6H(10X1P  /                    PUN00060
C                                                                        PUN00070
      DO 10  I1=1,N,6                                                    PUN00080
      NSEQ = NSEQ + 1                                                    PUN00090
      K = MINO(5,N-I1)                                                   PUN00100
      I2 = I1 + K                                                        PUN00110
      IF(K.NE.KL)  CALL  S4MAT(K,F,KL)                                   PUN00120
      F(1) = SPACE                                                       PUN00130
      WRITE(6,F)  (A(I),I=I1,I2), AID, NSEQ                              PUN00140
      F(1) = BLANK                                                       PUN00150
   10 PUNCH F,    (A(I),I=I1,I2), AID, NSEQ                            PUN00160
C                                                                        PUN00170
      RETURN                                                             PUN00180
      END                                                                PUN00190
```

```
      FUNCTION  SIND(X)                                          SIND0010
      SIND = SIN(X/57.2958)                                      SIND0020
      RETURN                                                     SIND0030
      END                                                        SIND0040


      FUNCTION  COSD(X)                                          COSD0010
      COSD = COS(X/57.2958)                                      COSD0020
      RETURN                                                     COSD0030
      END                                                        COSD0040


      FUNCTION  ARSIN(X)                                         ARSIN010
      ARSIN = ATAN(X/SQRT(1.-X*X))                               ARSIN020
      RETURN                                                     ARSIN030
      END                                                        ARSIN040


      SUBROUTINE  ERRTRA                                         ERRTRA10
      Y = 1.                                                     ERRTRA20
      RETURN                                                     ERRTRA30
      END                                                        ERRTRA40


      SUBROUTINE  TIME                                           TIME0010
      Y = 1.                                                     TIME0020
      RETURN                                                     TIME0030
      END                                                        TIME0040
```

```
      CALL PLOTN(NTHML,THETAM, NTHR,NTHL, NRWALL,RADM, NEL,THETAE,RADE, LISP4420
     1 LSPEC, IERR)                                                     LISP4440
      CALL CRTLBL(TITLEN,AMAT,ABSIN,ORDN)                               LISP4480
      CALL PLOT2(NTH,THETAM(I1),STRW1(I1),STRW2(I1),RADM(I1),ZOM,IERR)  LISP4620
      CALL CRTLBL(TITLE,AMAT,ABSI,ORD)                                  LISP4660
      IF(KCRT.EQ.1) CALL PLOTC(AMAT)                                    LISP4700
      IF(IERR.NE.25)                                                    N4MA2000
     X CALL PLOTT                                                       N4MA2010
      CALL LGRID(1, Z(1),Z(NP), -RMAX,RMAX, 24,0,24,45, IR)             STCRT450
      IF(IR.EQ.0) GO TO 140                                             STCRT460
        WRITE(6,130)                                                    STCRT470
  130   FORMAT(1H1////ESHCE R R O R   ENCOUNTERED IN PLOTTING STREAMTUBESTCRT480
     X RADII OSID )                                                     STCRT490
        GO TO 1000                                                      STCRT500
C                                                                       STCRT510
  140 DO 150 I=1,NST                                                    STCRT520
  150 CALL LINEC(-NP,Z,RST(1,I),1,1,2)                                  STCRT522
        DO 160 I=1,NP                                                   STCRT530
        RST(I,1) = SQRT(CCSAR(I)/3.14159)                               STCRT532
  160   RST(I,2) = -RST(I,1)                                            STCRT534
      CALL LINEC(-NP,Z,RST,1,1,2)                                       STCRT536
      CALL  APLOTV(NP,Z,RST,10,10,1,44,IR)                              STCRT538
      CALL  APLOTV(NP,Z,RST(1,2),10,10,1,44,IR)                         STCRT539
       CALL RITE2V(379,1014,1023,90,2,19,1,19HSTREAMTUBE  PROFILE, IL)  STCRT540
       CALL RITE2V(404,9,1023,90,2,14,1,14HAXIAL DISTANCE, IL)          STCRT550
       CALL RITE2V(9,496,1023,180,2, 6,1, 6HRADIUS, IL)                 STCRT560
C                                                                       STCRT570
          ICRTSD = 1                                                    CPM20778
      IF(ICRTSD.NE.1) GO TO 250                                         CPM20780
C       C R T   PLOT                                                    CPM20790
      CALL LGRID(0,0.,TR(50),0.,1., 24,0,24,45, IR)                     CPM20800
      CALL LINEC(50,TR,SPRAYF,1,1,2)                                    CPM20810
      CALL LINEC(50,TR,SPRAYO,1,1,2)                                    CPM20820
      CALL APLOTV(48,TR(2),SPRAYF(2),10,10,1,22,IR)                     CPM20830
      CALL APLOTV(48,TR(2),SPRAYO(2),10,10,1,38,IR)                     CPM20840
```

```
Y IL)                                                                    CPM20860
 CALL SITE2V(469,9,1023,90,2,9,1,9HTIME (MS), IL)                        CPM20870
 CALL SITE2V(9,370,1023,180,2,20,1,20HFRACTION UNVAPORIZED,IL)           CPM20880
   IF(ICRTP.EQ.1)  CALL PULPLT                                           PULS0824
 SUBROUTINE CRTLBL(TITLE, AMAT, ABSI,ORD)                                LBL00010
 SUBROUTINE  LGRID(K, X1,X2,Y1,Y2, ML,MR,MB,MT, IR)                      LGRID010
 SUBROUTINE SCALE(XMIN,XMAX,ND,X1,X2,DX, IERR)                           SCALE020
 SUBROUTINE LINEG(N,X,Y,NDX,NDY,L)                                       LINEC020
 SUBROUTINE  PLOTC(AMAT)                                                 PLOTC010
 SUBROUTINE  CLEVLS(NCLI,WMN,WMX)                                        CLEVL010
 SUBROUTINE  CONTSE                                                      CNTE0010
 SUBROUTINE  CONTPP(K,KX1,KY1,KX2,KY2)                                   CNTPP010
 SUBROUTINE  CONTUR ( NCLI, WMN, WMX, AMAT, TITLE)                       CONTR010
 SUBROUTINE PLOTN(NTH,TH,NTHR,NTHL,NR,R, NE,THE,RE,NTYPE,IERR)           PLNOC010
 SUBROUTINE PLOT2(N,X,Y1,Y2,RAD,ZOM,IERR)                                PLOT2010
 SUBROUTINE  PLOTT                                                       PLOT0010
 SUBROUTINE  PULPLT                                                      PPLT0010
 END
```

```
INSERT MAIN,PMPMID,PPIN,ENGBAL,CDTRAN,RTNI,FCTPIE                99990010
INSERT SCALE,LINEG,LGRID,CRTLBL,MXMN                             99990020
INSERT PUN,S4MAT                                                 99990022
INSERT YOF,LOCATE,XITRP,LOCFAC,DINTRP                            99990030
INSERT ITRP2,ITRP2I,ITRP2X                                       99990032
INSERT PMDER,HEADER                                              99990040
INSERT ADJ,ISCR                                                  99990042
OVERLAY A                                                        99990050
INSERT LISP                                                      99990052
INSERT LABML,SHAPEC                                              99990054
OVERLAY B                                                        99990060
INSERT EFLOW,DSIZE,SCOEF                                         99990062
INSERT FSA,FSB,FTSSA,FTSSB,FTDSA,FTDSB,FPSSA,FPDSA               99990070
OVERLAY B                                                        99990074
INSERT FAMIN,NFLUX,ENDY,SUMM,SUM2,SUMV                           99990076
OVERLAY B                                                        99990090
INSERT PLOTC,CONTUR,CONTRE,CONTRP,CLEVLS,MIXEFF                  99990100
INSERT CNTRE                                                     99990110
INSERT PLOIN,PLOT2                                               99990120
OVERLAY A                                                        99990130
INSERT PMSTC                                                     99990132
INSERT GRP,GAS,PCS                                               99990134
INSERT COM6,PS,SAVF,VAP,SUM,P,STKI                               99990136
OVERLAY C                                                        99990140
INSERT CINPUT,STAPE,SCRMBL,SORTR4,SCR                            99990142
INSERT CSTAP                                                     99990144
OVERLAY C                                                        99990160
INSERT CINIT,TABLES,PCCORD,STCRT,CHANGS                          99990162
OVERLAY D                                                        99990170
INSERT AVAP,KPRIME,ESHSM                                         99990172
OVERLAY D                                                        99990174
INSERT TRANS,N4MAIN,HALL,ITER,PLOTT                              99990176
OVERLAY D                                                        99990180
INSERT CSPRAY,EVAPS,CGDYN                                        99990182
INSERT CPRINT,AVD30A                                             99990184
INSERT PVSST,PVSR,ITERE                                          99990186
```

INSERT AND OVERLAY CARDS

```
INSERT CPM1                                                    99990138
OVERLAY C                                                      99990200
INSERT TRKSET                                                  99990210
OVERLAY A                                                      99990220
INSERT CPM2,PMWORK                                             99990230
OVERLAY A                                                      99990300
INSERT PULSE,FEEDS,FLOW,PFNCTF,PFNCTD                          99990310
INSERT TCSAV                                                   99990312
INSERT IGN1,IGN2,IGN4,CCASG,CTCOMB                             99990320
OVERLAY F                                                      99990330
INSERT PULSIN,PINIT,VALINP                                     99990340
OVERLAY F                                                      99990360
INSERT TCOMF,CASCEN,BOIL                                       99990370
INSERT ICNFX,IGN6X                                             99990372
OVERLAY F                                                      99990380
INSERT IGN,NTRNDT,TRCOIN,IGFUEL,IGFEED,IGOXID,VACIN,DENF,DENO  99990390
INSERT PDFNCF,PDFNCD                                           99990400
INSERT IGN5,IGN6,IGN7                                          99990410
OVERLAY F                                                      99990420
INSERT PULERT,DCYCCM                                           99990430
OVERLAY F                                                      99990440
INSERT PULPLT,PUNDCY,SAVEC                                     99990450
OVERLAY F                                                      99990460
INSERT DCYCLE,SYNTHE,DPUNIN                                    99990470
     END
```

APPENDIX C

INPUT DATA DECK LISTING FOR EXAMPLE CASE

EXAMPLE CASE INPUT DATA

```
[illegible] THRUSTER,  NTO/MMH  MR=1.6, PC=100, F=23, CR=2.54, BERRYLLIUM TC00000010
[illegible]                    NOZZLE EPS=9 WITH 22 DEG SCARF,          00000020
60 PCT DELL,  LC=2.10, DC=.676, DT=.424, LSTAR=5.3, ORIF DO=.042,F=.03700000030
* MST ANALYSIS *          NOMINAL CASE                                  00000040
          1          1          0          0                           00000050
          2          1          1          1          0                00000060
                   N T O / M M H      P = 100 PSIA                      00000090
         18          3          4         11                           00000100
    0.1        0.4        0.6        0.8        1.0        1.3          00000111
    1.6        1.8        2.0        2.2        2.5        2.9          00000112
    3.5        4.3        5.5        8.0       15.0       30.0          00000113
    0.         0.15       1.00                                         00000120
 1979.3     2301.1     2783.3     3574.8     4237.7     4974.0          00000211
 5414.6     5569.3     5643.9     5666.9     5647.1     5571.2          00000212
 5414.1     5174.0     4791.5     4023.3     2665.5     1500.0          00000213
  .0900      .1050      .1217      .1466      .1670      .1898          00000221
  .2039      .2091      .2121      .2137      .2144      .2138          00000222
  .2114      .2067      .1981      .1784      .1375      .0983          00000223
   1.276      1.320      1.321      1.290      1.269      1.249         00000231
   1.237      1.232      1.229      1.227      1.226      1.225         00000232
   1.225      1.227      1.233      1.247      1.280      1.321         00000233
  13.130     13.258     13.911     15.353     16.725     18.579         00000241
  20.147     21.029     21.794     22.460     23.314     24.252         00000242
  25.350     26.413     27.449     28.503     29.448     30.027         00000243
 2995.      3291.      3617.      3846.      3951.      3997.           00000251
 3922.      3874.      3817.      3760.      3682.      3587.           00000252
 3464.      3325.      3168.      2909.      2391.      1859.           00000253
 1975.7     2295.2     2773.7     3563.7     4226.1     4963.1          00000311
 5406.2     5562.0     5637.2     5660.4     5640.8     5564.8          00000312
 5407.5     5167.0     4783.6     4014.0     2657.4     1573.8          00000313
  .0899      .1049      .1215      .1463      .1667      .1895          00000321
  .2036      .2089      .2120      .2135      .2143      .2137          00000322
  .2112      .2065      .1979      .1781      .1372      .0981          00000323
   1.276      1.320      1.321      1.290      1.269      1.249         00000331
   1.237      1.232      1.229      1.227      1.226      1.225         00000332
   1.225      1.227      1.233      1.247      1.280      1.322         00000333
```

EXAMPLE CASE INPUT DATA

13.135	[illegible]	[illegible]	[illegible]	[illegible]	18.582	00000341
20.152	21.035	21.600	22.467	[illegible]		
25.357	26.419	27.454	28.504	29.448	30.027	00000343
2995.	3291.	3617.	3846.	3951.	3997.	00000351
2992.	3874.	3817.	3760.	3682.	3587.	00000352
3464.	3335.	3168.	2909.	2391.	1859.	00000353
1835.6	2084.9	2401.9	3121.9	3756.6	4530.6	00000411
5055.1	5258.8	5362.9	5399.9	5386.7	5309.2	00000412
5141.3	4878.0	4451.8	3633.1	2337.9	1356.6	00000413
.0855	.0984	.1104	.1338	.1540	.1782	00000421
.2041	.1986	.1885	.1665	.1259	.0887	00000422
.1946	.2012	.2050	.2068	.2077	.2069	00000423
1.276	1.322	1.331	1.299	1.275	1.251	00000431
1.237	1.231	1.227	1.225	1.223	1.223	00000432
1.324	1.227	1.234	1.251	1.287	1.333	00000433
13.367	13.450	13.922	15.356	16.743	18.670	00000441
20.335	21.273	22.074	22.760	23.625	24.560	00000442
25.435	26.652	27.602	28.539	29.448	30.027	00000443
2850.1	3071.6	3363.4	3616.9	3756.0	3827.7	00000451
3799.1	3750.6	3697.2	3643.5	3568.4	3476.1	00000452
3356.3	3224.3	3062.8	2784.0	2251.6	1730.3	00000453
4227.	4477.	4703.	5113.	5382.	5616.	00000501
5702.	5696.	5652.	5588.	5479.	5335.	00000502
5137.	4902.	4592.	4064.	3197.	2405.	00000503
20.	30.	40.	60.			00000510
1.8493	1.8571	1.8249	1.7653	1.7579	1.7750	00000521
1.8020	1.8274	1.8534	1.8763	1.8920	1.8834	00000522
1.8622	1.8343	1.8018	1.7689	1.7349	1.7181	00000523
1.8936	1.9030	1.8688	1.8024	1.7901	1.8066	00000531
1.9373	1.9642	1.8933	1.9200	1.9417	1.929e	00000532
1.9039	1.9716	1.8351	1.7979	1.7588	1.742	00000533
1.9231	1.9331	1.8978	1.8269	1.8113	1.8266	00000541
1.8589	1.8875	1.9186	1.9478	1.9738	1.9590	00000542
1.9300	1.9950	1.8559	1.8157	1.7735	1.760	00000543
1.9612	1.9723	1.9258	1.8594	1.8396	1.8521	00000551
1.9963	1.9168	1.9505	1.9828	2.0149	1.9961	00000552

EXAMPLE CASE INPUT DATA

```
  1.9831      1.9245      1.8817      1.8376      1.803       1.7918  00000553
  54.6        90.66                                                   00000570
100.          45.5        82.6        -0.04       -0.04        3.81 -0400000580
  4.33 -04    34.3        26.5         5.60 -04    2.77 -04            00000590
   0.         500.       1000.       1500.       2000.       3000.    00000600
4000.         4500.      5000.       5400.       5667.                00000610
   .0          .34         .551        .653        .751        .821   00000620
   .862        .879        .892        .903        .910               00000630
   .0          .0210       .0383       .0550       .0700       .0960  00000640
   .1150       .1221       .1278       .1300       .1255              00000650
   0.         500.       1000.       1500.       2000.       3000.    00000660
4000.         4500.      5000.       5400.       5667.                00000670
   .0          .20         .242        .259        .270        .284   00000680
   .293        .297        .301        .305        .308               00000690
   .0          .0124       .0232       .0330       .0442       .0600  00000700
   .0780       .0877       .0990       .1010       .1255              00000710
 640.0       530.1        50.7        90.0       1053.3       776.5   00000720
 779.        618.         45.5        82.6                            00000730
  46.072      92.011      46.072      46.005      458.        186.    00000740
       9           10          9           10                         00000750
400.          480.        530.        560.        640.        720.    00000760
800.          880.                                                    00000770
 58.7         56.4        54.6        53.8        51.1        48.0    00000780
 44.4         40.9                                                    00000790
400.          500.        530.        540.        580.        620.    00000800
660.          700.        740.        770.                            00000810
 99.7         92.5        90.66       89.4        86.0        84.1    00000820
 77.7         71.8        63.0        55.0                            00000830
427.          480.        520.        560.        620.        680.    00000840
760.          840.        920.                                        00000850
    .01          .119        0.53        1.78        7.7        24.5  00000860
  80.         212.        440.                                        00000870
400.          460.        500.        540.        580.        620.    00000880
660.          700.        740.        780.                            00000890
   2.3          2.0         6.2        18.4        48.5       112.    00000900
236.          470.        832.       1500.                            00000910
```

EXAMPLE CASE INPUT DATA

```
 398.          0.72        472.          0.42                                  00000920
        1             1                                                        00001000
        1             1     .0372        .0420                                 00001010
199.8        214.8          1.60        100.8          1.0527                 00001030
  0.7790       0.9569       0.9772        0.998                                00001040
  0.424        1.5          0.676         0.005         0.50                   00001050
  0.1142       0.           0.0048        0.            0.           -4.6456-400001060
  0.1222       0.           0.0048        0.            0.           -5.3754-400001070
                                                                              00002010
                                                                              00002020
   1    20    19    16     1    19     1     0     0     1     2            100002030
   1    19   -14   -14   -14   -14                                            00002040
   8    16                                                                    00002050
  0.676       10.          0.           0.5                                   00002060
  0.09664                                                                     00002070
   1     1     2     0                                                        00002110
  0.0372       0.0420       0.781        0.746         0.030        80.       00002120
 0.          -5.                                                              00002130
        1    0.           0.           0.                                     00003010
 0.          -1.          0.          -1.            0.           -1.         00004010
 0.           1.                                                              00004020
        2             9            12             6            81            300005010
        4             4             1            10            10             00005020
  0.           .675        1.685         .676         2.1           .424       00005030
  1.272        0.           0.9414       0.5           0.03         0.03       00005050
  0.5                                                                         00005060
```

* * PULSE AND DCYCLE SUBMITTED SEPARETELY * *

```
        4             2             0             1             0             000006010
  0.2         30.         530.          0.          530.         530.        00006020
 27.          27.           0.0462       0.00823      0.5        2000.        00006030
  0.15         0.20        620.         620.                                  00006040
 30.          60.         120.         240.                                  00006050
```

EXAMPLE CASE INPUT DATA

```
 630.        2000.                                                          00006000
        2           2           2           2                               00006100
   0.          1.                                                           00006110
   0.          1.                                                           00006120
   0.          1.                                                           00006130
   1.          0.                                                           00006140
   0.          1.                                                           00006150
   0.          1.                                                           00006160
   0.          1.                                                           00006170
   1.          0.                                                           00006180
   0.02        4.          4.3         0.          4.1         0.           00006190
   0.02        4.          4.3         0.          4.1         0.           00006200
   0.41        0.41        0.00340     0.00332     0.190       0.272        00006210
   0.700       2.1         1.2708      4.31         .094        .076        00006300
   0.9414      1.722-05                                                     00006310
0.0         3.56879E-02 7.13757E-02 1.07064E-01 1.42751E-01 1.78439E-0100006321
2.14127E-01 2.49815E-01 2.85503E-01 3.21191E-01 3.56878E-01 3.92566E-0100006322
4.28254E-01 4.63942E-01 4.99630E-01 5.35317E-01 5.71005E-01 6.06693E-0100006323
6.42381E-01 6.78069E-01 7.13757E-01 7.49445E-01 7.85132E-01 8.20820E-0100006324
8.56508E-01 8.92196E-01 9.27884E-01 9.63572E-01 9.99259E-01 1.03495E 0000006325
1.07063E 00 1.10632E 00 1.14201E 00 1.17770E 00 1.21339E 00 1.24907E 0000006326
1.28476E 00 1.32045E 00 1.35614E 00 1.39183E 00 1.42751E 00 1.46320E 0000006327
1.49889E 00 1.53458E 00 1.57026E 00 1.60595E 00 1.64164E 00 1.67733E 0000006328
1.71302E 00 1.74870E 00                                                     00006329
1.00000E 00 9.98937E-01 9.97874E-01 9.96811E-01 9.95747E-01 9.94684E-0100006330
9.93621E-01 9.92558E-01 9.91495E-01 9.90432E-01 9.89369E-01 9.88305E-0100006331
9.87242E-01 9.86179E-01 9.70936E-01 9.34031E-01 8.92483E-01 8.46291E-0100006332
7.95456E-01 7.42299E-01 6.88955E-01 6.37114E-01 5.87905E-01 5.42217E-0100006333
5.00490E-01 4.62667E-01 4.29235E-01 3.98287E-01 3.68461E-01 3.33764E-0100006334
3.09152E-01 2.73825E-01 2.51081E-01 2.31360E-01 1.88609E-01 1.73175E-0100006335
1.27199E-01 1.05748E-01 3.66425E-02 2.15166E-02 5.37141E-03 0.0         00006336
0.0         0.0         0.0         0.0         0.0         0.0         00006337
0.0         0.0                                                          00006338
1.00000E 00 9.98650E-01 9.97300E-01 9.95949E-01 9.94599E-01 9.93249E-0100006339
9.91899E-01 9.90549E-01 9.89198E-01 9.87848E-01 9.86498E-01 9.85148E-0100006340
9.83798E-01 9.82447E-01 9.81097E-01 9.79747E-01 9.50849E-01 9.11262E-0100006341
```

EXAMPLE CASE INPUT DATA

```
8.67379E-01 8.19200E-01 7.66725E-01 7.09955E-01 6.48889E-01 5.83527E-0100006342
5.16017E-01 4.55993E-01 4.02924E-01 3.55404E-01 3.13017E-01 2.75434E-0100006343
2.42524E-01 2.13715E-01 1.88353E-01 1.65801E-01 1.46456E-01 1.29303E-0100006344
1.13045E-01 9.84642E-02 8.66756E-02 7.60586E-02 6.15273E-02 5.24171E-0200006345
4.56805E-02 3.86535E-02 2.99073E-02 1.35626E-02 9.62233E-03 3.76962E-0300006346
2.01059E-03 0.0                                                          00006347
DUTY CYCLE TO EVALUATE TWALL, TON & TOFF PARAMETERS                      00007400
TOFF = 30,60,120,240,1K(TON=30)      TON = 30,60,120,240,1K(TOFF=60)     00007410
        10     0.60                                                      00007412
         1            010000.        60.         60.                     00007414
        10            2   30.        30.         30.                     00007420
        10            2   30.        60.         60.                     00007430
        10            2   30.       120.        120.                     00007440
        10            2   30.       240.        240.                     00007450
        10            2   30.      1000.       1000.                     00007460
        10            2   60.        60.         60.                     00007490
        10            2  120.        60.         60.                     00007500
        10            2  240.        60.         60.                     00007510
        10            2 1000.        60.         60.                     00007520
```