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AEROX – COMPUTER PROGRAM FOR TRANSONIC AIRCRAFT AERODYNAMICS TO HIGH ANGLES OF ATTACK

VOLUME III – AEROX COMPUTER PROGRAM LISTING

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16. Abstract

The theory, users' guide, test cases, and program listing are presented in the three volumes. The AEROX program estimates lift, induced-drag and pitching moments to high angles of attack (typ. 60°) for wings and for wing-body combinations with or without an aft horizontal tail. Minimum drag coefficients are not estimated, but may be input for inclusion in the total aerodynamic parameters which are output in listed and plotted formats.

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C       MAIN DRIVER PROGRAM
C
C       NEW VERSION CREATED ON 6/10/76
C
        COMMON /WING/ ARW,SPANW,SWING,TRW,CROOT,CTIP,CRUSW,TCRW,TCTW,TCWP,-
       1TCW,SOW,SWPW,SWPWLE,XOMAC,CSWOC,SEXT,XEXT,FLEX,TDIF,FINT,DELX
        COMMON /DISPLY/ LDISP(6),DDISP(4),TITLE(14),PPLOT
        COMMON /FWING/ CLW(20,20),CDW(20,20),CLWU(20,20),CLWL(20,20),     -
       1CDSFP(20,20),CLOS,DL(20,20),CLALF(20,20),CMU(20),CDU(20),CLM,CLMU,-
       2DLMU,CPLIM,CP2,CPMXS
        COMMON /FTOTAL/ CL(20,20),CDL(20,20)
        COMMON /NOSE/ BDMAX,ASECT,APLAN,XLN,CLN(20,20),CDN(20,20),        -
       1CMNOSE(20,20),XLB,CLOB(20),CMOB(20),CDOB(20)
        COMMON /TAIL/ SHOR,SHOSW,AOHOR,YHOR,CLH(20,20),CDH(20,20),SOH,ARH,-
       1ALFTR(20,20)
        COMMON /FLOW/ SMN(20),NSMN,RNLUC(20),I6A,I6B,I6C,Z(20,20),AMC
        COMMON /AFOIL/ ALELJ,XCD,SHK,ROC
        COMMON /TRIM/ CLI,CLT,I,K,LL,ALPHA,DCDTR(20,20),DALTR(20,20),     -
       1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,-
       2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDD
        COMMON /TROUT/ STM(20,20),DFLH(20,20),DWASH(20,20),DWASHR(20,20)
        DIMENSION FOILID(10),TRIMID(4),XCDID(4),FLEXID(4),CDOID(4),X(4),  -
       1CLOD(20,20),CDTOT(20,20)
        INTEGER ALELJ,Z,DDISP,PPLOT,ALELJI
        REAL  MNARW,MXARW,INARW,MNTRW,MXTRW,INTRW,MNSOW,MXSOW,INSOW,MNALF,-
       1MXALF,INALF,MNXCD,MXXCD,INXCD,LE,LT,IT
        DATA FOILID/4HSHAR,4HP   ,4H230,,4H00XX,4H6 SE,4HRIES,4HSLAB,4H   -
       1 ,4HROC ,4HSPEC/,BLANK/4H    /
        DATA TRIMID/4HUNTR,4HIMD ,4HTRIM,4HMED)/
        DATA XCDID/4HCONS,4HTANT,4HVARI,4HABLE/
        DATA FLEXID/4HSLEN,4HDER ,4HRE-F,4HNTRY/
        DATA CDOID/4HCDO=,4HU.O ,4HCDO ,4HDFF /
        DATA RAD/57.29578/
        NAMELIST /ARRAYS/ NSMN,SMN,ICDD,CDU,CMU,CLOB,CDOB,CMOB,ITRIM
        NAMELIST /WINGIN/ ALELJ,MNARW,MXARW,INARW,MNTRW,MXTRW,INTRW,MNSOW,-
       1MXSOW,INSOW,CLO,SWING,SPANW,CROOT,CTIP,TCRW,TCTW,XOMAC,CHARW,ROC, -
       2SEXT,XEXT,IFLEX
        NAMELIST /NOSEIN/ BDMAX,XLN,XLB,XCG
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```
      NAMELIST /TAILIN/ SHOR,XQHOR,ARH,SQH,YHOR,IT
      NAMELIST /FLOWIN/ MNALF,MXALF,INALF,MNXCD,MXXCD,INXCD,IXCD,SHK,    -
     1ALTV
      NAMELIST /FACTOR/ FTOTL,FTOTD,FCM
      NAMELIST /OUTPUT/ IDATA,ITABL,IPLOT,PPLOT,LDISP,DDISP
      DO 20 JJ=1,20
      DO 20 II=1,20
      DWASH(II,JJ)=0.
   20 DELH(II,JJ)=0.
      DO 30 II=1,14
   30 TITLE(II)=BLANK
C
C
C     ITRIM=0: CALCULATES UNTRIMMED CHARACTERISTICS
C     ITRIM=1: CALCULATES UNTRIMMED AND TRIMMED CHARACTERISTICS
C
C       LDISP(1)=1: HOR. TAIL LIFT COEFF. IS PLOTTED
C       LDISP(2)=1: NOSE        ?     ?     ?     ?
C       LDISP(3)=1: LOWER WING  ?     ?     ?     ?
C       LDISP(4)=1: UPPER WING  ?     ?     ?     ?
C       LDISP(5)=1: TOTAL WING  ?     ?     ?     ?
C       LDISP(6)=1: TOTAL AIRCRAFT    ?     ?     ?
C
C       DDISP(1)=1: NOSE      DRAG COEFFICIENT IS PLOTTED
C       DDISP(2)=1: SEPARATION   ?    ?    ?
C       DDISP(3)=1: TOTAL WING    ?      ?      ?      ?
C       DDISP(4)=1: TOTAL AIRCRAFT       ?      ?      ?
C
C
C     LTABL  = 1 : A TABLE OF THE GEOMETRY INPUTS IS PRINTED
C              0 : NO TABLE IS PRINTED
C
C     LSTOUT = 1: AN OUTPUT  LISTING OF FORCE COEFFICIENTS IS PRODUCED
C              0: NO OUTPUT TABLE IS PRODUCED
C
C
C
      READ (5,120) TITLE
      READ (5,ARRAYS)
```

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      READ (5,WINGIN)
      READ (5,NUSEIN)
      READ (5,TAILIN)
      READ (5,FLOWIN)
      READ (5,FACTOR)
      READ (5,OUTPUT)
      CALL AT62 (ALTV,X)
      CLOS=CLO
      T=X(3)*1.8
      IF (T.GE.225.) VISC=2.27E-8*SQRT(T**3)/(T+198.6)
      IF (T.LT.225.) VISC=.8038E-9*T
      DO 40 I=1,NSMN
      V=SMN(I)*X(4)
      RNLOC(I)=X(1)*V/VISC
   40 CONTINUE
      I1A=INT(MNARW*100.+.01)
      I1B=INT(MXARW*100.+.01)
      I1C=INT(INARW*100.+.01)
      I3A=INT(MNSQW*1000.+.5)
      I3B=INT(MXSQW*1000.+.5)
      I3C=INT(INSQW*1000.+.5)
      I4A=INT(MNTRW*1000.+.5)
      I4B=INT(MXTRW*1000.+.5)
      I4C=INT(INTRW*1000.+.5)
      I5A=INT(MNXCD*1000.+.01)
      I5B=INT(MXXCD*1000.+.01)
      I5C=INT(INXCD*1000.+.01)
      I6A=INT(MNALF*100.+.01)
      I6B=INT(MXALF*100.+.01)
      I6C=INT(INALF*100.+.01)
      IPAGE=1
      NPLOT=1
C
C******WING ASPECT RATIO=ARW
C
      DO 110 I1=I1A,I1B,I1C
      ARW=FLOAT(I1)/100.
C
```

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C*****WING SWEEP OF QUARTER CHORD--SQW
C
      DO 110 I3=I3A,I3B,I3C
      SQW=FLOAT(I3)/1000.
      IF (SQW.GT.89.95) SQW=89.95
      SWPW=SQW/RAD
      IF (SWPW.EQ.0.) SWPW=0.01
C
C******TAPER RATIO-TRW
C
      DO 110 I4=I4A,I4B,I4C
      TRW=FLOAT(I4)/1000.
      IF (TRW.GT.1.) TRW=1.
      CALL GEOM1
C
C******CHORDWISE SHOCK LOCATION-XCD
C
      DO 110 I5=I5A,I5B,I5C
      XCD=FLOAT(I5)/1000.
      IF (XCD.GT.1.) XCD=1.
      CALL AXE
      ISMN=1
      DO 100 I=1,NSMN
      IF (ITABL.EQ.0) GO TO 50
      ALELJI=ALELJ*2-1
      IDTRIM=(ITRIM(I)+1)*2-1
      IDXCD=(IXCD+1)*2-1
      IDFLEX=(IFLEX+1)*2-1
      IDCDO=(ICDO+1)*2-1
      RN106=RNLOC(I)/1.E6
      WRITE (6,130) TITLE,IPAGE,ALELJ,FOILID(ALELJI),FOILID(ALELJI+1)
      WRITE (6,140) ARW,CDO(I),XCG,ARH,SMN(I),SWING,CLO,XLB,SHOR,
     1ITRIM(I),TRIMID(IDTRIM),TRIMID(IDTRIM+1)
      WRITE (6,150) SPANW,CMO(I),BOMAX,XOHOR,IXCD,XCDID(IDXCD),    XCDID-
     1(IDXCD+1),CROOT,SEXT,XLN,YHOR,ICDO,CDOID(IDCDO),CDOID(IDCDO+1)
      WRITE (6,160) CTIP,XEXT,ASECT,SGH,IFLEX,FLEXID(IDFLEX),
     1FLEXID(IDFLEX+1),TRW,XOMAC,APLAN,IT,ALTV
      WRITE (6,170) SQW,CBARW,CLOB(I),LT,RN106,SWPWLE,SHK,CDOB(I),LE,AMC
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      WRITE (6,180) TCRW,XCD,CMOB(I),TCTW
   50 IF (IDATA.EQ.0) GO TO 70
      IF (ITABL.EQ.0) WRITE (6,190) IPAGE
      WRITE (6,200)
      DO 60 I6=I6A,I6B,I6C
      K=(I6-I6A)/I6C+1
      CDTOT(I,K)=CDL(I,K)+CDO(I)
      CLOD(I,K)=CL(I,K)/CDTOT(I,K)
      ALPHA=FLOAT(I6)/100.
      WRITE (6,210) ALPHA,CL(I,K),CDTOT(I,K),CLW(I,K),CDW(I,K),CLWU(I,K)=
     1,CLWL(I,K),CLN(I,K),CDN(I,K),CLH(I,K),CDH(I,K),DWASH(I,K),        =
     2CDSEP(I,K),CLALF(I,K),Z(I,K),CM(I,K),CLOD(I,K),DELH(I,K),         =
     3DALTR(I,K),ALFTR(I,K)
   60 CONTINUE
      IF (ITRIM(I).EQ.0) GO TO 70
      WRITE (6,220) ISMN
      ISMN=ISMN+1
C.....PRINT ON OUTPUT FILE: CORRECTED COEFFICIENTS
   70 IF (FTOTL.EQ.1.0.AND.FTOTD.EQ.1.0.AND.FCM.EQ.1.0) GO TO 90
      IF (IDATA.NE.0) WRITE (6,230) TITLE,SQW,FTOTL,IT,FTOTD,SMN(I),FCM,=
     1XCD
      DO 80 I6=I6A,I6B,I6C
      K=(I6-I6A)/I6C+1
      ALPHA=FLOAT(I6)/100.
      CL(I,K)=CL(I,K)*FTOTL
      CDL(I,K)=CDL(I,K)*FTOTD
      CM(I,K)=CM(I,K)*FCM
      IF (ITABL.NE.0) WRITE (6,240) ALPHA,CL(I,K),CDL(I,K),CM(I,K),      =
     1ALFTR(I,K)
   80 CONTINUE
   90 IF (ITRIM(I).NE.0) GO TO 100
      IF (IPLOT.EQ.1) CALL PLOT (NPLOT)
      IPAGE=IPAGE+1
      NPLOT=NPLOT+1
  100 CONTINUE
      IF (ITRIM(I).NE.1) GO TO 110
      IF (IPLOT.EQ.1) CALL MPLOT (NPLOT)
      IPAGE=IPAGE+1
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      NPLOT=NPLOT+1
  110 CONTINUE
      STOP
C
  120 FORMAT (14A4)
  130 FORMAT (1H1,T50,20HGEOMETRY  DATA :     ,14A4,T129,I2///T25,4HWING,=
     1T61,9HBODY/NOSE,T85,15HHORIZONTAL TAIL,T112,15HFLOW PARAMETERS//  =
     2T17,8HALELJ = ,I1,2H (,2A4,1H)/)
  140 FORMAT (T4,9HARW     = ,F4.3,T28,8HCDO    = ,F6.4,T56,8HXCG    = ,    =
     1F7.3,3H FT,T82,8HARH    = ,F5.3,T108,8HSMN    = ,F6.3,5H MACH/T4,    =
     29HSWING  = ,F6.1,6H SQ FT,T28,8HCLD    = ,F5.3,T56,8HXLB    = ,F7.3,=
     33H FT,T82,8HSHOR  = ,F6.1,6H SQ FT,T108,8HITRIM = ,I1,2H (,2A4)
  150 FORMAT (T4,9HSPANW   = ,F6.2,3H FT,T28,8HCMU    = ,F5.3,T56,         =
     18HBDMAX = ,F6.3,3H FT,T82,8HXOHOR = ,F6.2,3H FT,T108,8HIXCD   = ,I1=
     2,2H (,2A4,1H)/T4,9HCROOT  = ,F6.3,3H FT,T28,8HSEXT   = ,F6.2,      =
     36H SQ FT,T56,8HXLN    = ,F6.3,3H FT,T82,8HYHOR   = ,F7.3,3H FT,T108,=
     48HICDO   = ,I1,2H (,2A4,1H))
  160 FORMAT (T4,9HCTIP    = ,F6.3,3H FT,T28,8HXEXT   = ,F6.3,3H FT,T56,  =
     18HASECT = ,F6.2,6H SQ FT,T82,8HSOH    = ,F5.2,4H DEG,T108,         =
     28HIFLEX = ,I1,2H (,2A4,1H)/T4,9HTRW     = ,F6.4,T28,8HXOMAC = ,    =
     3F6.2,3H FT,T56,8HAPLAN = ,F6.1,6H SQ FT,T82,8HIT     = ,F6.2,4H DEG=
     4,T108,8HALTV   = ,F7.0,3H FT)
  170 FORMAT (T4,9HSOW     = ,F5.2,4H DEG,T28,8HCBARW = ,F6.3,3H FT,T56,  =
     18HCLOB   = ,F6.4,T82,8HLT     = ,F6.2,3H FT,T108,8HRNLOC = ,F8.6,    =
     27HE6 1/FT/T4,9HSWPWLE = ,F5.3,4H RAD,T28,8HSHK    = ,F6.4,4H RAD,    =
     3T56,8HCDOB   = ,F6.4,T82,8HLE     = ,F6.2,3H FT,T108,8HAMC    = ,F5.2=
     4,4H DEG)
  180 FORMAT (T4,9HTCRW    = ,F6.4,T28,8HXCD    = ,F5.3,9H OF CHORD,T56,   =
     18HCMOB   = ,F6.4/T108,T4,9HTCTW    = ,F6.4)
  190 FORMAT (1H1,T129,I2)
  200 FORMAT (//T55,26HFORCE  COEFFICIENTS  TABLE///T3,13HALPHA  CLTOT ,=
     163H CDTOT   CLW    CDW    CLWU   CLWL    CLN    CDN    CLHOR  CDHOR =
     2,54HDWASH  CDSEP  DLWING 7   CM     L/D    DELH DALTR ALFTR/)
  210 FORMAT (3X,F4.1,1X,10(F6.4,1X),F5.2,1X,F6.4,1X,F7.4,1X,I1,1X,F6.3,=
     11X,F6.3,1X,F5.1,1X,F5.2,1X,F4.1)
  220 FORMAT (T66,1H(,I1,1H))
  230 FORMAT (1H1/T36,14A4///T25,14HGEOMETRY DATA,T54,7HFACTORS///T21,   =
     18HSOW   = ,F5.2,8H DEGREES,T50,10HFTOTL   = ,F6.3/T21,7HIT    = ,   =
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22900        2F6.2,8H DEGREES,T50,10HFTOTD  =  ,F6.3/T21,8HSMN  =  ,F6.3,5H MACH=
23000        3,T50,10HFCM    =  ,F6.3/T21,8HXCD  =  ,F5.3,9H OF CHORD,////T32,  =
23100        422HCORRECTED COEFFICIENTS///T17,5HALPHA,T29,5HCLTOT,T41,5HCDTOT,  =
23200        5T54,2HCM,T63,5HALFTR/)
23300    240 FORMAT (17X,F4.1,2(4X,F8.4),5X,F7.3,6X,F4.1)
23400        END
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      SUBROUTINE AT62 (ZFT,ANS)
      DIMENSION HT(8),TH(8),THD(8),PH(8),ANS(4),PZ(13)
      DIMENSION ZT(13),TZ(13),TZD(13),HZ(13),A(13),B(13)
      DIMENSION WA(13),WB(13),WC(13),D1(13),D2(13),D3(13)
      DATA HT/0.,11.,20.,32.,47.,52.,61.,79./
      DATA TH/288.15,216.65,216.65,228.65,270.65,270.65,252.65,180.65/
      DATA THD/-6.5,0.,1.,2.8,0.,-2.,-4.,0./
      DATA PH/101325.,22632.0638,5474.88855,868.018647,110.906298,     -
     159.0009367,18.2100724,1.03771164/
      DATA ZT/90.,100.,110.,120.,150.,160.,170.,190.,230.,300.,400.,500.-
     1,600./
      DATA TZ/180.65,210.65,260.65,360.65,960.65,1110.65,1210.65,1350.65-
     1,1550.65,1830.65,2160.65,2420.65,2590.65/
      DATA TZD/3.,5.,10.,20.,15.,10.,7.,5.,4.,3.3,2.6,1.7,1.1/
      DATA HZ/88.7433565,98.4509829,108.128578,117.776280,146.541401,  -
     1156.070901,165.571187,184.484657,221.966870,286.476269,376.312415,-
     2463.526097,548.230014/
      DATA A/.99999916,.99999897,.99999877,.99999832,.99999776,.99999746-
     1,.99999698,.99999592,.99999355,.99998378,.99998131,.99997196,    -
     2.99996075/
      DATA B/.00015734766,.00015734953,.00015735140,.00015735513,       -
     1.00015735887,.00015736074,.00015736355,.00015736915,.00015737943, -
     2.000157939532,.00015741401,.00015743271,.00015745140/
      DATA WA/21.998808,15.798995,31.044527,40.387675,29.538575,        -
     132.268971,27.789444,32.166670,30.241635,34.561172,36.099504,     -
     238.195672,8.258073/
      DATA WB/.15479092,.27878720,.0015957013,-.15412343,-.0094687678,  -
     1-.043598715,.0091016009,-.036974463,-.020235026,-.049031942,     -
     2-.056723605,-.065108273,.0013503901/
      DATA WC/-.8599496E-3,-.1479931E-2,-.2199696E-3,.4288601E-3,       -
     1-.5332209E-4,.5333399E-4,-.1016669E-3,.1958587E-4,-.1680421E-4,  -
     2.3119065E-4,.4080523E-4,.491899E-4,-.6192324E-5/
      DATA D1/.0017834765,.0010654122,.00053055610,.00026454351,        -
     1.00035360997,.00053348782,.00076836496,.0010889831,.0013783559,  -
     2.0016975137,.0022189663,.0037023997,.0067578185/
      DATA D2/-11.281753,-6.7098914,-3.3278396,-1.6546388,-2.271667,    -
     1-3.3643151,-4.8850055,-7.0083025,-8.9810162,-11.235530,-15.122423,-
     2.520411,-59.311259/
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      DATA D3/.016920782,.024329051,.039545102,.057409044,.016199137,   -
     1.0093014845,.0059339235,.0037645169,.0026065966,.0018120459,      -
     2.0011923023,.00064736059,.00033627561/
      DATA PZ/.16438012,.030079034,.0073545270,.0025216927,.00050617890,-
     1.00036943532,.00027926462,.00016852498,.6960537E-4,.1883878E-4,   -
     2.4030432E-5,.1095696E-5,.3450261E-6/
      ALT=ZFT*0.3048
      Z=ALT/1000.
      IF (Z.LT.-5.) Z=-5.
      IF (Z.GT.700.) Z=700.
      IF (Z.GT.90.) GO TO 80
      DEN=1.0+0.00015733831*Z
      H=Z/DEN
      GMW=28.9644
      IF (H.GE.47.) GO TO 30
      IF (H.GE.20.) GO TO 20
      J=1
      IF (H.GE.11.) J=2
      GO TO 50
   20 J=3
      IF (H.GE.32.) J=4
      GO TO 50
   30 IF (H.GE.61.) GO TO 40
      J=5
      IF (H.GE.52.) J=6
      GO TO 50
   40 J=7
      IF (H.GE.79.) J=8
   50 TM=TH(J)+THD(J)*(H-HT(J))
      IF (THD(J).EQ.0.) GO TO 60
      PLOG=-34.163195*ALOG(TM/TH(J))/THD(J)
      GO TO 70
   60 PLOG=-34.163195*(H-HT(J))/TM
   70 PB=PH(J)
      GO TO 140
   80 IF (Z.LT.170.) GO TO 110
      IF (Z.LT.300.) GO TO 100
      IF (Z.LT.500.) GO TO 90
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      J=13
      IF (Z.LT.600.) J=12
      GO TO 130
   90 J=11
      IF (Z.LT.400.) J=10
      GO TO 130
  100 J=9
      IF (Z.LT.230.) J=8
      IF (Z.LT.190.) J=7
      GO TO 130
  110 IF (Z.LT.120.) GO TO 120
      J=6
      IF (Z.LT.160.) J=5
      IF (Z.LT.150.) J=4
      GO TO 130
  120 J=3
      IF (Z.LT.110.) J=2
      IF (Z.LT.100.) J=1
  130 GMW=WA(J)+Z*(WB(J)+Z*WC(J))
      TM=TZ(J)+TZD(J)*(Z-ZT(J))
      DEN=A(J)+Z*B(J)
      H=Z/DEN
      DELTAH=H-HZ(J)
      PLOG=D1(J)*DELTAH+D2(J)*ALOG(1.0+D3(J)*DELTAH)
      PR=PZ(J)
  140 P=PR*EXP(PLOG)
      ANS(1)=6.759448E-6*P/TM
      ANS(2)=P*0.020885434
      ANS(3)=GMW*TM/28.9644
      ANS(4)=894.50046
      ARG1=4325.73899*TM
      IF (ZFT.LT.300000.) ANS(4)=SQRT(ARG1)
      RETURN
      END
```

```
      SUBROUTINE GEOM1
C
C     NEW VERSION CREATED ON 5/19/76
C
      COMMON /WING/ ARW,SPANW,SWING,TRW,CROOT,CTIP,CROSW,TCRW,TCTW,TCWP,-
     1TCW,SOW,SWPW,SWPWLE,XOMAC,CSWOC,SEXT,XEXT,FLEX,TDIF,FINT,DELX
      COMMON /NOSE/ BDMAX,ASECT,APLAN,XLN,CLN(20,20),CDN(20,20),        -
     1CMNOSE(20,20),XLB,CLOB(20),CMOB(20),CDOB(20)
      COMMON /TAIL/ SHOR,SHOSW,XOHOR,YHOR,CLH(20,20),CDH(20,20),SOH,ARH,-
     1ALFTR(20,20)
      COMMON /FLOW/ SMN(20),NSMN,RNLOC(20),I6A,I6B,I6C,Z(20,20),AMC
      COMMON /TRIM/ CLI,CLT,I,K,LL,ALPHA,DCDTR(20,20),DALTR(20,20),     -
     1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,-
     2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDU
      REAL LE,LT
      INTEGER Z
      PI=3.1415927
      IF (SWING.EQ.0.) GO TO 10
      IF (SPANW.LE.0.) SPANW=SQRT(SWING*ARW)
      IF (CROOT.LE.0.) CROOT=2.*SWING/((1.+TRW)*SPANW)
      IF (CTIP.LE.0.) CTIP=TRW*CROOT
      CB1=CROOT+CTIP
      CB2=CROOT*CTIP/CB1
      IF (CBARW.LE.0.) CBARW=2.*(CB1-CB2)/3.
      YBAR=SPANW*(1.+TRW-2.*TRW*TRW)/(6.*(1.-TRW*TRW))
      IF (XOMAC.LE.0.) XOMAC=CROOT/4.+YBAR*TAN(SWPW)
      IF (XCG.LE.0.) XCG=XOMAC
      SHOSW=SHOR/SWING
      SWPWLE=ATAN(TAN(SWPW)+(1.-TRW)/((1.+TRW)*ARW))
      A=(1.+2.*TRW)/(3.*(1.+TRW))
      B=TCRW+A*(TRW*TCTW-TCRW)
      TCW=1.5*B*(1.+TRW)/(1.+TRW+TRW*TRW)
      TCWP=TCW/COS(SWPW)
   10 LE=XOHOR-XCG
      LT=XOHOR-XOMAC
      ED=XOMAC-XCG
      IF (SWING.EQ.0.) GO TO 20
      FLEX=SEXT/SWING*.7
```

```
      FDELX1=(TAN(SWPW)-(1.-TRW)/(ARW*(1.+TRW)))
      BOS=BDMAX/SPANW
      TRX=TRW/(1.-(1.-TRW)*BOS)
      YCB=SPANW*(1.+TRW-2.*TRW*TRW)/(6.*(1.-TRW*TRW))
      YCX=(SPANW-BDMAX)*(1.+TRX-2.*TRX*TRX)/(6.*(1.-TRX*TRX))+BDMAX/2.
      DELYX=YCX-YCB
      DELX=DELYX*FDELX1
      IF (ABS(BDMAX).LT..001) GO TO 30
   20 ASECT=(PI*BDMAX**2)/4.
      APLAN=.7*XLN*BDMAX
      RETURN
   30 ASECT=0.
      APLAN=0.
      RETURN
      END
```

```
      SUBROUTINE AXE
C
C     NEW VERSION CREATED ON 6/15/76
C
      COMMON /WING/ ARW,SPANW,SWING,TRW,CROOT,CTIP,CROSW,TCRW,TCTW,TCWP,-
     1TCW,SOW,SWPW,SWPWLE,XOMAC,CSWOC,SEXT,XEXT,FLEX,TDIF,FINT,DELX
      COMMON /FWING/ CLW1(20,20),CDW1(20,20),CLWU1(20,20),CLWL1(20,20), -
     1CDSEP(20,20),CLOS,DL1(20,20),CLALF(20,20),CMU(20),CDU(20),CLM,CLMU-
     2,DLMU,CPLIM,CP2,CPMXS
      COMMON /FTOTAL/ CL(20,20),CDL(20,20)
      COMMON /NOSE/ BDMAX,ASECT,APLAN,XLN,CLN(20,20),CDN(20,20),        -
     1CMNOSE(20,20),XLB,CLOB(20),CMOB(20),CDOB(20)
      COMMON /TAIL/ SHOR,SHOSW,XOHOR,YHOR,CLH(20,20),CDH(20,20),SOH,ARH,-
     1ALFTR(20,20)
      COMMON /FLOW/ SMN(20),NSMN,RNLOC(20),I6A,I6B,I6C,Z(20,20),AMC
      COMMON /AFOIL/ ALELJ,XCD,SHK,ROC
      COMMON /TRIM/ CLI,CLT,I,K,LL,ALPHA,DCDTR(20,20),DALTR(20,20),     -
     1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,-
     2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDU
      INTEGER Z,ALELJ
      REAL MACH,LE,LT
      DATA PI,RAD,EPS,GAM2/3.14159,57.29578,.001,1.4285717/
      FEXP=0.78
      AMC=40.0
      AMCR=AMC/RAD
      PIARW=PI*ARW
      CLALFA=2.*PI/RAD
      DO 730 I=1,NSMN
      DO 720 I6=I6A,I6B,I6C
      ALPHA=FLOAT(I6)/100.
      ALPHAS=ALPHA
      K=(I6-I6A)/I6C+1
      MACH=SMN(I)
      SMNSQ=MACH**2
      SMNSR=1./SMNSQ
      BETAM=SQRT(ABS(1.-SMNSQ))
      CDSEP(I,K)=0.
      CLO=CLOS
```

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```
      CLW=0.
      CDLW=0.
      CLWU=0.
      CLWL=0.
      ARD=ALPHA/RAD
      SA=SIN(ARD)
      CA=COS(ARD)
      TA=TAN(ARD)
      Z(I,K)=1
      IF (SWING.EQ.0.) CLALFA = 0.
      IF (SWING.EQ.0.) GO TO 680
      CDCAM=CLU/20.
      IF (ICDO.EQ.1) CDCAM=2.*CLU*(SQRT(CDO(I)/(PI*ARW)))
      IF (ALPHA.GT.EPS.OR.CLU.GT.0.) GO TO 20
      SA=0.001
      CA=1.0
      TA=0.001
      GO TO 680
   20 CISQ=SA**4.+CA*CA-2.*SA*SA-3.*SA*SA*CA*CA/2.
      FISQ=1.-SA*SA/2.
      TAM=(1.528-0.695*SMNSQ)
      IF (TAM.LE.0.0) TAM=0.0
      AMT=(SQRT(TAM))/MACH
      ALER=0.
      ALERM1=0.
      IF (ARW.LT.2.0) GO TO 90
C
C     CALCULATE ANGLE OF ATTACK FOR LEADING EDGE LIMIT
C
C     ALELJ = 1  SHARP AND NEAR SHARP AIRFOILS
C     ALELJ = 2  230-XX AND 00XX AIRFOILS
C     ALELJ = 3  6 SERIES AIRFOILS
C     ALELJ = 4  FLAT AIRFOILS WITH ROUNDED LEADING EDGE
C     ALELJ = 5  LEADING EDGE RADIUS TO CHORD RATIO SPECIFIED
C
      GO TO (30,40,50,60,70), ALELJ
   30 GO TO 90
   40 DTC=1.+1.35/TCWP
```

```
      ALER=AMT/DTC
      ALERM1=0.913/DTC
      GO TO 80
   50 DTC=1.+1.68/TCWP
      ALER=AMT/DTC
      ALERM1=0.913/DTC
      GO TO 80
   60 DTC=1.+2./SQRT(TCWP)
      ALER=AMT/DTC
      ALERM1=0.913/DTC
      GO TO 80
   70 FROC=SQRT(2./ROC)
      ALER=AMT/(1.+FROC)
   80 IF (ALER.LT.0.) ALER=0.
      IF (ALERM1.LT.0.) ALERM1=0.
C
C     DEFINITION OF FLOW CONDITIONS
C
C     Z = 1  INCOMPRESSIBLE
C     Z = 2  COMPRESSIBLE
C     Z = 3  LEADING EDGE MACH LIMITED
C     Z = 4  SURFACE MACH LIMITED
C     Z = 5  SUPERSONIC SHARP LEADING EDGE, ATTACHED SHOCK
C     Z = 6  SUPERSONIC LEADING EDGE, DETACHED SHOCK
C
   90 CONTINUE
      SQAR=ARD/AMCR
      IF(SQAR.GT.1.) SQAR=1.
      BOS=BDMAX/SMANW
      BOSQ=(1.-BOS)**2
      FINT=(1.+(1.-SQAR)**2.*BOS)**2.
      IF (MACH.LE.1.) GO TO 100
      FINT=(1.+(1.-SQAR*(1.4-MACH)/0.4)**2*BOS)**2
      IF (MACH.GT.1.4) FINT=(1.+BOS)**2
  100 SINT=(2.*MACH-1.)*SMNSR
      IF (IFLEX.EQ.1) SINT=0.5*(1.+SMNSR*SMNSR)
      BOSAR2=BDMAX/SQRT(2.*SWING)
      DNBL=MACH**(2./3.)
```

```
      IF (MACH.GT.1.77) DNBL=BETAM
      CSWQC=COS(SWPW)
      SSWQC=SIN(SWPW)
      CSWLE=COS(SWPWLE)
      SSWLE=SIN(SWPWLE)
      TSWLE=TAN(SWPWLE)
      TSWTE=TSWLE-4.*(1.-TRW)/(ARW*(1.+TRW))
      ARWC=ARW/(ARW+2.)
      ARM2=MACH/(MACH+1.)
      ESQW=ARSIN(SSWQC*CA)
      ESLEW=ARSIN(SSWLE*CA)
      SESQW=SIN(ESQW)
      CESQW=COS(ESQW)
      CESLEW=COS(ESLEW)
      SQCESL=CESLEW*CESLEW
      AM1=(1.+.2*SMNSQ)**3.5
      CONST=GAM2/SMNSQ
      CPSTAG=1.0
      IF (MACH.LT.1.0) GO TO 110
      STAG1=(1.2*SMNSQ)**3.5
      STAG2=(2.4/(2.8*SMNSQ-0.4))**2.5
      CPSTAG=CONST*(STAG1*STAG2-1.0)
  110 IF (MACH.GT..98) GO TO 120
      FCEXN=0.5
      XC=XCD
      GO TO 130
  120 CEXN=((MACH-.98)/(1./CSWLE-.98))**2.
      FCEXN=(1.-CEXN)/2.
      XC=XCD+(1.-XCD)*CEXN
      IF (XC.GT.1.) XC=1.
  130 IF (IXCD.EQ.1) GO TO 140
      CONC=ARW*(1.+TRW)
      SXC=ATAN(TAN(SWPWLE)-4.*XC*(1.-TRW)/CONC)
      SQCSXC=COS(SXC)**2
      SQSSXC=SIN(SXC)**2
      BM1=(1.+.2*SMNSQ*SQCSXC)**3.5
      AM2=2.2+SMNSQ*SQSSXC
      AM3=(1.+.2*AM2)**3.5
```

```
      RR1=1.16667*AM2*SQCSXC-.16667
      CPLIMS=(BM1/3.58-1.)*CONST
      CPDS=CONST*(RR1*AM1/AM3-1.)
      CPDST=CPDS*(1.-XC)/2.
      GO TO 150
  140 TSHK=TAN(SHK)
      SQCSHK=COS(SHK)*COS(SHK)
      SQSSHK=SIN(SHK)*SIN(SHK)
      BM1S=(1.+.2*SMNSQ*SQCSHK)**3.5
      AM2S=2.2+SMNSQ*SQSSHK
      AM3S=(1.+.2*AM2S)**3.5
      RR1S=1.16667*AM2S*SQCSHK-.16667
      CPLIMS=(BM1S/3.58-1.)*CONST
      CP2=CONST*(RR1S*AM1/AM3S-1.)
      IF (MACH.GT..98) TSHK=TSHK+(TSWTE-TSHK)*CEXN
      TDIF=TSWLE-TSHK
  150 IF (CPLIMS.GT.0.) CPLIMS=0.
      CPLIM=CPLIMS
      IF (MACH.LE.1.) GO TO 160
      CLIM=SMNSR*(1.-.32/MACH**2.5)
      IF (CLIM.GT.ABS(CPLIMS)) CPLIM=-CLIM
      SULIM=-CPLIM*CA
  160 DEXP=1.5-SMNSQ*CESLEW/4.
      IF (MACH.LE.1.) DEXP=1.5-MACH*CESLEW/4.
      IF (DEXP.LT.1.) DEXP=1.
      A2=CESQW*CA
      SXOS=1.-(BOS*2./(1.+TRW))*(1.-BOS*(1.-TRW)/2.)
      ARWX=ARW*BOSQ/SXOS
      ARMX=ARWX/(ARWX+2./MACH)
      SXOS2=1.-BOSAR2*2./(1.+TRW)*(1.-BOSAR2*(1.-TRW)/2.)
      ARWX2=2.*BOSQ/SXOS2
      ARM2X=ARWX2/(ARWX2+2./MACH)
      TEST1=MACH*CESLEW
      IF (TEST1.GT.1.) GO TO 200
      AMXS=(1.+.2*FINT*SMNSQ*SQCESL)**3.5
      CPMXS=CONST*(AMXS-1.)/SQCESL
      IF (ARW.GE.2.0) GO TO 210
  170 TRIG1=2.-9.*SA*SA+5.*SA**4.
```

```
      TRIG2=4.-10.*SA*SA+5.*SA**4.
      CLWU=(SQRT(ARWX)+(2.+ARWX)*TA)*SA*CA*CA*FISO*SXUS*FINT/2.
      CLWL=CLWU
      DLALFA=(SQRT(ARWX)*CA*TRIG1+(2.+ARWX)*SA*TRIG2)*FINT*SXUS/2.
      IF (MACH.LE.2.) GO TO 180
      CLWU=(CLWU*1.73205)/BETAM
      DLALFA=DLALFA*(0.5+(.866025/BETAM))
  180 IF (ARW.GT.1.75) GO TO 190
      CLW=CLWU+CLWL
      CLALFA=DLALFA/RAD
      CDLW=CLW*TA
      GO TO 680
  190 CLUP=CLWU
      CLLP=CLWL
      CLP=CLUP+CLLP
      CDP=CLP*TA
      DLP=DLALFA
      TARX=4.*ARW-7.
      GO TO 210
  200 IF (MACH.GE.1..AND.MACH.LT.1.9) ARDET=.41*(MACH-1.)
      IF (MACH.GE.1.9.AND.MACH.LE.4.) ARDET=.8-.382/(MACH-1.)
      IF (MACH.GT.4.) ARDET=ARSIN(.71429*SQR!(1.-4./SMNSQ))
      IF (ARW.LT.2.0) GO TO 170
  210 IF (ALELJ.GT.1) GO TO 510
C
C     SHARP LEADING EDGE
C
      FUJ1=1.0
      IF (MACH.LT.1.0) FUJ1=1./(2.0-MACH)**FEXP
      IF (ARW.GE.2.0) GO TO 220
      FCLIL2=PI*A2*SA*CA*FISO*(1.+FLEX)/2.
      CLIL2=FCLIL2+CLO/2.
      CLIU2=CLIL2
      CLI2=2.*CLIL2
      DLI2=PI*A2*CISO*(1.+FLEX)
      CDI2=CLI2*TA**DEXP+CLI2*CLI2/(2.*PI)+CDCAM
      DLC2=DLI2*(1.+CPMXS)/2.
      CLIU=CLUP+(CLIU2-CLUP)*TARX
```

```
      DLI=DLP+(DLI2-DLP)*TARX
      CDI=CDP+(CDI2-CDP)*TARX
      GO TO 230
  220 CLIL=PI*ARWC*A2*SA*CA*FISQ
      CLIU=CLIL
      CLI=(CLIU+CLIL)*(1.+FLEX)
      DLIL=PI*A2*CISQ*ARWC
      DLIU=DLIL
  230 IF (MACH.LE..1) GO TO 280
      IF (TEST1.GT.1.) GO TO 260
      IF (IXCD.EQ.0.) GO TO 240
      CPDIF=CP2-2.*CPLIM*(1.+FLEX)
      XCSH=XC/(1.+TRW)
      CLMU=CA*(CPDIF*(XCSH-TDIF*ARW/B.)-CP2/2.)
      DLMU=-SA*(CPDIF*(XCSH-TDIF*ARW/B.)-CP2/2.)
      GO TO 250
  240 CONMS=CPLIMS*XC+CPDST
      IF (MACH.GT.1.) CONMS=CPLIM*XC+CPDST
      CLMU=-CONMS*CA
      DLMU=CONMS*SA
      IF (ARW.GE.2.0) GO TO 250
      CLCL2=CPMXS*FCLIL2+CLO*FCEXN
      DLCL2=CPMXS*DLI2/2.
      CLCL=CLLP+(CLCL2-CLLP)*TARX
      Z(I,K)=4
      CLUM2=CLIU2/(1.+FLEX)+CLO*FCEXN
      IF (CLMU.GT.CLUM2) Z(I,K)=3
      GO TO 270
  250 CLCL=CPMXS*CLIL
      DLCL=CPMXS*DLIL
      Z(I,K)=4
      CLUCAM=CLIU+CLO/2.
      IF (CLMU.GT.CLUCAM) Z(I,K)=3
      GO TO 270
  260 Z(I,K)=5
      IF (ARD.GE.ARDET) Z(I,K)=6
  270 IF (MACH.GE.2.) FLEX=(SQRT(1.-1./MACH))*SEXT/SWING
      INDEX=Z(I,K)
```

```
      GO TO (280,300,300,340,360,460), INDEX
C
C     INCOMPRESSIBLE SHARP LEADING EDGE (Z=1)
C
  280 IF (ARW.GE.2.0) GO TO 290
      CLIL=CLIU
      CLI=2.*CLIU
      CLW=CLI
      CDLW=CDI
      CLALFA=DLI/RAD
      CLWU=CLIU+CLO/2.
      CLWL=CLWU
      GO TO 680
  290 CLI=(CLIU+CLIL)*(1.+FLEX)
      DLI=(DLIU+DLIL)*(1.+FLEX)
      CDI=CLI*TA**DEXP+CLI*CLI/PIARW
      CLW=CLI+CLO
      CDLW=CDI+CDCAM
      CLALFA=DLI/RAD
      CLWU=CLIU*(1.+FLEX)+CLO/2.
      CLWL=CLIL*(1.+FLEX)+CLO/2.
      GO TO 680
C
C     COMPRESSIBLE AND SHARP LEADING EDGE MACH LIMITED  (Z=2 & Z=3)
C
  300 IF (ARW.GE.2.0) GO TO 330
      IF (MACH.GT.1.0) GO TO 310
      CLCU2=FCLIL2*FUJ1+CLO/2.
      CLC2=CLCL2+CLCU2
      DLC2=DLI2*(FUJ1+CPMXS)/2.
      GO TO 320
  310 CLCU2=FCLIL2
      CLC2=FCLIL2*(1.+CPMXS)
      DLC2=DLI2*(1.+CPMXS)/2.
  320 DLC=DLP+(DLC2-DLP)*TARX
      CLALFA=DLC/RAD
      CLC=CLP+(CLC2-CLP)*TARX
      CLWU=CLUP+(CLCU2-CLUP)*TARX
```

```
      CLWL=CLCL
      CDC2=CLC2*TA**DEXP+CLC2*CLC2/(2.*PI)+CDCAM
      CDC=CDP+(CDC2-CDP)*TARX
      CLW=CLC
      CDLW=CDC
      GO TO 680
  330 CLCU=CLIU*FUJ1
      CLC=(CLCU+CLCL)*(1.+FLEX)
      DLC=(DLIU*FUJ1+DLCL)*(1.+FLEX)
      CDC=CLC*TA**DEXP+CLC*CLC/PIARW
      CLW=CLC+CLO
      CDLW=CDC+CDCAM
      CLALFA=DLC/RAD
      CLWU=CLCU*(1.+FLEX)+CLO/2.
      CLWL=CLCL*(1.+FLEX)+CLO/2.
      GO TO 680
C
C     SURFACE MACH LIMITED  (Z=4)
C
  340 IF (ARW.GE.2.0) GO TO 350
      CLM2=CLMU*(1.+FLEX)+CLCL2
      DLM2=DLMU*(1.+FLEX)+DLCL2
      CLM=CLP+(CLM2-CLP)*TARX
      DLM=DLP+(DLM2-DLP)*TARX
      CDM2=CLM2*CLM2/(2.*PI)+CLM2*TA**UEXP
      CDM=CDP+(CDM2-CDP)*TARX
      CLW=CLM
      CLWU=CLMU*(1.+FLEX*TARX)
      CLWL=CLW-CLWU
      CDLW=CDM
      CLALFA=DLM/RAD
      GO TO 680
  350 CLM=(CLMU+CLCL)*(1.+FLEX)
      DLM=(DLMU+DLCL)*(1.+FLEX)
      CDM=CLM*CLM/PIARW+CLM*TA**DEXP
      CLW=CLM+CLO*FCEXN
      CDLW=CDM+CDCAM*FCEXN
      CLWU=CLMU*(1.+FLEX)
```


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      CLWL=CLCL*(1.+FLEX)+CLO*FCEXN
      CLALFA=DLM/RAD
      GO TO 680
C
C     SUPERSONIC SHARP LEADING EDGE, ATTACHED SHOCK  (Z=5)
C
  360 FLAX=(1.+HUS)**2
      RTHA=0.
      RTLA=0.
      FLAX2=(1.+BOSAR2)**2
      FCLAM=0.65/MACH+FLAX*(1.-0.65/MACH)
      FCLAMU=0.65/(MACH*FLAM)
      FCLAML=FLAX*(1.-0.65/MACH)/FCLAM
      CLO=0.
      IF (ARW.GE.2.0) GO TO 390
      FCLA2=2.*PI*SA*CA*CA*ARM2X*SXOS2*FISO*(1.+FLEX)
      FCLAM2=0.65/MACH+FLAX2*(1.-0.65/MACH)
      CLA2=FCLA2*FCLAM2
      IF (MACH.GT.1.414) CLA2=CLA2/BETAM
      IF (MACH.LE.3.) GO TO 380
      IF (ALPHA.LE.16.) GO TO 370
      HYPH=1.-4.*SMNSR-1.96*SA*SA
      IF (HYPH.LE.0.) HYPH=0.01
      RTHA=SQRT(HYPH)
      CLA2=5.*(1.+1.4*SA*SA-CA*RTHA)*CA*ARM2X/6.
      GO TO 380
  370 HYPL=1.-4.*SMNSR*ALPHA/16.-1.96*SA*SA
      RTLA=SQRT(HYPL)
      CLA2=5.*(1.+1.4*SA*SA-CA*RTLA)*CA*ARM2X/6.
  380 IF (ARD.GT.0.008726) GO TO 420
      DLA2=4.*SXOS2*FCLAM2*(1.+FLEX)/BETAM
      GO TO 430
  390 FCLA=2.*PI*SA*CA*CA*ARMX*(1.+FLEX)*SXOS*FISO
      CLA=FCLA*FCLAM
      IF (MACH.GT.1.414) CLA=CLA/BETAM
      IF (MACH.LE.3.) GO TO 410
      IF (ALPHA.LE.16.) GO TO 400
      HYPH=1.-4.*SMNSR-1.96*SA*SA
```

```
      IF (HYPH.LE.0.) HYPH=0.01
      RTHA=SQRT(HYPH)
      CLA=5.*(1.+1.4*SA*SA-CA*RTHA)*CA*ARMX*SXOS/6.
      GO TO 410
  400 HYPL=1.-4.*SMNSR*ALPHA/16.-1.96*SA*SA
      RTLA=SQRT(HYPL)
      CLA=5.*(1.+1.4*SA*SA-CA*RTLA)*CA*ARMX*SXOS/6.
  410 IF (ARD.GT..008726) GO TO 440
      DLA=4.*(1.+FLEX)*SXOS*FCLAM/BETAM
      GO TO 450
  420 DLA2=2.*PI*CISQ*CA*ARM2X*SXOS2*FCLAM2*(1.+FLEX)
      IF (MACH.GT.1.414) DLA2=DLA2/BETAM
      IF (MACH.LE.3.) GO TO 430
      IF (RTHA.EQ.0.) RTHA=RTLA
      IF (RTLA.EQ.0.) RTLA=RTHA
      DLA2=(ARM2X*5.*(2.8*SA*CA*CA+SA*CA*RTLA+1.96*SA*CA*CA*CA/RTLA)/
     16.-CLA2*TA)*SXOS2
  430 DLA=DLP/DNBL+(DLA2-DLP/DNBL)*TARX
      CLA=CLP/DNBL+(CLA2-CLP/DNBL)*TARX
      GO TO 450
  440 DLA=2.*PI*CISQ*CA*ARMX*(1.+FLEX)*SXOS*FCLAM
      IF (MACH.GT.1.414) DLA=DLA/BETAM
      IF (MACH.LE.3.) GO TO 450
      IF (RTHA.EQ.0.) RTHA=RTLA
      IF (RTLA.EQ.0.) RTLA=RTHA
      DLA=(ARMX*5.*(2.8*SA*CA*CA+SA*CA*RTHA+1.96*SA*CA*CA*CA/RTHA)/
     16.-CLA*TA)*SXOS
  450 CDA=CLA*TA
      CLW=CLA
      CDLW=CDA
      CLALFA=DLA/RAD
      CLWU=CLA*FCLAMU
      CLWL=CLA*FCLAML
      GO TO 680
C
C     SUPERSONIC LEADING EDGE, DETACHED SHOCK  (Z=6)
C
  460 FLAX=(1.+BOS)**2.
```

```
      FLAX2=(1.+BOSAR2)**2.
      FMOMU=1.0
      IF (MACH.GT.1.2) FMOMU=1./(MACH-0.2)
      FMOML=1.6-0.6*MACH
      IF (MACH.GT.1.5) FMOML=0.7
      IF (MACH.GT.2.2) FMOML=0.1+1./(MACH-.55)
      IF (IFLEX.EQ.1.AND.MACH.LT.4.) FMOML=FMOML*(.6+(MACH-1.)/10.)
      IF (SQW.LE.50.) GO TO 470
      IF (ALPHA.LE.24.) GO TO 470
      FWAZ6=1-(SQW-50.)*(1.-0.4*COTAN(ARD))/20.
      IF (FWAZ6.LT.0.5) FWAZ6=0.5
      FMOML=FMOML*FWAZ6
  470 TRIG3=2.*CA*CA-SA*SA
      CLIMP=CPSTAG*SA*SA*CA
      DLIMP=CPSTAG*SA*TRIG3
      IF (ARW.GE.2.0) GO TO 490
      CLDU22=FMOMU*PI*SA*CA*CA*FISO*ARM2/DNBL
      CLDU2=CLDU22*SXOS2*(1.+FLEX)
      CLDL2=(CPSTAG*FMOML*PI*SA*CA*CA*FISO*ARM2*SXOS2*FLAX2/DNBL+CLIMP) -
     1*(1.+FLEX)
      DLD2=(PI*CA*CISO*ARM2*SXOS2*(FMOMU+FMOML*FLAX2*CPSTAG)/DNBL+DLIMP)*
     1*(1.+FLEX)
      IF (SULIM.GT.CLDU22) GO TO 480
      CLDU2=CA*CLIM*SXOS2*(1.+FLEX)
      DLD2=(CPSTAG*PI*FMOML*CA*CISO*ARM2*SXOS2*FLAX2/DNBL-SULIM*TA
     1*SXOS2+DLIMP)*(1.+FLEX)
  480 CLDU=CLUP/DNBL+(CLDU2-CLUP/DNBL)*TARX
      CLDL=CLLP/DNBL+(CLDL2-CLLP/DNBL)*TARX
      DLD=DLP+(DLD2-DLP)*TARX
      GO TO 500
  490 FLZ6=PI*SA*CA*CA*FISO*ARMX/DNBL
      CLDU2=FMOMU*FLZ6
      CLDU=CLDU2*SXOS*(1.+FLEX)
      CLDL=CPSTAG*FMOML*FLZ6*SXOS*FLAX*(1.+FLEX)+CLIMP*(1.+FLEX)
      DLD1=ARMX*SXOS*(1.+FLEX)/DNBL
      DLD=DLD1*((FMOMU+FMOML*FLAX*CPSTAG)*PI*CA*CISO+DLIMP*(1.+FLEX))
      IF (SULIM.GT.CLDU2) GO TO 500
      CLDU=CA*CLIM*(1.+FLEX)*SXOS
```

```
      FDLD=SULIM*TA*(1.+FLEX)*SXOS
      DLD=ARMX*SXOS*FLAX*(1.+FLEX)*FMUML*CPSTAG*PI*CA*CISO/DNBL-FDLD+
     1DLIMP*(1.+FLEX)
  500 CLD=CLDU+CLDL
      CDD=CLD*TA
      CLW=CLD
      CDLW=CDD
      CLWU=CLDU
      CLWL=CLDL
      CLALFA=DLD/RAD
      GO TO 680
C
C     BLUNT LEADING EDGE
C
  510 SQARD=SQAR*SQAR
      SQALE=(ALER/AMCR)**2
      SQALI=(ALERMI/AMCR)**2
      CALER=COS(ALER)
      SALER=SIN(ALER)
      SALERI=SIN(ALERMI)
      SQCEOW=CESQW*CESQW
      SQCOW=CSWOC*CSWOC
      ESQER=ARSIN(SSWOC*CALER)
      CESQR=COS(ESQER)
      SESQR=SIN(ESQER)
      SQCEQR=CESQR*CESQR
      F1=(ARD+ALER)/2.
      CF1=COS(F1)
      SF1=SIN(F1)
      CISQF1=SF1**4.+CF1*CF1-2.*SF1*SF1-3.*SF1*SF1*CF1*CF1/2.
      AMCR2=2./(AMCR*AMCR)
      TARD=ARD*AMCR2
      IF(TARD.GT.0.17) TARD=0.17
      CLIL=PI*ARWC*SA*CESQW
      CLI=CLIL*2.
      DLIL=PI*A2*ARWC
      IF (MACH.LE..1) GO TO 590
      IF (TEST1.GT.1.) GO TO 560
```

```
      CTWOC=CSWOC/SSWOC
      IF (CTWOC.GT.4.) CTWOC=4.
      CTESQW=CESQW/SESQW
      IF (CTESQW.GT.4.) CTESQW=4.
      CTESOR=CESOR/SESOR
      IF (CTESOR.GT.4) CTESOR=4.
      CLCUM1=PI*SA*CTESQW*ARWC*FINT*(1.-(1.-SESQW)*SQARD)
      CLUEM1=PI*ARWC*FINT*SALER1*CTESOR*(1.-(1.-SESOR)*SQAL1)
      AT2=(1.-(1.-SESQW)*SQARD)*CA-(1.-SESQW*TARD)*SA
      DLCUM1=AT2*PI*ARWC*FINT*CTESQW
      BETALE=SQRT(ABS(1.-SMNSQ*SQCEOR))
      IF (BETALE.LE..25) BETALE=.25
      BETAMA=SQRT(ABS(1.-SMNSQ*SQCEQW))
      IF (BETAMA.LE..25) BETAMA=.25
      D4=1.-BETAMA
      D5=CESQW/BETAMA
      D2=(1.-D4*SQARD)*SA*D5
      G1=(1.-D4*SQARD)*CA-D4*TARD*SA
      CLCU=PI*ARWC*D2*FINT
      IF (MACH.GT.1.) CLCU=CLCUM1*SINT
      E3=1.-BETALE
      E1=(1.-E3*SQALE)*SALER
      E2=E1*CFSOR/BETALE
      CLUES=PI*ARWC*FINT*E2
      IF (MACH.GT.1.) CLUES=CLUEM1*SINT
      CLUBS=PI*(ARD-ALER)*CF1*ARWC*CESQW*CISOF1
      CLEU=CLUES+CLUBS
      CLEUJ1=PI*ARWC*A2*SA*CA*FISO
      IF(CLEU.LT.CLEUJ1) CLEU=CLEUJ1
      IF (MACH.LE.1.3) GO TO 520
      FUZ3=1.-1.1*MACH*CSWLE*CSWLE*SQRT(MACH-1.3)
      CLEU=CLEU*FUZ3
  520 CLCL=CPMXS*CLIL
      DLCL=PI*A2*CPMXS*ARWC
      CLLES=CPMXS*PI*ARWC*CESOR*SALER
      DLEL=0.5*CPMXS*PI*A2*CISO*ARWC
      CLEL=CLLES+DLEL*(ARD-ALER)
      CLJIEL=CPMXS*PI*ARWC*A2*SA*CA*FISO
```

```
      DLJIEL=CPMXS*PI*A2*ARWC*CISQ
      IF (CLJIEL.GT.CLEL) CLEL=CLJIEL
      IF (CLJIEL.GT.CLEL) DLEL=2.*DLEL
      CONMS=CPLIMS*XC+CPDST
      TCWW=TCWP*CSWOC
      FTC=1.-16.*TCWW**2
      IF (FTC.LT.0.) FTC=0.
      IF (MACH.GT.1.) CONMS=CPLIM*XC+CPDST
      IF (IXCD.EQ.0) GO TO 530
      CPDIF=CP2-2.*CPLIM*(1.+FLEX)
      XCSH=XC/(1.+TRW)
      CLMU=CA*(CPDIF*(XCSH-TDIF*ARW/8.)-CP2/2.)
      DLMU=-SA*(CPDIF*(XCSH-TDIF*ARW/8.)-CP2/2.)
      GO TO 540
  530 CLMU=-CONMS*CA*FTC
      DLMU=CONMS*SA
  540 IF (ARD.GE.ALER) GO TO 550
      Z(I,K)=2
      CLUCAM=CLCU+CLD/2.
      IF (CLMU.LT.CLUCAM) Z(I,K)=4
      GO TO 570
  550 Z(I,K)=4
      CLUEAM=CLEU+CLD/2.
      IF (CLUEAM.LT.CLMU) Z(I,K)=3
      GO TO 570
  560 Z(I,K)=6
  570 IF (MACH.GE.2.) FLEX=(SQRT(1.-1./MACH))*SEXT/SWING
      IF (IFLEX.EQ.0) GO TO 580
      IF (Z(I,K).LE.4) FLEX=(SQAR)*.7*SEXT/SWING
      IF (MACH.GE.6.) GO TO 580
      IF (Z(I,K).GT.4) FLEX=(SEXT/SWING)*(SQRT(1.-1./MACH))*(2.+MACH)/8.
  580 INDEX=Z(I,K)
      GO TO (590,610,630,650,670,670), INDEX
C
C     INCOMPRESSIBLE  (Z=1)
C
  590 IF (ARW.GE.2.0) GO TO 600
      CLIL2=PI*SA*CESQW*(1.+FLEX)+CLD/2.
```

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```
      CLI2=CLIL2*2.
      DLI2=PI*A2*(1.+FLEX)
      CDI2=CLI2*CLI2/(2.*PI)+CDCAM+(CLI2*(TA**DEXP))
      CLI=CLP+(CLI2-CLP)*TARX
      DLI=DLP+(DLI2-DLP)*TARX
      CDI=CDP+(CDI2-CDP)*TARX
      CLIL=CLI/2.
      CLIU=CLIL
      CLWU=CLIU
      CLWL=CLIL
      CLW=CLI
      CDLW=CDI
      CLALFA=DLI/RAD
      GO TO 680
  600 CLI=2.*CLIL*(1.+FLEX)
      DLI=2.*DLIL*(1.+FLEX)
      CDI=CLI*CLI/PIARW
      IF (ARW.LT.3.) CDI=(CLI*CLI/PIARW)+(CLI*(TA**DEXP)*(3.-ARW))
      CLW=CLI+CLO
      CDLW=CDI+CDCAM
      CLALFA=DLI/RAD
      CLWU=CLIL*(1.+FLEX)+CLO/2.
      CLWL=CLIL*(1.+FLEX)+CLO/2.
      GO TO 680
C
C     COMPRESSIBLE  (Z=2)
C
  610 IF (ARW.GE.2.0) GO TO 620
      CLCU2=PI*D2*FINT*(1.+FLEX)/2.+CLO/2.
      IF (MACH.GT.1.0) CLCU2=CLCUM1*(1.+FLEX)/(ARWC*2.)
      DLCU2=G1*PI*CESOW*FINT*(1.+FLEX)/(2.*BETAMA)
      IF (MACH.GT.1.0) DLCU2=DLCUM1*(1.+FLEX)/(ARWC*2.)
      DLCL2=PI*A2*CPMXS*(1.+FLEX)/2.
      DLC2=DLCL2+DLCU2
      DLC=DLP+(DLC2-DLP)*TARX
      CLCL2=CPMXS*PI*SA*CESOW*(1.+FLEX)/2.+CLO/2.
      CLC2=CLCL2+CLCU2
      CLC=CLP+(CLC2-CLP)*TARX
```

```
      CDC2=CLC2*CLC2/(PI*2.)+CDCAM+CLC2*(TA**DEXP)
      CDC=CDP+(CDC2-CDP)*TARX
      CLCU=CLUP+(CLCU2-CLUP)*TARX
      CLCL=CLLP+(CLCL2-CLLP)*TARX
      CLWU=CLCU
      CLWL=CLCL
      CLW=CLCU+CLCL
      CDLW=CDC
      CLALFA=DLC/RAD
      GO TO 680
  620 CLC=(CLCU+CLCL)*(1.+FLEX)
      DLCU=G1*PI*CESQW*ARWC/BETAMA*FINT
      IF (MACH.GT.1.) DLCU=DLCUM1*SINT
      DLC=(DLCU+DLCL)*(1.+FLEX)
      CDC=CLC*CLC/PIARW
      IF (ARW.LT.3.) CDC=(CLC*CLC/PIARW)+(CLC*(TA**DEXP)*(3.-ARW))
      CLW=CLC+CLO
      CDLW=CDC+CDCAM
      CLALFA=DLC/RAD
      CLWU=CLCU*(1.+FLEX)+CLO/2.
      CLWL=CLCL*(1.+FLEX)+CLO/2.
      GO TO 680
C
C     LEADING EDGE MACH LIMITED  (Z=3)
C
  630 IF (ARW.GE.2.0) GO TO 640
      CLUEM2=CLUEM1/(ARWC*2.)
      CLUES2=CLUES/(ARWC*2.)
      IF (MACH.GT.1.0) CLUES2=CLUEM2*SINT
      CLUBS2=CLUBS/(ARWC*2.)
      CLEU2=CLUES2+CLUBS2
      IF (MACH.GT.1.3) CLEU2=CLEU2*FUZ3
      CLLES2=CLLES/(ARWC*2.)
      DLEL2=DLEL/(ARWC*2.)
      CLEL2=CLLES2+DLEL2*(ARD-ALER)
      CLJL2=CLJLEL/(ARWC*2.)
      IF (CLJL2.GT.CLEL2) CLEL2=CLJL2
      IF (CLJL2.GT.CLEL2) DLEL2=2.*DLEL2
      DLM=DLP+(DLM2-DLP)*TARX
      CLW=CLM
```

```
      CLWU=CLMU*(1.+FLEX*TARX)
      CLWL=CLM-CLWU
      CDLW=CDM
      CLALFA=DLM/RAD
      GO TO 680
  660 CLM=(CLMU+CLJIEL)*(1.+FLEX)
      DLM=(DLMU+DLJIEL)*(1.+FLEX)
      CDM=CLM*CLM/PIARW+CLM*TA**DEXP
      CLW=CLM+CLO*FCEXN
      CDLW=CDM+CDCAM*FCEXN
      CLALFA=DLM/RAD
      CLWU=CLMU*(1.+FLEX)
      CLWL=CLJIEL*(1.+FLEX)+CLO*FCEXN
      GO TO 680
C
C     SUPERSONIC BLUNT LEADING EDGE, DETACHED SHOCK  (Z=6)
C
  670 CLO=0.
      GO TO 460
C
C     LIFT AND DRAG OF BODY NOSE AND LIFT AND DRAG DUE TO LIFT
C     OF THE HORIZONTAL TAIL
C
  680 CALL RCLCD1
      IF (SWING.NE.0.) GO TO 690
         CL(I,K) = CLN(I,K)
         CDL(I,K) = CDN(I,K)
         GO TO 710
  690 IF (Z(I,K).NE.4) GO TO 700
      CDSEP(I,K)=(1-XC)*(SA/2)*(SPANW-BDMAX)*CBARW/SWING
  700 LL=1
      CLW1(I,K)=CLW
      CDW1(I,K)=CDLW
      CLWU1(I,K)=CLWU
      CLWL1(I,K)=CLWL
      DL1(I,K)=CLALFA*RAD
      CLALF(I,K)=DL1(I,K)/RAD
  710 CALL TRIMDG
```

```
      IF (SWING.EQ.0.) GO TO 720
      CL1=CLW+CLH(I,K)+CLN(I,K)
      LL=2
      CALL TRIMDG
      CDL1=(CDLW+CDH(I,K)+CDN(I,K)+CDSEP(I,K)+D(DTR(I,K))
      IF (ALPHAS.GT.25.OR.DALTR(I,K).EQ.0.) CL1=CL1+DCLTR(I,K)
      CL(I,K)=CL1
      CDL(I,K)=CDL1
      IF(ALPHA.LE.45.) GO TO 720
      CDFP=1.2+SMNSQ/2.
      IF(MACH.GT.1.) CDFP=0.9+0.8/(SMNSQ*MACH)
      CDL2=CDFP*(2.*SA*SA-1.)*(SXOS+SHUSW)
      CDL(I,K)=CDL1+CDL2
  720 CONTINUE
  730 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BCLCD1
C
C     CALCULATES CL, CD AND CM FOR BODY NOSE BASED UPON
C
C     NEW VERSION CREATED ON 5/19/76
C
      COMMON /WING/ ARW,SPANW,SWING,TRW,CROOT,CTIP,CROSW,TCRW,TCTW,TCWP,*
     1TCW,SQW,SWPW,SWPWLE,XOMAC,CSWQC,SEXT,XEXT,FLEX,TDIF,FINT,DELX
      COMMON /NOSE/ BDMAX,ASECT,APLAN,XLN,CLN(20,20),CDN(20,20),        *
     1CMNOSE(20,20),XLB,CLDB(20),CMDB(20),CDDB(20)
      COMMON /FLOW/ SMN(20),NSMN,RNLOC(20),I6A,I6B,I6C,Z(20,20),AMC
      COMMON /TRIM/ CLI,CLT,I,K,LL,ALPHA,DCDTR(20,20),DALTR(20,20),     *
     1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,*
     2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDD
      LOGICAL RNCTST
      REAL MACH
      INTEGER Z
      FLNOSE=1.
      FDNOSE=1.
      LREF = CBARW
      SREF = SWING
      IF (SWING.NE.0.) GO TO 70
         SREF = ASECT
         LREF = BDMAX
   70 CONTINUE
C     THE CROSSFLOW MACH NUMBER CONDITIONS.
      IF (BDMAX.NE.0.0) ETAN=.0125*XLN/BDMAX+.55
      MACH=SMN(I)
      CLN(I,K)=0.0
      CDN(I,K)=0.0
      CMNOSE(I,K)=0.0
      IF (BDMAX.LE.0.001) GO TO 60
      ARD=ALPHA/57.29578
      SMNSQ=SMN(I)**2
      S2A=2.*SA*CA
      CA2=COS(ARD/2.)
      CMN=SMN(I)*SA
      RNC=RNLOC(I)*BDMAX*SA
```

```
      CON=2.5*CMN-1.5
      CON1=ABS(CON)**(.66667)
      CON2=CON/CON1
      IF (CMN.GE..3) GO TO 20
      CDC=1.2
      IF ((RNC.GE.2.E5).AND.(RNC.LT.5.E5)) CDC=1.88-3.4E-6*RNC
      IF ((RNC.GE.5.E5).AND.(RNC.LT.5.E6)) CDC=.125+.11E-6*RNC
      IF (RNC.GE.5.E6) CDC=.675
      GO TO 40
   20 IF (CMN.LT..4) GO TO 30
      IF (CMN.LT.1.) CDC=1.5+.33*CON2
      IF (CMN.GE.1.) CDC=1.24+.59/SMNSQ
      GO TO 40
   30 CDC=1.5+.33*CON2
      RNCTST=((RNC.GE.2.E5).AND.(RNC.LT.5.E5))
      IF (RNCTST) CDC=(34.E-6*RNC-6.42)*CMN-13.6E-6*RNC+3.806
      RNCTST=((RNC.GE.5.E5).AND.(RNC.LT.5.E6))
      IF (RNCTST) CDC=(11.13-1.1E-6*RNC)*CMN+.44E-6*RNC-3.214
      IF (RNC.GE.5.E6) CDC=5.63*CMN-1.014
   40 CNNOSE=(S2A*CA2*ASECT+CDC*ETAN*SA*SA*APLAN)/SREF
      IF (Z(I,K).LE.4) GO TO 50
      IF (SWING.EQ.0.) GO TO 50
      DXAFT=XLB-XLN-CBARW
      CNBODY=CNNOSE*(1.+(DXAFT/XLN)*(MACH-1.)/MACH)
      CLN(I,K)=CNBODY*CA*FLNOSE+CLUB(I)
      CDN(I,K)=CNBODY*SA*FDNOSE+CDUB(I)
      FCMNSE=(CNBODY-CNNOSE)*(XLB-DXAFT/2.-XCG)
      CMNOSE(I,K)=(CNNOSE*(XCG-0.6*XLN)-FCMNSE)/LREF+CMOB(I)
      GO TO 60
   50 CLN(I,K)=CNNOSE*CA*FLNOSE+CLUB(I)
      CDN(I,K)=CNNOSE*SA*FDNOSE+CDUB(I)
      CMNOSE(I,K)=CNNOSE*(XCG-0.6*XLN)/LREF+CMOB(I)
   60 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE TRIMDG
C
C     NEW VERSION CREATED ON 4/26/76
C
      COMMON /WING/ ARW,SPANW,SWING,TRW,CROOT,CTIP,CROSW,TCRW,TCTW,TCWP,-
     1TCW,SQW,SWPW,SWPWLE,XOMAC,CSWQC,SEXT,XEXT,FLEX,TDIF,FINT,DELX
      COMMON /FWING/ CLW(20,20),CDW(20,20),CLWU(20,20),CLWL(20,20),     -
     1CDSEP(20,20),CLOS,DL1(20,20),CLALF(20,20),CMO(20),CDU(20),CLM,    -
     2CLMU,DLMU,CPLIM,CP2,CPMXS
      COMMON /FTOTAL/ CL(20,20),CDL(20,20)
      COMMON /NOSE/ BDMAX,ASECT,APLAN,XLN,CLN(20,20),CDN(20,20),        -
     1CMNOSE(20,20),XLB,CLOB(20),CMOB(20),CDOB(20)
      COMMON /TAIL/ SHOR,SHOSW,XOHOR,YHOR,CLH(20,20),CDH(20,20),SQH,ARH,-
     1ALFTR(20,20)
      COMMON /FLOW/ SMN(20),NSMN,RNLOC(20),I6A,I6B,I6C,Z(20,20),AMC
      COMMON /AFOIL/ ALELJ,XCD,SHK,ROC
      COMMON /TRIM/ CLI,CLT,I,K,LL,ALPHA,DCDTR(20,20),DALTR(20,20),     -
     1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,-
     2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDO
      COMMON /TROUT/ STM(20,20),DELH(20,20),DWASH(20,20),DWASHR(20,20)
      REAL LT,LE,IT,MACH
      INTEGER ALELJ,Z,W
      DATA RAD,PI,PI2/57.29578,3.14159,6.28318/
      IF (LL.EQ.2) GO TO 170
      MACH=SMN(I)
      CLO=CLOS
      CM(I,K)=CMO(I)
      DCLTR(I,K)=0.
      DALTR(I,K)=0.
      DCDTR(I,K)=0.
      ALFTR(I,K)=ALPHA
      CMCL(I,K)=-9.
      FTRIM=1.
      CLH(I,K)=0.
      CDH(I,K)=0.
      STM(I,K)=9.
      CLAFHT = 0.
      CLAFHR = 0.
```

```
      DEPDA = 0.
      IF (SWING.NE.0.) GO TO 5
         CM(I,K) = CMNOSE(I,K)
         RETURN
    5 CONTINUE
      IF (CLW(I,K).EQ.0.) RETURN
      FCEXN=0.5
      IF (MACH.GT..98) FCEXN=(1.-CEXN)/2.
      IF (LT.LE.0.) GO TO 30
      ARWC=ARW/(ARW+2.)
      SPAH=PI*ARH*SHOSW
      SWPH=SQH/RAD
      CSH=COS(SWPH)
      ALPHAS=ALPHA
      SQAR=ALPHA/AMC
      IF(SQAR.GT.1.) SQAR=1.
      AZ3=SQRT(SQAR)
      SPANL=.5*SPANW/LT
      OSPNL=1./SPANL
      ALR=ALPHA/RAD
      CLALFO=2.*PI*CSWQC*ARWC
      ALCAM=ALR+CLO/CLALFO
      IF (ARW.GT.1.75) GO TO 30
      CSWLE=COS(SWPWLE)
      TEST1=MACH*CSWLE
      IF (TEST1.LT.1.0) GO TO 20
      EBAR=ED+DELX+0.2*CBARW
      GO TO 90
   20 EBAR=ED+DELX+0.2*CBARW*TEST1**2
      GO TO 90
   30 W=Z(I,K)
      GO TO (40,50,50,60,70,80), W
   40 EBAR=ED
      GO TO 90
   50 EBAR=ED+MACH**2*CBARW/10.
      IF (MACH.GT.1.5) EBAR=ED+.225*CBARW-.15*A/3*CBARW
      GO TO 90
   60 EU=ED+CBARW*(.5*XC-.25)
```

```
      EL=ED+MACH**2*CBARW/10.
      IF (MACH.GT.1.5) EL=ED+.225*CBARW
      CLWA=CLW(I,K)-CLO*ECEXN
      IF (CLWA.EQ.0.0) CLWA=0.001
      EBAR=(CLWU(I,K)*EU+CLWL(I,K)*EL)/CLWA
      GO TO 90
   70 EBAR=ED+.25*CBARW+DELX
      GO TO 90
   80 EBAR=ED+.2*CBARW+DELX
      IF (IFLEX.EQ.0) GO TO 90
      EBAR=ED+.1*CBARW+DELX
      IF (MACH.GE.6.) EBAR=ED+.2*CBARW+DELX
      IF (MACH.GT.4.0.AND.MACH.LT.6.0) EBAR=ED+(0.1+(MACH-4.)/20.)
     1*CBARW+DELX
C
C     AVERAGE WAKE DOWNWASH ANGLE  (RADIANS)
C
   90 IF (LT.LE.0.) GO TO 140
      T1=2./ARW
      T2=SQRT(2.*SPANW/(3.*CBARW))
      T3=SQRT(SPANL)
      CONAR=.333333
      IF (ARW.NE.3.) CONAR=1./(3.*ARW**(ARW-3))
      T4=(1.3-CONAR)/SQRT(1.+TRW)
      IF (MACH.LE.1.) EPSD=ALCAM*T4*(T1+.1*(T2+T3))
      IF (MACH.GT.1.) EPSD=ALR*T4*(T1+.1*(T2+T3))
C
C     ABSOLUTE VALUE OF NONDIMENSIONAL DISTANCE BETWEEN
C     WAKE AND THE HORIZONTAL TAIL
C
      V1=2.*YHOR/SPANW
      YDOSS=(OSPNL-1.5/ARW)*SIN(EPSD)-OSPNL*SA
      AYOSS=ABS(V1+YDOSS)
C
C     DOWNWASH ANGLE AT THE HORIZONTAL TAIL  (RADIANS)
C     AND DOWNWASH DERIVATIVE, DEPDA
C
      W1=.2/SQRT(OSPNL)
```

```
      W2=(2.+COS(2.25*ALR))/3.
      W3=1.-1.5*AYOSS
      W4=.75*ALR*SIN(2.25*ALR)
      W5=W2-W4
      IF (MACH.LE.1.) EPS1=ALCAM*T4*(W1+T1)*W2*W3
      IF (MACH.GT.1.) EPS1=ALR*T4*(W1+T1)*W2*W3
      DEPDA1=T4*(W1+T1)*W5*W3
      ATENF=1.
      IF (MACH.GT.1.) GO TO 100
      GO TO 110
  100 ATENF=1.-.1*BETAM*(1.+TAN(SWPWLE)/(T1+OSPNL))
      IF (ATENF.LT.0.) ATENF=0.
  110 DWASHR(I,K)=EPS1*ATENF
      IF (DWASHR(I,K).GT.ALCAM) DWASHR(I,K)=ALCAM
      IF (DWASHR(I,K).LT.0.) DWASHR(I,K)=0.
      DWASH(I,K)=DWASHR(I,K)*RAD
      DEPDA=DEPDA1*ATENF
      CEPS=COS(DWASHR(I,K))
C
C     HORIZONTAL TAIL CALCULATIONS.
C
      IF (SHOR.EQ.0.0) GO TO 140
      ALPHAH=ALR-DWASHR(I,K)+IT/RAD
      ALFAHD=ALR+IT/RAD
      TAHDR=TAN(ALFAHD)
      SAH=SIN(ALPHAH)
      CAH=COS(ALPHAH)
      TAH=TAN(ALPHAH)
      IF (TAH.EQ.0.0) TAH=0.001
      FISH=1.-SAH*SAH/2.
      X3=ARH/(ARH+2.)
      X4=PI2*CSH*CEPS
      IF (Z(I,K).GT.4) GO TO 120
C
C     SUBSONIC LEADING EDGE
C
      X5=2.*SAH**4+2.*CAH*CAH-4.*SAH*SAH-3.*SAH*SAH*CAH*CAH
      CLH(I,K)=((CPMXS+1.)/2.)*SAH*CAH*CAH*FISH*X3*X4*SHOSW
```

```
      CDH(I,K)=ABS(CLH(I,K)*TAHDR)
      CLAFHR=SHOSW*CAH*X3*X4*X5/2.
      CLAFHT=CLAFHR/RAD
      GO TO 140
C
C     SUPERSONIC LEADING EDGE
C
  120 X1=(ARW+2.)/(ARH+2.)
      X2=ARH*X1*CSH/(ARW*COS(SWPW))
      F=SHOSW*X2
      IF (ALR.EQ.0.0) ALR=0.001
      CLH(I,K)=CLW(I,K)*F*CEPS*ALPHAH/ALR
      IF (SOW.LE.50.) GO TO 130
      IF (ALPHA.LE.24.) GO TO 130
      FHAZ6=1.-CBARW*(SOW-50.)*(1.-0.4*COTAN(ALR))/(20.*MACH*LT)
      IF (FHAZ6.LT.0.4) FHAZ6=0.4
      CLH(I,K)=CLH(I,K)*FHAZ6
  130 CDH(I,K)=ABS(CLH(I,K)*TAHDR)
      CLAFHT=CLALFA*F*CEPS
      IF ((SOW.GT.50.).AND.(ALPHA.GT.24.)) CLAFHT=CLAFHT*FHAZ6
      CLAFHR=CLAFHT*RAD
C
C     PITCHING MOMENT ABOUT THE CENTER OF GRAVITY, CM
C     AND STATIC LONGITUDINAL STABILITY, STM
C
  140 Y1=CBARW*CA
      IF (Z(I,K).LE.3) Y2=CLW(I,K)-CLO
      IF (Z(I,K).EQ.4) Y2=CLW(I,K)-CLO*FCEXN
      IF (Z(I,K).GE.5) Y2=CLW(I,K)
      Y3=CLH(I,K)*LE/Y1
      FMEX=FLEX*(XCG-XEXT)
      Y4=FMEX-EHAR
      DNMTR=CLALFA+CLAFHT*(1.-DEPDA)
      IF (DNMTR.EQ.0.0) DNMTR=0.001
      IF (IXCD.EQ.0) GO TO 150
      IF (Z(I,K).NE.4) GO TO 150
      IF (TRW.GE.1.0) TRW=.999
      XCT=XC/TRW-ARW*(1.+TRW)*TDIF/(4.*TRW)
```

```
      YLIM=SPANW*(2.*XCT*TRW+XC)/(6.*(XCT*TRW+XC))
      Y2S=SPANW*(2.*TRW*(1.-XCT)+(1.-XC))/(6.*(TRW*(1.-XCT)+(1.-XC)))
      ALOS=2.*XC/(1.+TRW)-ARW*TDIF/4.
      XCLIM=(XC-YLIM*TDIF/CROOT)/(1.-YLIM*(1.-TRW)*2./SPANW)
      CYLIM=CROOT-2.*YLIM*CROOT*(1.-TRW)/SPANW
      DELXL=CBARW/4.+(YBAR-YLIM)*TAN(SWPWLE)-ED-XCLIM*CYLIM/2.
      CMUAL=(ALOS*DELXL+FMEX)*CPLIM/CBARW
      CY2=CROOT-2.*Y2S*CROOT*(1.-TRW)/SPANW
      XC2=(XC-Y2S*TDIF/CROOT)/(1.-2.*Y2S*(1.-TRW)/SPANW)
      A2OS=1.-2.*XC/(1.+TRW)+ARW*TDIF/4.
      Y5=FMEX-EL
      CML=(CLM/(1.+FLEX)-CLMU)*Y5/Y1
      DELX1=XC*CROOT+Y2S*TAN(SHK)+CY2*(1.-XC2)/3.
      DELX2=ED-CBARW/4.-YBAR*TAN(SWPWLE)+DELX1
      CMU2=CP2*A2OS*DELX2/CBARW
      CMUS=CMUAL+CMU2
      CM(I,K)=CMO(I)+CMUS+CML-Y3+CMNUSE(I,K)
      CMCL(I,K)=((CLALFA/(1.+FLEX)-DLMU)*Y5-LE*CLAFHT*(1.-DEPDA))/
     1(Y1*DNMTR)
      GO TO 160
  150 CM(I,K)=CMO(I)+Y2*Y4/(Y1*(1.+FLEX))-Y3+CMNUSE(I,K)
      IF (ALPHAS.GT.25.OR.CLALFA.LE.0.) GO TO 160
      CMCL(I,K)=(Y4*CLALFA/(1.+FLEX)-LE*CLAFHT*(1.-DEPDA))/(Y1*DNMTR)
  160 STM(I,K)=-CMCL(I,K)
      RETURN
  170 IF (CLW(I,K).EQ.0..OR.ITRIM(I).EQ.0) RETURN
      IF (ALPHAS.GT.25.OR.CLALFA.LE.0.) GO TO 180
C
C     TRIM AT CONSTANT LIFT COEFFICIENT  (ALPHA LE 25 DEG)
C
      DCLTR(I,K)=CM(I,K)/(LE/Y1-STM(I,K))
      DALTR(I,K)=-DCLTR(I,K)/(CLALFA+CLAFHT*(1.-DEPDA))
      IF (ABS(DALTR(I,K)).GT.15.) GO TO 180
      IF (CLAFHR.EQ.0.0) CLAFHR=0.001
      DELHR=DCLTR(I,K)/CLAFHR
      GO TO 190
C
C     TRIM AT CONSTANT ANGLE OF ATTACK  (ALPHA GT 25 DEG)
```

```
C
  180 DALTR(I,K)=0.
      DCLTR(I,K)=CM(I,K)*Y1/LE
      DELHR=DCLTR(I,K)/(CFPS*CLAFHR)
C
  190 DELH(I,K)=DELHR*RAD
      ALPHA=ALPHA+DALTR(I,K)
      ALFTR(I,K)=ALPHA
      ALR=ALPHA/RAD
      SA=SIN(ALR)
      CA=COS(ALR)
      TA=TAN(ALR)
      TCON=40./RAD
      ABAG=ABS(ALPHAH+DELHR)
      IF (ABAG.LE.TCON) GO TO 200
      ABAG=TCON
      DELHR=TCON*DELH(I,K)/ABS(DELH(I,K))-ALPHAH
      DELH(I,K)=DELHR*RAD
  200 ALRHTD=ALR+DELHR+IT/RAD
      TAHTD=TAN(ALRHTD)
      IF (ALPHAS.GT.25.OR.DALTR(I,K).EQ.0.) GO TO 220
C
C     TRIM DRAG AT CONSTANT CL  (ALPHA LE 25 DEG)
C
      CDTB1=((CLH(I,K)+DCLTR(I,K))**2-CLH(I,K)*CLH(I,K))/SPAH
      CDTB2=DCLTR(I,K)*TAHTD
      CDTB3=(CLW(I,K)*CLW(I,K)-(CLW(I,K)+DCLTR(I,K))**2)/(PI*ARW)
      CDTB4=-DCLTR(I,K)*TA**DEXP
      IF (ALEDJ.EQ.1.OR.Z(I,K).GT.2) GO TO 210
      DCDTR(I,K)=(CDTB1+CDTB3)*FTRIM
      GO TO 240
  210 DCDTR(I,K)=CDTB4+CDTB2
      GO TO 240
C
C     TRIM DRAG AT CONSTANT ANGLE OF ATTACK  (ALPHA GT 25 DEG)
C
  220 ZNUM1=CLH(I,K)+DCLTR(I,K)/CEPS
      CDTA1=(ZNUM1*ZNUM1-CLH(I,K)*CLH(I,K))/SPAH
```

```
      IF (ALEL J.EQ.1.OR.Z(I,K).GT.2) GO TO 230
      DCDTR(I,K)=CDTA1*FTRIM
      GO TO 240
  230 DCDTR(I,K)=DCLTR(I,K)*TAHTD
  240 IF (ITRIM(I).EQ.1) CM(I,K)=0.0
      IF (ITRIM(I).EQ.0) DELH(I,K)=0.0
      RETURN
      END
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
      SUBROUTINE PLOT (NPLOT)
C
C     PLOT PROGRAM TO PRINT CL VS ALPHA AND CL VS CD ON AN OUTPUT FILE
C
C     NEW VERSION CREATED ON 5/19/76
C
      COMMON /DISPLY/ LDISP(6),DDISP(4),TITLE(14),PPLOT
      COMMON /FWING/ CLW(20,20),CDW(20,20),CLWU(20,20),CLWL(20,20),     -
     1CDSFP(20,20),CLO,DL(20,20),CLALF(20,20),CMU(20),CDU(20),CLM,CLMU, -
     2DLMU,CPLIM,CP2,CPMXS
      COMMON /FTOTAL/ CL(20,20),CDL(20,20)
      COMMON /NOSE/ BDMAX,ASECT,APLAN,XLN,CLN(20,20),CDN(20,20),        -
     1CMNOSE(20,20),XLB,CLDB(20),CMDB(20),CDDB(20)
      COMMON /TAIL/ SHOR,SHOSW,XQHOR,YHOR,CLH(20,20),CDH(20,20),SOH,ARH,-
     1ALFTR(20,20)
      COMMON /FLOW/ SMN(20),NSMN,RNLOC(20),I6A,I6B,I6C,Z(20,20),AMC
      COMMON /TRIM/ CLI,CLT,I,KAY,LL,ALPHA,DCDIR(20,20),DALTR(20,20),   -
     1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,-
     2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDU
      DIMENSION WLIST(61),DLIST(61),PLIST(101),DISLST(7),DVAL(6),       -
     1PVAL(11)
      INTEGER DDISP,PPLOT
      DATA WLIST,DLIST,PLIST,DISLST/223*1H ,1HH,1HN,1HL,1HU,1HW,1HT,1HS/
      DATA PLUS,BLANK,AST,EYE/1H+,1H ,1H*,1HI/
C.....SKIP TO TOP OF PAGE, PRINT PLOT NUMBER IN UPPER RIGHT HAND
C           CORNER OF PAGE
      WRITE (6,450) NPLOT
C.....FIND MAX. LIFT COEFF. (CLMAX), MAX. DRAG COEFF. (CDMAX), MIN. CM
C           COEFF. (CMMIN) AND MAX. CM COEFF. (CMMAX)
      CLMAX=0.0
      CDMAX=0.0
      CMMIN=10.0
      CMMAX=-10.0
      DO 20 I6=I6A,I6B,I6C
      K=(I6-I6A)/I6C+1
      CLMAX=AMAX1(CL(I,K),CLMAX)
      CDMAX=AMAX1(CDL(I,K),CDMAX)
      CMMIN=AMIN1(CM(I,K),CMMIN)
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```
      CMMAX=AMAX1(CM(I,K),CMMAX)
   20 CONTINUE
C.....DETERMINE SCALE (SCALE) FOR CLMAX (LIFT COEFF. VS ANGLE OF ATTACK
C     PLOT)
      SCALE=60.
      IF (CLMAX.GT..7) SCALE=30.
      IF (CLMAX.GT.1.4) SCALE=20.
      IF (CLMAX.GT.2.1) SCALE=15.
      IF (CLMAX.GT.2.8) SCALE=12.
C.....DETERMINE SCALE (DSCALE) FOR CDMAX
C         (TOT. LIFT COEFF. VS DRAG COEFFS. PLOT)
      DSCALE=500.
      IF (CDMAX.GT..12) DSCALE=200.
      IF (CDMAX.GT..30) DSCALE=100.
      IF (CDMAX.GT..6) DSCALE=50.
      IF (CDMAX.GT.1.2) DSCALE=60./1.8
      IF (CDMAX.GT.1.8) DSCALE=25.
      IF (CDMAX.GT.2.4) DSCALE=20.
      IF (CDMAX.GT.3.) DSCALE=10.
C.....DETERMINE RANGE OF CM. CALCULATE FACTOR
      RANGE=CMMAX-CMMIN
      FACTOR=10.0
      IF (RANGE.GT.0.1) FACTOR=5.0
      IF (RANGE.GT.0.2) FACTOR=2.0
      IF (RANGE.GT.0.5) FACTOR=1.0
      IF (RANGE.GT.1.0) FACTOR=2./3.
      IF (RANGE.GT.1.5) FACTOR=0.5
      IF (RANGE.GT.2.0) FACTOR=0.2
C.....TEST FOR NEGATIVE CMMAX! IF - .CL AXIS IS AT FAR RIGHT
      IF (CMMAX.GT.0.0) GO TO 30
      ISCLE2=-500
      IF (CMMIN.LT.-0.5) ISCLE2=-1000
      IF (CMMIN.LT.-1.0) ISCLE2=-1500
      IF (CMMIN.LT.-1.5) ISCLE2=-2000
      IF (CMMIN.LT.-2.0) ISCLE2=-5000
      FACTOR=1000./FLOAT(IABS(ISCLE2))
      K0=101
      GO TO 70
```

```
C.....TEST FOR POSITIVE CMMIN; IF + , CL AXIS IS AT FAR LEFT
   30 IF (CMMIN.LT.0.0) GO TO 40
      ISCLE2=0
      FACTOR=10.0
      IF (CMMAX.GT.0.1) FACTOR=5.0
      IF (CMMAX.GT.0.2) FACTOR=2.0
      IF (CMMAX.GT.0.5) FACTOR=1.0
      IF (CMMAX.GT.1.0) FACTOR=2./3.
      IF (CMMAX.GT.1.5) FACTOR=0.5
      IF (CMMAX.GT.2.0) FACTOR=0.2
      KO=1
      GO TO 70
C.....DETERMINE MINIMUM SCALE VALUE (SCALE2), INCREMENT (AINCR)
C            AND CL AXIS LOCATION (KO)
   40 IMIN=IFIX(CMMIN*1000.)
      IDECR=IFIX(100./FACTOR)
      ICMMAX=1500
      ICMMIN=-1500
      DO 50 ISCLE2=ICMMIN,ICMMAX,IDECR
      IF (ISCLE2.GT.IMIN) GO TO 60
   50 CONTINUE
   60 ISCLE2=ISCLE2-IDECR
   70 SCALE2=FLOAT(ISCLE2)/1000.
      AINCR=0.1/FACTOR
      IF (CMMAX.GT.0.0.AND.CMMIN.LT.0.0) KO=INT(ABS(SCALE2)*FACTOR*100.+-
     10.5)+1
      IF (PPLOT.EQ.0) GO TO 80
      KO=102-KO
      GO TO 100
C.....CALCULATE SCALE VALUES FOR CM
   80 PVAL(1)=SCALE2
      DO 90 J2=2,11
      PVAL(J2)=PVAL(J2-1)+AINCR
   90 CONTINUE
      GO TO 120
  100 PVAL(11)=SCALE2
      DO 110 J2=2,11
      J3=12-J2
```

```
      PVAL(J3)=PVAL(J3+1)+AINCR
  110 CONTINUE
C.....START PLOTS OF CL VS. ANGLE OF ATTACK AND CL VS. CD
C.....LOOP THROUGH NUMBER OF LINES ON PAGE
  120 DO 360 J=1,42
      VER=FLOAT(43-J)
C.....INSERT (+) INTO WLIST AND DLIST EVERY SIXTH LINE, STARTING WITH
C           FIRST
      JTEST=((J-1)/6)*6
      IF (JTEST.NE.J-1) GO TO 150
      DO 130 K2=1,61,12
  130 WLIST(K2)=PLUS
      DO 140 K2=1,61,10
  140 DLIST(K2)=PLUS
C.....LOOP THROUGH NUMBER OF ANGLES OF ATTACK
  150 DO 240 I6=I6A,I6B,I6C
      K=(I6-I6A)/I6C+1
C.....COMPUTE COLUMN INDEX FOR ANGLE OF ATTACK
      K1=(I6*60)/4000+1
      IF (I6B.GT.4000) K1=(I6*60)/8000+1
C.....TEST FOR PLOT OF CL DUE TO HORIZONTAL TAIL (H)
      IF (LDISP(1).EQ.0) GO TO 160
      IF (ABS(CLH(I,K)*SCALE-VER).LE..5) WLIST(K1)=DISLST(1)
C.....TEST FOR PLOT OF CL DUE TO TO NOSE (N)
  160 IF (LDISP(2).EQ.0) GO TO 170
      IF (ABS(CLN(I,K)*SCALE-VER).LE..5) WLIST(K1)=DISLST(2)
C.....TEST FOR PLOT OF CL DUE TO WING LOWER SURFACE (L)
  170 IF (LDISP(3).EQ.0) GO TO 180
      IF (ABS(CLWL(I,K)*SCALE-VER).LE..5) WLIST(K1)=DISLST(3)
C.....TEST FOR PLOT OF CL DUE TO WING UPPER SURFACE (U)
  180 IF (LDISP(4).EQ.0) GO TO 190
      IF (ABS(CLWU(I,K)*SCALE-VER).LE..5) WLIST(K1)=DISLST(4)
C.....TEST FOR PLOT OF CL DUE TO NET WING (W)
  190 IF (LDISP(5).EQ.0) GO TO 200
      IF (ABS(CLW(I,K)*SCALE-VER).LE..5) WLIST(K1)=DISLST(5)
C.....TEST FOR PLOT OF CL DUE TO TOTAL COMPONENTS (T)
  200 IF (ABS(CL(I,K)*SCALE-VER).GT..5) GO TO 240
      IF (LDISP(6).NE.0) WLIST(K1)=DISLST(6)
```

```
C.....TEST FOR PLOT OF CD DUE TO SEPARATION (S)
      IF (DDISP(2).EQ.0) GO TO 210
      IX=INT(CDSEP(I,K)*DSCALE+.50001)+1
      IF (IX.GE.1.AND.IX.LE.61) DLIST(IX)=DISLST(7)
C.....TEST FOR PLOT OF CD DUE TO NOSE (N)
  210 IF (DDISP(1).EQ.0) GO TO 220
      IX=INT(CDN(I,K)*DSCALE+.50001)+1
      IF (IX.GE.1.AND.IX.LE.61) DLIST(IX)=DISLST(2)
C.....TEST FOR PLOT OF CD DUE TO WING (W)
  220 IF (DDISP(3).EQ.0) GO TO 230
      IX=INT(CDW(I,K)*DSCALE+.50001)+1
      IF (IX.GE.1.AND.IX.LE.61) DLIST(IX)=DISLST(5)
C.....TEST FOR PLOT OF CD DUE TO TOTAL AIRCRAFT (T)
  230 IF (DDISP(4).EQ.0) GO TO 240
      IX=INT(CDL(I,K)*DSCALE+.50001)+1
      IF (IX.GE.1.AND.IX.LE.61) DLIST(IX)=DISLST(6)
  240 CONTINUE
C.....WRITE LINE WITH SCALE VALUE EVERY SIXTH LINE, STARTING WITH FIRST
      IF (JTEST.EQ.J-1) GO TO 320
      IF (J.GT.6) GO TO 280
C.....WRITE LABELS FOR LIFT VS. ANGLE OF ATTACK PLOT
      GO TO (320,330,250,260,270,330), J
  250 WRITE (6,460) (WLIST(J2),J2=24,61),(DLIST(J3),J3=1,61)
      GO TO 340
  260 WRITE (6,470) (WLIST(J2),J2=24,61),(DLIST(J3),J3=1,61)
      GO TO 340
  270 WRITE (6,480) (WLIST(J2),J2=24,61),(DLIST(J3),J3=1,61)
      GO TO 340
  280 IF (J.LT.39) GO TO 330
      J3=J-38
C.....WRITE LABELS FOR LIFT VS. DRAG PLOT
      GO TO (290,300,310,330), J3
  290 WRITE (6,490) (WLIST(J2),J2=1,61),(DLIST(J4),J4=1,37)
      GO TO 340
  300 WRITE (6,500) (WLIST(J2),J2=1,61),(DLIST(J4),J4=1,46)
      GO TO 340
  310 WRITE (6,510) (WLIST(J2),J2=1,61),(DLIST(J4),J4=1,40)
      GO TO 340
```

```
C.....WRITE @VALUE LINE@
  320 CLL=FLOAT(43-J)/SCALE
      WRITE (6,520) CLL,(WLIST(J2),J2=1,61),(DLIST(J3),J3=1,61)
      GO TO 340
C.....WRITE @NORMAL LINE@
  330 WRITE (6,530) (WLIST(J2),J2=1,61),(DLIST(J3),J3=1,61)
C.....RE-SET LINE TO BLANKS AND @*@
  340 WLIST(1)=AST
      DLIST(1)=AST
      DO 350 J2=2,61
      WLIST(J2)=BLANK
      DLIST(J2)=BLANK
  350 CONTINUE
  360 CONTINUE
C.....CALCULATE SCALE VALUES FOR INDUCED DRAG COEFFICIENTS
      DO 370 J2=1,6
  370 DVAL(J2)=10.*FLOAT(J2)/DSCALE+.00001
C.....WRITE LAST TWO LINES
      IF (I6B.GT.4000) WRITE (6,590) (DVAL(J2),J2=1,6)
      IF (I6B.LE.4000) WRITE (6,540) (DVAL(J2),J2=1,6)
C.....START PLOT OF TOTAL LIFT COEFF. VS. PITCHING MOMENT COEFF.
C.....SKIP TO TOP OF PAGE, PRINT PLOT NUMBER IN UPPER RIGHT HAND
C           CORNER OF PAGE
      WRITE (6,550) NPLOT
C.....LOOP THROUGH NUMBER OF LINES ON PAGE
      DO 440 J=1,42
      VER=FLOAT(43-J)
C.....INSERT (+) INTO PLIST EVERY SIXTH LINE, STARTING WITH FIRST
      JTEST=((J-1)/6)*6
      IF (JTEST.NE.J-1) GO TO 390
      DO 380 K2=1,101,10
      PLIST(K2)=PLUS
  380 CONTINUE
  390 DO 400 I6=I6A,I6B,I6C
      K=(I6-I6A)/I6C+1
      IF (ABS(CL(I,K)*SCALE-VER).GT.0.5) GO TO 400
      K1=INT(((CM(I,K)+ABS(SCALE2))*FACTOR)*100.+0.5)+1
      IF (PPLOT.EQ.1) K1=102-K1
```

```
      IF (K1.GE.1.AND.K1.LE.101) PLIST(K1)=AST
  400 CONTINUE
C.....WRITE LINE WITH CL SCALE VALUE EVERY SIXTH LINE, STARTING
C           WITH FIRST
      IF (JTEST.NE.J-1) GO TO 410
C.....WRITE @VALUE LINE@
      CLL=FLOAT(43-J)/SCALE
      WRITE (6,560) CLL,(PLIST(J2),J2=1,101),CLL
      GO TO 420
C.....WRITE @NORMAL LINE@
  410 WRITE (6,570) (PLIST(J2),J2=1,101)
C.....RE-SET LINE TO BLANKS AND @I@
  420 DO 430 J2=1,101
      PLIST(J2)=BLANK
  430 CONTINUE
      PLIST(K0)=EYE
  440 CONTINUE
C.....WRITE CM AXIS, CM SCALE AND TITLE
      WRITE (6,580) (PVAL(J2),J2=1,11)
      RETURN
C
  450 FORMAT (1H1,T124,4HPLOT,I3,1HA)
  460 FORMAT (T6,1H*,T12,17HLIFT COEFFICIENTS,38A1,T70,61A1)
  470 FORMAT (T6,1H*,T19,3HVS.,T29,38A1,T70,61A1)
  480 FORMAT (T6,1H*,T13,15HANGLE OF ATTACK,T29,38A1,T70,61A1)
  490 FORMAT (T6,61A1,T70,37A1,22HTOTAL LIFT COEFFICIENT)
  500 FORMAT (T6,61A1,T70,46A1,3HVS.)
  510 FORMAT (T6,61A1,T70,40A1,16HDRAG COEFFICIENT)
  520 FORMAT (T2,F3.1,1H-,61A1,T70,61A1)
  530 FORMAT (T6,61A1,T70,61A1)
  540 FORMAT (T2,5H0.0_+,20(3H__+),T70,1H+,12(5H----+)/T6,1H0,T18,1H8,  -
     1T29,2H16,T41,2H24,T53,2H32,T65,2H40,T69,3H0.0,6(5X,F5.2))
  550 FORMAT (1H1,T40,44HTOTAL LIFT COEFFICIENT  VS.  PICHING MOMENT ,  -
     111HCOEFICIENT ,T124,4HPLOT,I3,1HB)
  560 FORMAT (T12,F3.1,2X,101A1,2X,F3.1)
  570 FORMAT (T17,101A1)
  580 FORMAT (T12,3H0.0,T17,1H+,10(10H---------+),5H  0.0/T10,          -
     111(5X,F5.2))
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26700     590 FORMAT (T2,5H0.0-+,20(3H--+),T70,1H+,12(5H----+)/T6,1H0,T17,2H16, =
26800        1T29,2H32,T41,2H48,T53,2H64,T65,2H80,T69,3H0.0,6(5X,F5.2))
26900          END
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MPLOT$  ,02/25/77 12:08:01

      SUBROUTINE MPLOT (NPLOT)
C
C     PLOT PROGRAM TO PRINT CL VS ALPHA AND CL VS CD FOR A GIVEN
C          RANGE OF MACH NUMBERS ON AN OUTPUT FILE
C
C     NEW VERSION CREATED ON 4/26/76
C
      COMMON /WING/ ARW,SPANW,SWING,TRW,CROOT,CTIP,CROSW,TCRW,TCTW,TCWP,=
     1TCW,SOW,SWPW,SWPWLE,XOMAC,CSWOC,SEXT,XEXT,FLEX,TDIF,FINT,DELX
      COMMON /FTOTAL/ CL(20,20),CDL(20,20)
      COMMON /TAIL/ SHOR,SHOSW,XOHOR,YHOR,CLH(20,20),CDH(20,20),SOH,ARH,=
     1ALFTR(20,20)
      COMMON /FLOW/ SMN(20),NSMN,RNLOC(20),I6A,I6B,I6C,Z(20,20),AMC
      COMMON /AFOIL/ ALFLJ,XCD,SHK,ROC
      COMMON /TRIM/ CLI,CLT,I,K,LL,ALPHA,DCDTR(20,20),DALTR(20,20),     =
     1CM(20,20),DCLTR(20,20),CMCL(20,20),FTRIM,XC,CBARW,YBAR,XCG,CLALFA,=
     2IT,DEXP,LE,LT,ED,ITRIM(20),BETAM,SA,CA,CEXN,IXCD,IFLEX,ICDO
      DIMENSION WLIST(61),DLIST(61),DISLST(10),VAL(6)
      INTEGER HNSMN
      DATA WLIST,DLIST/122*1H /
      DATA DISLST/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H0/
      DATA BLANK,AST,PLUS/1H ,1H*,1H+/
C.....SKIP TO TOP OF PAGE, WRITE ARW, XCD AND MACH SPEEDS
      HNSMN=NSMN
      WRITE (6,210) ARW,XCD,(J1,SMN(J1),J1=1,HNSMN)
      WRITE (6,220) NPLOT
C.....DETERMINE MAX. LIFT COEFF. (CLMAX) AND MAX. DRAG COEFF. (CDMAX)
      CLMAX=CL(1,1)
      CDMAX=CDL(1,1)
      DO 20 I=1,NSMN
      DO 20 I6=I6A,I6B,I6C
      IF (ITRIM(I).EQ.0) GO TO 20
      K=(I6-I6A)/I6C+1
      IF (CL(I,K).GT.CLMAX) CLMAX=CL(I,K)
      IF (CDL(I,K).GT.CDMAX) CDMAX=CDL(I,K)
   20 CONTINUE
C.....DETERMINE SCALING
      RANGE=CLMAX
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      SCALE=60.
      IF (RANGE.GT..7) SCALE=30.
      IF (RANGE.GT.1.4) SCALE=20.
      IF (RANGE.GT.2.1) SCALE=15.
      IF (RANGE.GT.2.8) SCALE=12.
      DRANGE=CDMAX
      DSCALE=500.
      IF (DRANGE.GT..12) DSCALE=200.
      IF (DRANGE.GT..3) DSCALE=100.
      IF (DRANGE.GT..6) DSCALE=50.
      IF (DRANGE.GT.1.2) DSCALE=60./1.8
      IF (DRANGE.GT.1.8) DSCALE=25.
      IF (DRANGE.GT.2.4) DSCALE=20.
C.....LOOP THROUGH NUMBER OF LINES PER PLOT
      DO 190 J=1,42
C.....INSERT (+) INTO WLIST AND DLIST EVERY SIXTH LINE, STARTING
C            WITH FIRST
      JTEST=((J-1)/6)*6
      IF (JTEST.NE.J-1) GO TO 50
      DO 30 K2=1,61,12
   30 WLIST(K2)=PLUS
      DO 40 K2=1,61,10
   40 DLIST(K2)=PLUS
   50 VER=FLOAT(43-J)
      KOUNT=0
C.....LOOP THROUGH NUMBER OF MACH NUMBERS
      DO 70 I=1,NSMN
      IF (ITRIM(I).EQ.0) GO TO 70
      KOUNT=KOUNT+1
C.....LOOP THROUGH NUMBER OF ANGLES OF ATTACK
      DO 60 I6=I6A,I6B,I6C
      K=(I6-I6A)/I6C+1
      IF (ABS(CL(I,K)*SCALE-VER).GT..5.OR.DALTR(I,K).EQ.0.0) GO TO 60
      K1=(ALFTR(I,K)*1.5+.50001)+1
      IF (I6B.GT.4000) K1=(ALFTR(I,K)*.75+.50001)+1
      IF (K1.GT.61) GO TO 60
      WLIST(K1)=DISLST(KOUNT)
      IX=INT(CDL(I,K)*DSCALE+.50001)
```

```
      IF(IX.EQ.0) IX=1
      IF (IX.LE.61) DLIST(IX)=DISLST(KOUNT)
   60 CONTINUE
   70 CONTINUE
C.....PRINT LINE WITH SCALE VALUE EVERY SIXTH LINE, STARTING WITH FIRST
      JTEST=((J-1)/6)*6
      IF (JTEST.EQ.J-1) GO TO 150
      IF (J.GT.6) GO TO 110
C.....WRITE LABELS FOR LIFT VS ANGLE OF ATTACK PLOT
      GO TO (110,110,80,90,100,110), J
   80 WRITE (6,230) (WLIST(J2),J2=24,61),(DLIST(J3),J3=1,61)
      GO TO 170
   90 WRITE (6,240) (WLIST(J2),J2=24,61),(DLIST(J3),J3=1,61)
      GO TO 170
  100 WRITE (6,250) (WLIST(J2),J2=24,61),(DLIST(J3),J3=1,61)
      GO TO 170
  110 IF (J.LT.39) GO TO 160
      J3=J-38
C.....WRITE LABELS FOR LIFT VS DRAG PLOT
      GO TO (120,130,140,160), J3
  120 WRITE (6,260) (WLIST(J2),J2=1,61),(DLIST(J4),J4=1,37)
      GO TO 170
  130 WRITE (6,270) (WLIST(J2),J2=1,61),(DLIST(J4),J4=1,45)
      GO TO 170
  140 WRITE (6,280) (WLIST(J2),J2=1,61),(DLIST(J4),J4=1,35)
      GO TO 170
C.....WRITE 'VALUE LINE'
  150 CLL=FLOAT(43-J)/SCALE
      WRITE (6,290) CLL,(WLIST(J2),J2=1,61),(DLIST(J3),J3=1,61)
      GO TO 170
C.....WRITE 'NORMAL LINE'
  160 WRITE (6,300) (WLIST(J2),J2=1,61),(DLIST(J3),J3=1,61)
C.....RE-SET LINE TO BLANKS AND @*@
  170 WLIST(1)=AST
      DLIST(1)=AST
      DO 180 J2=2,61
      WLIST(J2)=BLANK
      DLIST(J2)=BLANK
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  180 CONTINUE
  190 CONTINUE
C.....CALCULATE SCALE VALUES FOR INDUCED DRAG COEFFICEIENTS
      DO 200 J2=1,6
  200 VAL(J2)=10.*FLOAT(J2)/DSCALE+.00001
C.....PRINT LAST TWO LINES (DASH AND PLUSES AND VALUE LINE
C           FOR BOTH PLOTS)
      IF (IGB.GT.4000) WRITE (6,320) (VAL(J2),J2=1,6)
      IF (IGB.LE.4000) WRITE (6,310) (VAL(J2),J2=1,6)
      RETURN
C
  210 FORMAT (1H1,T2,4HARW=,F5.2,2X,4HXCD=,F5.3,9H OF CHORD,2X,3HSMN,    -
     110(2X,I1,1H=,F4.2))
  220 FORMAT (1H+,T124,4HPLOT,I3)
  230 FORMAT (T6,1H+,T12,17HLIFT COEFFICIENTS,38A1,T70,61A1)
  240 FORMAT (T6,1H+,T18,4HV.S.,T29,38A1,T70,61A1)
  250 FORMAT (T6,1H+,T13,15HANGLE OF ATTACK,T29,38A1,T70,61A1)
  260 FORMAT (T6,61A1,T70,37A1,22HTOTAL LIFT COEFFICIENT)
  270 FORMAT (T6,61A1,T70,45A1,4HV.S.)
  280 FORMAT (T6,61A1,T70,35A1,22H      DRAG COEFFICIENTS)
  290 FORMAT (T2,F3.1,1H=,61A1,T70,61A1)
  300 FORMAT (T6,61A1,T70,61A1)
  310 FORMAT (T2,5H0.0-+,20(3H--+),T70,1H+,12(5H----+)/T6,1H0,T18,1H8,   -
     1T29,2H16,T41,2H24,T53,2H32,T65,2H40,T69,3H0.0,6(5X,F5.2))
  320 FORMAT (T2,5H0.0-+,20(3H--+),T70,1H+,12(5H----+)/T6,1H0,T17,2H16,  -
     1T29,2H32,T41,2H48,T53,2H64,T65,2H80,T69,3H0.0,6(5X,F5.2))
      END
```