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C  ********************************************************************
C                                PEDROP
C  THIS PROGRAM COMPUTES PRESSURE DROP VERSUS MASS FLOW RATE
C  OF A UNIFORMLY HEATED SUBCHANNEL MADE UP OF FOUR RODS
C  ARRANGED IN A SQUARE ARRAY. THE COOLANT AT THE INLET IS SINGLE
C  PHASE PRESSURIZED WATER. THERMODYNAMIC PROPERTIES ARE VALID FOR THE
C  PRESSURE RANGE OF 5.514 TO 11.029 MPA (800 TO 1600 PSIA).
C
C
C  ********************************************************************
C
C  NOMENCLATURE AND UNITS OF INPUTS.
C  P      PRESSURE(MPA)
C  DROD   ROD DIAMETER(M)
C  PITCH  ROD CENTER-TO-CENTER DISTANCE(M)
C  TL     CHANNEL AXIAL LENGTH(M)
C  TIN    COOLANT INLET TEMPERATURE(K)
C  TSAT   SATURATION TEMPERATURE(K)
C  HIN    INLET ENTHALPY (KJ/KG)
C  NQ     NUMBER OF HEAT FLUXES
C  Q      HEAT FLUX(MW/M**2)
C  MASS   HIGHEST MASS FLOW RATE(KG/SEC)
C  DEC    MASS FLOW RATE DECREMENTS(KG/SEC)
C  MINM   LOWEST MASS FLOW RATE(KG/SEC)
C  LBOT   BOTTOM UNHEATED LENGTH (M)
C  LTOP   TOP UNHEATED LENGTH (M)
C  LEBOT  BOTTOM, EQUILEVENT LENGTH TO ACCOUNT FOR FORM LOSS(M)
C  LETOP  TOP      ''          '          '     '   '     '
C  IFLAG  IFLAG>0 => NO CALCULATION OF ACCELERATION PR. DROP
C  JFLAG  JFLAG>0 => USE DEVIDED FACTOR IN PRESSURE RANGE
C                    14.7 PSI <  P  <  100 PSI
C  KFLAG   KFLAG>0 => TWO PHASE MULTIPLIER IN SUBCOOLED BOILING REGION =1
C
C  ZSC    AXIAL POINT OF INCEPTION OF SUBCOOLED BOILING(M)
C  ZB     AXIAL POINT OF INCEPTION OF BULK BOILING(M)
C  ZV     AXIAL POINT OF INCEPTION OF SINGLE PHASE VAPOR(M)
      COMMON Q(30)
      CHARACTER*64 FINPUT,FOUTPUT
      REAL MASS,MDOT,MINM,LBOT,LTOP,LEBOT,LETOP
      DATA C4,C5,C6,C7,C8/958.75,-0.8566,2619410.618,-4.995E10,3.403E5/
      DATA C9,C10,C11,C12/1.0665545,1.02E-8,-2.548E-15,2589600./
      DATA C13,C14,C15,C16/6.350E-3,-1.0582E-9,1.0764,3.625E-10/
      DATA C17,C20,C23,C24,C26/-9.063E-17,461.7,647.3,1.3,0.3/
      DATA PI/3.1415926/
C     CALL LINK('UNIT5=IPEDROP,UNIT6=(OPEDROP,CREATE,TEXT),UNIT59=TTY//'
C    1)
      WRITE(*,888)
      READ(*,887)FINPUT
       WRITE(*,886)
       READ(*,887)FOUTPUT
       OPEN(5,  FILE=FINPUT)
       OPEN(6,  FILE=FOUTPUT,STATUS='NEW')
888    FORMAT(' INPUT DATA FILE NAME'\)
887    FORMAT(A)
886    FORMAT(' OUTPUT DATA FILE NAME'\)
C     CALL ERRSET(208,256,-1,0,0,0)
      READ(5,1001) NSET
      DO 700 K=1,NSET
        LBOT=0.0
        LTOP=0.0
        IFLAG=0
        JFLAG=0
        KFLAG=0
        LEBOT=0.
        LETOP=0.
        DETOP=0.
        DFTOP=0.
        DEBOT=0.
        DFBOT=0.
      WRITE(6,1) K
    1 FORMAT(///3X,'RESULTS OF DATA SET NUMBER = ',I5//)
      READ(5,1000) P,DROD,PITCH,TL,TIN,TSAT,HIN
      READ(5,1000) MASS,DEC,MINM,LBOT,LTOP,LEBOT,LETOP
      READ(5,1001) NQ,IFLAG,JFLAG,KFLAG
      READ(5,1000) (Q(I),I=1,NQ)
      A11 = 2.*C26/(C24+C20)
      A13 = A11*(1.+C26)
      A12 = 1./A13
      A15 = 1./C23
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C
C  CALCULATION OF HYDRAULIC DIAMETER.
C
      A = PITCH**2-PI*DROD**2/4.
      PW = PI*DROD
      D = 4.*A/PW
      WRITE(6,3)
    3 FORMAT(3X,'GEOMETRICAL PARAMETERS AND INLET CONDITIONS')
      WRITE(6,4)
    4 FORMAT(3X,'*****************************************'/)
      WRITE(6,5) A,PW,D,TL
    5 FORMAT(3X,'CHANNEL FLOW AREA = ',E13.6,1X,'M**2'/3X,'WETTED PERIME
     1TER = ',E13.6,1X,'M'/3X,'HYDRAULIC DIAMETER = ',E13.6,1X,'M'/3X,'C
     2HANNEL AXIAL LENGTH = ',E13.6,1X,'M')
      WRITE(6,6) P,TIN
    6 FORMAT(3X,'INLET PRESSURE = ',F10.4,1X,'MPA'/3X,'INLET TEMPERATURE
     1 = ',F10.4,1X,'K')
      DO 700 I=1,NQ
      WRITE(6,7)
    7 FORMAT(//3X,'*****************************')
      WRITE(6,10) Q(I)
   10 FORMAT(3X,'HEAT FLUX = ',E13.6,1X,'MW/M**2')
      WRITE(6,20)
   20 FORMAT(3X,'*****************************'/)
      MDOT = MASS
C     IF(Q(I).EQ.0.0) MMP = 31
C     IF(Q(I).GT.0.0) MMP = 30
C     DO 700 J=1,MMP
   23 DFNONB = 0.0
      DENONB = 0.0
      DANONB = 0.0
      HFO = 0.0
      DTNONB = 0.0
      DTSUB = 0.0
      DEBB = 0.0
      DFBB = 0.0
      DABB = 0.0
      DESUB = 0.0
      DASUB = 0.0
      DFSUB = 0.0
      DTSUB=0.0
      DTBB = 0.0
      DEVAP = 0.0
      DAVAP = 0.0
      DFVAP = 0.0
      DTVAP = 0.0
      DROP = 0.0
C
C  FLUID PROPERTIES AT INLET.
C
      TBA = TIN
      CPF = CP(TBA)
      TKW = TKCOOL(TBA,P)
      UBF = UF(TBA)
C     RHOFI = RHOF(TBA)
       PP=P*1.E6
       CALL STATE(PP,TBA,TBA,ROV,RHOFI,EV,EL,TTSAT,HVS,HLS,DTSTP,
     1 DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IOP,IERR)
      IF(MDOT.LT. MINM) GO TO 700
      IF(MDOT .LE. 0.) GO TO 700
      VELI = MDOT/(RHOFI*A)
      G = VELI*RHOFI
      WRITE(6,40) MDOT,G
   40 FORMAT(/3X,'MASS FLOW RATE = ',E13.6,1X,'KG/SEC'/3X,'MASS FLUX = '
     1,E13.6,1X,'KG/SEC-M**2')
C
C  CALCULATION OF THE POINT OF BUBBLE DETACHMENT (ASSUMED = ZSC) USING
C  THE SAHA AND ZUBER METHOD.
C
      IF(Q(I).EQ.0.0) GO TO 53
      PEC = G*D*CPF/TKW
      IF(PEC.LE.70000.) DELSUB = .0022*Q(I)*1.E6*D/TKW
      IF(PEC.GT.70000.) DELSUB = 153.8*Q(I)*1.E6/(G*CPF)
      TFZSC = TSAT-DELSUB
      ZSC = D*G*CPF*(TFZSC-TIN)/(4.*Q(I)*1.E6)
      WRITE(6,50) PEC,DELSUB,TFZSC,ZSC
   50 FORMAT(3X,'PECLET NUMBER = ',E13.6/3X,'DELTA-T SUB = ',E13.6,1X,'K
     1'/3X,'FLUID TEMP. AT ZSC = ',E13.6,1X,'K'/3X,'ZSC = ',E13.6,1X,'M'
     2)
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   53 IF(ZSC.GT.TL.OR.Q(I).EQ.0.0) ZSC = TL
      IF(ZSC.LT.0.0) ZSC=0.0
C
C  NON-BOILING PRESSURE DROPS.
C       WRITE(6,121) VELI
C
      IF(VELI.GT.0.0) RE = G*D/UBF
      IF(VELI.GT.0.0) FRIC = .316/RE**.25
      IF(VELI.LE.0.0) GO TO 55
      HFO = .023*TKW/D*(G*D/UBF)**.8*(UBF*CPF/TKW)**.4
      TBA = TIN+0.5*(TFZSC-TIN)
C     RHOBF = RHOF(TBA)
       PP=P*1.E6
       CALL STATE(PP,TBA,TBA,ROV,RHOBF,EV,EL,TTSAT,HVS,HLS,DTSDP,
     1 DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IOP,IERR)
   55 IF(Q(I).EQ.0.0) RHOBF=RHOFI
      IF(VELI.GT.0.0) DFNONB = ZSC*FRIC*G**2/(2.*D*RHOBF)
      DENONB = RHOBF*9.81*ZSC
        DFBOT=(LBOT+LEBOT)*FRIC*G**2/(2.*D*RHOFI)
        DEBOT=RHOFI*9.81*LBOT
         DTBOT=DEBOT+DFBOT
      TBA = TFZSC
C     RHOZSC = RHOF(TBA)
      PP=P*1.E6
      CALL STATE (PP,TBA,TBA,ROV,RHOZSC,EV,EL,TTSAT,HVS,HLS,DTSDP,
     1 DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IQP,IERR)
      IF(Q(I).EQ.0.0) RHOZSC=RHOFI
      IF(VELI.LE.0.0) GO TO 59
      IF(ZSC.GT.0.0) DANONB=G**2*(1./RHOZSC-1./RHOFI)
        IF(IFLAG .GT.  0) DANONB=0.0
        IF(ZSC .LT. TL) GO TO 59
        DFTOP=(LTOP+LETOP)*FRIC*G**2/(2.*D*RHOBF)
        DETOP=RHOBF*9.81*LTOP
        DTTOP=DETOP+DFTOP
   59 DTNONB = DFNONB+DENONB+DANONB
C     WRITE(6,60) RE,FRIC,RHOBF,RHOZSC,HFO
   60 FORMAT(3X,'REYNOLDS NUMBER = ',E13.6/3X,'FRICTION FACTOR = ',E13.6
     1/3X,'AV. NON-BOILING BULK FLUID DENSITY = ',F10.3,1X,'KG/M**3'/3X,
     2'FLUID DENSITY AT ZSC = ',F10.3,1X,'KG/M**3'/3X,'COEFFICIENT OF HE
     3AT TRANSFER = ',F10.3,1X,'W/M**2-K')
      IF(ZSC.GE.TL.OR.Q(I).EQ.0.0) GO TO 625
C
C  DETERMINATION OF ZB.
C
      TBA = TSAT
C     RHOFZB = RHOF(TBA)
C     PP=P*1.E6
       PB=P-0.004*P
  100  PPB=PB*1.E6
      CALL STATE(PPB,TBA,TBA,ROV,RHOFZB,EV,EL,TTSAT,HVS,HLS,DTSDP,
     1 DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IQP,IERR)
       CALL STATE(PPB,TTSAT,TTSAT,RHOGZB,RHOFZB,EV,EL,TTTSAT,HVS,HLS,DTSD
     1P,DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IQP,IERR)
       HF=HLS/1.E3
        UBF=UF(TSAT)
        UBG=UG(TSAT)
C     WRITE(6,121) RHOGZB,RHOFZB,HLS
C     RHOGZB = RHOG(TBA,PB)
       TBA=.5*(TSAT+TFZSC)
       RHOSUB=.5*(RHOFZB+RHOZSC)
      CPF = CP(TBA)
      ZB = MDOT*(HF-HIN)/(PI*Q(I)*1.E3*DROD)
      IF(ZB.GT.TL) ZB=TL
      IF(ZB.LT.0.0) ZB=0.0
      IF(ZB .LT. ZSC) ZSC=ZB
C
C  SUBCOOLED BOILING PRESSURE DROPS.
C
      DESUB = RHOSUB*9.81*(ZB-ZSC)
      IF(ZB.GT.0.0) DASUB=(G**2*(1./RHOFZB-1./RHOZSC))
      RE=G*D/UF(TBA)
      IF(VELI.GT.0.0) FRIC=.316/RE**.25
C
C  BRITISH UNITS USED FOR SUBCOOLED FRICTION PR. DROP CALCULATIONS.
C
      FPD = (G*737.73)**2*FRIC/(2.*32.2*3600.**2*D*3.281*RHOSUB*0.06243)
      TLBSTR= (((TSAT-273.15)*1.8+32.+60.*((Q(I)*.3169E6/.1E7)**.25/EXP(
     1PB*.145E3/900.))-.766*Q(I)*.3169E6/(HFO*.1761))-32.)*5./9.+273.15
      PHLOMN = (1.2*((RHOFZB/RHOGZB)-1.)*.042**.824)
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C     WRITE(6,120)
  120 FORMAT(1X,'FPD,TLBSTR,PHLOMN,FACTOR,CORFAC')
C     WRITE(6,121) FPD,TLBSTR,PHLOMN,FACTOR,CORFAC
  121 FORMAT(1X,8E13.6)
  150 IF(G*737.73.LT.7.E5) CORFAC = 1.36+.0005*PB*.145E3+.1*(G*737.73/1.
     1E6)-.000714*PB*.145E3*(G*737.73/1.E6)
      IF(G*737.73.GT.7.E5) CORFAC = 1.26-.0004*PB*.145E3+.119*(1.E6/(G*7
     137.73))+.00028*PB*.145E3*(1.E6/(G*737.73))
      FSAT = PHLOMN*CORFAC+1.
      DEVID=(7.04-3.8*.042)*(1.172-1.7*PB)+3.4*PB-0.344
      IF(JFLAG .GT. 0) FSAT=FSAT/DEVID
      FOFISO = 1.+(TBA-TLBSTR)*(FSAT-1.)/(TSAT-TLBSTR)
      IF (TBA .LT. TLBSTR) FOFISO = 1.-0.001*Q(I)/HFO
      IF (KFLAG .GT. 0) FOFISO=1
      DFSUB = 47.867*FPD*(ZB-ZSC)*3.281*FOFISO
        IF(ZB .LT. TL) GO TO 160
        TEXIT=TIN+TL*PI*Q(I)*1.E6*DROD/(MDOT*CPF)
        PPB=PB*1.E6
        CALL STATE(PPB,TEXIT,TEXIT,ROV,RHOFTL,EV,EL,TTSAT,HVS,HLS,DTSDP,
     1  DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IQP,IERR)
C       WRITE(6,121) RHOFTL
C       WRITE(6,121) TEXIT,RHOFTL
        DASUB=G**2*(1./RHOFTL-1./RHOZSC)
         DESUB=.5*(RHOFTL+RHOZSC)*9.81*(TL-ZSC)
        CPEXIT=CP(TEXIT)
        TKEXIT=TKCOOL(TEXIT,PB)
        UBFEX=UF(TEXIT)
        RE=G*D/UBFEX
        FRIC=.316/RE**.25
        DFTOP=(LTOP+LETOP)*FRIC*G**2/(D*RHOFTL*2.)
        DETOP=RHOFTL*9.81*LTOP
  160   IF(IFLAG .GT.  0) DASUB=0.0

      DTTOP=DFTOP+DETOP
      DTSUB = DESUB+DASUB+DFSUB
C     WRITE(6,170)
C 170 FORMAT(1X,'CORFAC,FSAT,FOFISO,TBA,TLBSTR')
C     WRITE(6,121)CORFAC,FSAT,FOFISO,TBA,TLBSTR
C
C  ITERATIONS OF PRESSURE AT ZB.
C
      PBB = (P*1.E6-(DTNONB+DTSUB+DTBOT))
C     WRITE(6,121) PB,PBB
      PBITE = ABS((PBB/1.E6-PB)/PB)
      IF(PBITE.GT.0.00005) PB=PBB/1.E6
      IF(PBITE.GT.0.00005) GO TO 100
        IF (KFLAG .LE. 0) GO TO 162
        DANONB=DANONB+DASUB
        TBA=(TIN+TSAT)/2.

        IF(ZB .GE. TL) TBA=(TEXIT+TIN)/2.
        PPB=PB*1.E6
        CALL STATE(PPB,TBA,TBA,ROV,RHOFBA,EV,EL,TTSAT,HVS,HLS,DTSDP,
     1  DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IQP,IERR)
        DENONB=RHOFBA*9.81*ZB
         DFNONB=DFNONB*(RHOBF/RHOFBA)*(ZB/ZSC)
        DTNONB=DANONB+DENONB+DFNONB
        DESUB=0.0
        DASUB=0.0
         DFSUB=0.0
        DTSUB=0.0
  162 WRITE(6,200) ZB
  200 FORMAT(3X,'ZB = ',F10.4,1X,'M')

      IF(ZB.GE.TL) GO TO 625
C
C  DETERMINATION OF ZV.
C
      PV = (P-0.006*P)
C 300 HG = ENTHAG(PV)
  300   PPV=PV*1.0E6
        CALL STATE(PPV,TSAT,TSAT,ROV,ROL,EV,EL,TTSAT,HVS,HLS,DTSTP,
     1DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IOP,IERR)
        HG=HVS/1.E3
      ZV = MDOT*(HG-HIN)/(PI*Q(I)*1.E3*DROD)
      IF(ZV.GT.TL) ZV=TL
      IF(ZV.LT.0.0) ZV=0.0
C
C  CALCULATION OF MARTINELLI-NELSON VOID FRACTION.
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C
      XZSC = -CPF*DELSUB/((HG-HF)*1.E3)
      XZB = -XZSC/2.71828
      XTTZB = (UBF/UBG)**.1*(((1.-XZB)/XZB)**.9)*(RHOGZB/RHOFZB)**.5
      RGZB = 1.-XTTZB/((XTTZB**2+20.*XTTZB+1.)**.5)
C
C   DETERMINATION OF X(Z=TL)=XOUT
C
C     HGPB=ENTHAG(PB)
        PPB=PB*1.E6
        CALL STATE (PPB,TSAT,TSAT,ROV,ROL,EV,EL,TTSAT,HVS,HLS,DTSDP,
     1  DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IQP,IERR)
        HGPB=HVS/1.E3
C       WRITE(6,121) HVS
      HOUT=TL*(PI*Q(I)*1.E3*DROD)/MDOT+HIN
      XEOUT=(HOUT-HF)/(HGPB-HF)
      XOUT=XEOUT-XZSC*EXP(XEOUT/XZSC-1.)
      IF(XEOUT .GT. 1.0) XEOUT = 1.0
      IF(XOUT  .GT. 1.0) XOUT  =1.0
C
C  BULK BOILING PRESSURE DROPS.
C
      XZV = 1.-XZSC*EXP(1./XZSC-1.)
      IF(ZV .GE. TL) XZV=XOUT
      IF(XZV.GT.1.0) XZV=1.0
      XTTZV = (UBF/UBG)**.1*(((1.-XZV)/XZV)**.9)*(RHOGZB/RHOFZB)**.5
      RGZV = 1.-XTTZV/((XTTZV**2+20.*XTTZV+1.)**.5)
      RHOB = RHOFZB-0.5*(RGZB+RGZV)*(RHOFZB-RHOGZB)
      DEBB = RHOB*9.81*(ZV-ZB)
        RHOZV=RHOFZB-RGZV*(RHOFZB-RHOGZB)
      DZV = XZV**2/(RHOGZB*RGZV)
      IF(XZV.NE.1..OR.RGZV.NE.1.) DZV = (1.-XZV)**2/(RHOFZB*(1.-RGZV)
     1)+DZV
      DZB = (1.-XZB)**2/(RHOFZB*(1.-RGZB))+XZB**2/(RHOGZB*RGZB)
      IF(ZV.GT.0.0) DABB = (G**2)*(DZV-DZB)
        XEZV=1.0
         IF(ZV .GE. TL) XEZV=XEOUT
      PHLOMN=1.2*((RHOFZB/RHOGZB)-1.)*(XEZV)**.824
      DFBB=(G*737.73)**2*FRIC*(PHLOMN*CORFAC/1.824+1.)*(ZV-ZB)/(RHOFZB*
     10.06243*2*32.2*3600.**2*D)*47.867
       DEVID=((7.04-3.8*XEZV)*(1.172-1.7*PB)+3.4*
     1 PB-.344)
        IF(IFLAG .GT.  0) DABB=0.
        IF(ZV .LT. TL ) GO TO 350
        DFTOP=G**2*FRIC*(PHLOMN*CORFAC+1.0)*(LTOP+LETOP)/
     1  (RHOFZB*D*2.)
        IF(JFLAG .GT. 0) DFTOP=DFTOP/DEVID
        DETOP=RHOZV*9.81*LTOP
        DTTOP=DFTOP+DETOP
  350   IF(JFLAG .GT.  0) DFBB=DFBB/DEVID
C     WRITE (6,320)
  320 FORMAT(1X,'DFBB,FRIC,PHLOMN,CORFAC,ZB,RHOFZB,RHOGZB')
C     WRITE(6,121) DFBB,FRIC,PHLOMN,CORFAC,ZB,RHOFZB,RHOGZB
      DTBB = DEBB+DABB+DFBB
C
C  ITERATIONS OF PRESSURE AT ZV.
C
      PVV = (P*1.E6-(DTNONB+DTSUB+DTBB+DTBOT))
      PVITE = ABS((PVV/1.E6-PV)/PV)
      IF(PVITE.GT.0.00005) PV=PVV/1.E6
      IF(PVITE.GT.0.00005) GO TO 300
      WRITE(6,400) ZV,XZSC,XZB,RGZB,XZV,RGZV,XEOUT,XOUT
  400 FORMAT(3X,'ZV= ',F10.4,1X,'M'/
     1 3X,'EQUILIBRIUM QUALITY AT ZSC = ',E13.6/
     2 3X,'NON EQUILIBRIUM QUALITY AT ZB =',E13.6/
     3 3X,'MARTINELLI-NELSON VOID FRACTION AT ZB =',F10.4/
     4 3X,'NON EQUILIBRIUM QUALITY AT ZV = ',E13.6/
     5 3X,'MARTINELLI-NELSON VOID FRACTION AT ZV =', E13.6/
     6 3X,'QUALITY AT CHANNEL OUTLET , EQ = ',F10.4,' NON EQ = ',F10.4)
      IF(ZV.GE.TL) GO TO 625
C
C  DETERMINATION OF VAPOR DENSITY AT EXIT.
C
       HTL = Q(I)*1.E3*PI*DROD*TL/MDOT+HIN
      TG = TSAT+2.
      IF(PV*1.E6.GT.2.E6) GO TO 500
      ES = C6+C7*(1./(C8+PV*1.E6))
      GS = C9+(C11*PV*1.E6+C10)*PV*1.E6
      GO TO 510
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  500 ES = C12+(C14*PV*1.E6+C13)*PV*1.E6
      GS = C15+(C17*PV*1.E6+C16)*PV*1.E6
  510 CPS = C4*(1.0-A15*TSAT)**C5
      BETA = TSAT**2*(1.0-1.0/(A11*CPS-1.0)**2)
  520 EG = ES+A12*((TG-TSAT)+(TG**2-BETA)**.5-TSAT/(A11*CPS-1.0))
      DENG = PV*1.E6/((GS-1.0)*ES+C26*(EG-ES))
      HG = EG+PV*1.E6/DENG
      HABS = ABS((HG/1.E3-HTL)/HTL)
      IF(TG.GT.700.) GO TO 530
      IF(HABS.GT.0.005) TG = TG+1.
      IF(HABS.GT.0.005) GO TO 520
C
C  SINGLE PHASE VAPOR PRESSURE DROPS. THESE PRESSURE DROPS MAY NOT BE
C  COMPATIBLE WITH THOSE CALCULATED EARLIER AND ARE NOT TABULATED.
C
  530 TBA = TG-0.5*(TG-TSAT)
      IF(TBA.GT.640.) TBA = 640.
      IF(TBA.GT.640.) WRITE(6,570)
  570 FORMAT(3X,'THE AV. VAPOR TEMP. HAS EXCEEDED THE RANGE OF VALIDITY
     1OF THE VAPOR VISCOSITY CORRELATION. SO AS TO AVOID A SUBSEQUENT NE
     2GATIVE ARGUMENT,TBA IS TAKEN TO BE 640. K')
      UBG = UG(TBA)
      RE = G*D/UBG
C     FRIC = .316/RE**.25
      DEVAP = 0.5*(RHOGZB+DENG)*9.81*(TL-ZV)
      DAVAP = G**2*(1./DENG-1./RHOGZB)
C     DFVAP = FRIC*G**2*(TL-ZV)/(2.*D*0.5*(RHOGZB+DENG))
       PHOLMN=1.2*(RHOFZB/RHOGZB-1.)
       DFVAP=FRIC*G**2.*(TL-ZV)*(PHOLMN*CORFAC+1.)/(RHOFZB
     1 *D*2.)
       DFTOP=FRIC*G**2.*(LTOP+LETOP)*(PHOLMN*CORFAC+1.)/(RHOFZB*D*2.)
      IF(IFLAG .GT.  0) DAVAP=0.0
C     DFVAP = DFVAP+FRIC*G**2*(LTOP+LETOP)/(2.*D*DENG)
      DETOP=DENG*9.81*LTOP
       IF(JFLAG .LE. 0) GO TO 580
       DFVAP=DFVAP/DEVID
       DFTOP=DFTOP/DEVID
  580 DTTOP=DETOP+DFTOP
      DTVAP = DEVAP+DAVAP+DFVAP
      WRITE(6,600) TG,HTL,DENG,HG,RE,DEVAP,DAVAP,DFVAP,DTVAP
  600 FORMAT(3X,'VAPOR TEMPERATURE AT EXIT = ',F10.3,1X,'K'/3X,'ENTHALPY
     1 AT EXIT(HEAT BALANCE)= ',F10.1,1X,'KJ/KG'/3X,'VAPOR DENSITY AT EX
     2IT = ',F10.3,1X,'KG/M**3'/3X,'ENTHALPY AT EXIT(CORRELATED) = ',F10
     3.1,1X,'J/KG'/3X,'VAPOR REYNOLDS NUMBER = ',F10.1/3X,'ELEVATION VAP
     4OR PR. DROP = ',F10.3,1X,'PA'/3X,'ACCELERATION VAPOR PR. DROP = ',
     5F10.3,1X,'PA'/3X,'FRICTION VAPOR PR. DROP = ',F10.3,1X,'PA'/3X,'TO
     6TAL VAPOR PR. DROP = ',F10.2,1X,'PA')
C
C  TOTAL PRESSURE DROP.
C
  625 DROP = DTNONB+DTSUB+DTBB+DTVAP+DTTOP+DEBOT+DFBOT
      WRITE(6,650) DROP
  650 FORMAT(/3X,'TOTAL PRESSURE DROP = ',F10.0,1X,'PA')
C
C  TABULATION OF PRESSURE DROP COMPONENTS
C
      DF = DFNONB+DFSUB+DFBB+DFTOP+DFBOT
      DE = DENONB+DESUB+DEBB+DETOP+DEBOT
      DA = DANONB+DASUB+DABB
      DFCENT = DF/DROP*100.
      DECENT = DE/DROP*100.
      DACENT = DA/DROP*100.
      DTNCEN = DTNONB/DROP*100.
      DTSCEN = DTSUB/DROP*100.
      DTBCEN = DTBB/DROP*100.
      WRITE(6,651)
  651 FORMAT(/3X,'******** TABULATION OF PRESSURE DROP COMPONENTS IN PAS
     1CALS *********')
      WRITE(6,652)
  652 FORMAT(3X,'**************************************************
     1*************')
      WRITE(6,653)
  653 FORMAT(13X,'BOILING REGIME                    SUBTOTAL (COMP./TOT
     1AL)%')
      WRITE(6,654)
  654 FORMAT(3X,'COMPONENT NON-BOILING  SUBCOOLED      BULK')
      WRITE(6,655)
  655 FORMAT(3X,'**************************************************
     1*************')
```

```
      WRITE(6,656) DFNONB,DFSUB,DFBB,DF,DFCENT
  656 FORMAT(3X,'FRICTION',4X,F10.0,1X,3F10.0,8X,F5.2)
      WRITE(6,657) DENONB,DESUB,DEBB,DE,DECENT
  657 FORMAT(3X,'ELEVATION',3X,F10.0,1X,3F10.0,8X,F5.2)
      WRITE(6,658) DANONB,DASUB,DABB,DA,DACENT
  658 FORMAT(3X,'ACCELERATION',F10.0,1X,3F10.0,8X,F5.2)
      WRITE(6,659)
  659 FORMAT(3X,'**************************************************
     1*************')
      WRITE(6,660)
  660 FORMAT(50X,'TOTAL')
      WRITE(6,661) DTNONB,DTSUB,DTBB,DROP
  661 FORMAT(3X,'SUBTOTAL',4X,F10.0,1X,3F10.0)
      WRITE(6,662)
  662 FORMAT(46X,'**********')
      WRITE(6,663) DTNCEN,DTSCEN,DTBCEN
  663 FORMAT(3X,'(REGIME/TOTAL)%',1X,F6.2,5X,F6.2,4X,F6.2)
      WRITE(6,675)
  675 FORMAT(/3X,'**************************************************
     1*************')
      WRITE(6,676) DETOP,DFTOP,DEBOT,DFBOT
  676  FORMAT(3X,'TOP    UNHEATED PR. DROP  ELEV  =',F8.2,' FRI=',F8.2/
     1 3X,'BOTTOM UNHEATED PR. DROP  ELEV  =',F8.2,' FRI=',F8.2)
      MDOT=MDOT-DEC
      GO TO 23
  700 CONTINUE
 1000 FORMAT(7f10.0)
 1001 FORMAT(6i5)
      STOP
      END

C.....................................................................
$DEBUG
      SUBROUTINE INPT(P,DROD,PITCH,TL,TIN,TSAT,HIN,MASS,DEC,MINM,
     1LBOT,LTOP,LEBOT,LETOP,IFLAG,JFLAG,KFLAG,NQ,Q,NSET)
       CHARACTER*23 HEAD(21)
       DIMENSION X(20),IX(10),Q(30)
       REAL MASS,MDOT,MINM,LBOT,LTOP,LEBOT,LETOP
       DATA HEAD/'PEDROP INPUT   ','# INPUT SETS -I',
     1           'PRESSURE(MPA)     -R','ROD DIAMETER(M) -R',
     2           'C-TO-C DIST. (M)-R','CH.AXIAL LEN (M)-R',
     3           'INLET TEMP.  (K)-R','SAT. TEMP.   (K)-R',
     4           'INLET ENTHAL.(KJ/KG)-R','HIGH MFR(KG/SEC)    -R',
     5           'MFR DECREM. (KG/SEC)-R','LOW MFR     (KG/SEC)-R',
     6           'BOT.UNHTD LEN(M)-R','TOP UNHTD LEN(M)-R',
     A           'BOT.LEN. LOSS(M)-R','TOP LEN. LOSS(M)-R',
     7           '# HEAT FLUXES-I','IFLAG        -I',
     8           'JFLAG        -I','KFLAG        -I',
     9           'HEAT FLUXES  (MW/M2)-R'/
       WRITE(*,324)HEAD(1),HEAD(1),HEAD(1)
 324   FORMAT(1X,A15,A15,A15)
       II=2
325    FORMAT(I4,5X,A23,'---->'\)
       WRITE(*,325) II,HEAD(2)
      READ(*,300) NSET
      DO 100 I=1,14
      II=I+2
       WRITE(*,325) II,HEAD(II)
      READ(*,200)X(I)
 100  CONTINUE
 200  FORMAT(F10.0)
      DO 110 I=1,4
      II=I+16
      WRITE(*,325) II,HEAD(II)
      READ(*,300) IX(I)
 110  CONTINUE
 300  FORMAT(BN,I10)
      NQ=IX(1)
      II=21
      WRITE(*,325) II,HEAD(II)
C       DO 120 I=1,NQ
      READ(*,*)(Q(I),I=1,NQ)
C  120   CONTINUE
 10     WRITE(*,400)
 400  FORMAT(' YOUR INPUT LOOKS LIKE THIS')
      DO 500 I=1,14
      II=I+2
      WRITE(*,325) II,HEAD(II)
      WRITE(*,*)X(I)
```

```
 500  CONTINUE
      DO 510 I=1,4
      II=I+16
      WRITE(*,325) II,HEAD(II)
       WRITE(*,*)IX(I)
 510  CONTINUE
      II=21
       WRITE(*,325)II,HEAD(21)
      WRITE(*,*)(Q(I),I=1,NQ)
 55   WRITE(*,450)
 450  FORMAT(' ENTER A SINGLE INTEGER'/' TO CHANGE AN ENTRY--1'/
     1' TO STOP EXECUTION --2'/' TO CONTINUE      --3')
      READ(*,300)ICK
      GO TO (700,800,600) ,ICK
        GO TO 55
 800  STOP
 600  P=X(1)
      DROD=X(2)
      PITCH=X(3)
      TL=X(4)
      TIN=X(5)
      TSAT=X(6)
      HIN=X(7)
      MASS=X(8)
      DEC=X(9)
      MINM=X(10)
      LBOT=X(11)
      LTOP=X(12)
      LEBOT=X(13)
      LETOP=X(14)
      IFLAG=IX(2)
      JFLAG=IX(3)
      KFLAG=IX(4)
      GO TO 50
 700  WRITE(*,530)
 530  FORMAT(' ENTER THE INDEX NUMBER OF ITEM TO BE CHANGED '\)
      READ(*,300) II
      WRITE(*,325) II,HEAD(II)
      IF(II.LT.17) THEN
         READ(*,200)X(II-2)
        ELSEIF(II.EQ.21) THEN
              READ(*,*)(Q(I),I=1,NQ)
        ELSE
              READ(*,300)IX(II-16)
              NQ=IX(1)
              ENDIF
      GO TO 10
 50   CONTINUE
C     RETURN
      END
c.....................................................................
      SUBROUTINE STATE(P,TV,TL,ROV,ROL,EV,EL,TSAT,HVS,HLS,DTSDP,        -0680
     1   DELDP,DEVDP,DELDT,DEVDT,DRLDP,DRVDP,DRLDT,DRVDT,IOP,IERR)      -0690
C                                                                       -0700
C                                                                       -0710
C    SUBROUTINE STATE CALCULATES THE STATE DYNAMIC PROPERTIES OF WATER  -0720
                                                                        -0770
C    SI UNITS ARE USED                                                  -0780
C                                                                       -0790
C    INPUT VARIABLES                                                    -0800
C       1. P   PRESSURE                                                 -0810
C       2. TL  TEMPERATURE OF THE LIQUID                                -0820
C       3. TV  TEMPERATURE OF THE VAPOR                                 -0830
C       4. IOP OPTION SELECTOR - NOT IN PRESENT VERSION                 -0840
C                                                                       -0850
C    OUTPUT VARIABLES                                                   -0860
C       1. EV     INTERNAL ENERGY OF THE VAPOR                          -0870
C       2. EL     INTERNAL ENERGY OF THE LIQUID                         -0880
C       3. TSAT   SATURATION TEMPERATURE                                -0890
C       4. HVS    VAPOR SATURATION ENTHALPY                             -0900
C       5. HLS    LIQUID SATURATION ENTHALPY                            -0910
C       6. ROL    DENSITY OF THE LIQUID                                 -0920
C       5. ROV    DENSITY OF THE VAPOR                                  -0930
C       6. DTSDP  DERIVATIVE OF TSAT WRT PRESSURE                       -0940
C       7. DELDP  DERIVATIVE OF TL WRT PRESSURE                         -0950
C       8. DEVDP  DERIVATIVE OF TV WRT PRESSURE                         -0960
C       9. DELDT  DERIVATIVE OF EL WRT TL                               -0970
C      10. DEVDT  DERIVATIVE OF EV WRT TV                               -0980
C      11. DRLDP  DERIVATIVE OF ROL WRT PRESSURE                        -0990
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C      12. DRVDP  DERIVATIVE OF ROV WRT PRESSURE                        -1000
C      13. DRLDT  DERIVATIVE OF ROL WRT TL                              -1010
C      14. DRVDT  DERIVATIVE OF ROV WRT TV                              -1020
C      15. IERR   ERROR FLAG (INPUT VARIABLE OUT OF RANGE)              -1030
C                                                                       -1040
C    CONSTANTS USED IN FITS                                             -1050
C                                                                       -1060
C    FOR TSAT, CPS                                                      -1070
      DATA TSC1,TSC2, TSEXP  /9.0395, 255.2, 0.223/                     -1080
      DATA CPS1,CPS2, CPSEXP  /9.5875E2, .00132334, -0.8566/            -1090
C       CPS2 = -CPSEXP * TCRINV                                         -1100
C    FOR ES, GAMS  IF P < 20 BARS                                       -1110
      DATA G11,G12,G13  /2.6194106E6, -4.995E10, 3.403E5/               -1120
      DATA G14,G15,G16  /1.0665544, 1.02E-8, -2.548E-15/                -1130
C          G11,G14 ARE ADJUSTED SO THAT ES RESP. GAMS JUMPS LESS THAN   -1140
C             1 PART IN 1.E-8 ACROSS P = 20 BARS.                       -1150
      DATA G17 /-5.096E-15/                                             -1160
C       G17 = 2.* G16                                                   -1170
C    FOR ES, GAMS  IF P > 20 BARS                                       -1180
      DATA G21,G22,G23  /2.5896E6, 6.350E-3, -1.0582E-9/                -1190
      DATA G24,G25,G26  /1.0764, 3.625E-10, -9.063E-17/                 -1200
      DATA G27,G28  /-2.1164E-9, -18.126E-17/                           -1210
C       G27 = 2.* G23,   G28 = 2.* G26                                  -1220
C                                                                       -1230
C    FOR HLS AND HVS                                                    -1240
       DATA  HL0,HL1,HL2,HL3,HL4,HL5/5.7474718E5,2.0920624E-1,          -1250
     1    -2.8051070E-8,2.3809828E-15,-1.0042660E-22,1.6586960E-30/     -1260
       DATA  HV0,HV1,HV2,HV3,HV4/2.7396234E6,3.758844E-2,               -1270
     1       -7.1639909E-9,4.2002319E-16,-9.8507521E-24 /               -1280
C                                                                       -1290
      DATA P20B /2.0E6/                                                 -1300
      DATA TCRIT /647.3/                                                -1310
      DATA TCRINV /.00154488/                                           -1320
      DATA CC,CCI,CCM  /1.3, .76923, 0.3/                               -1330
C                                                                       -1340
C      FOR ROL IF T < 576.5 DEG K                                       -1350
C                                                                       -1360
      DATA RL0,RL1,RL2,RL3 /1735.3320,-4.6406842,1.0431090E-2,          -1370
     1                        -9.4367085E-6/                            -1380
      DATA RL22,RL33 /2.086218E-2,-2.8310126E-5 /                       -1390
C       RL22 = 2.*RL2       RL33 =3.*RL3                                -1400
C                                                                       -1410
C       FOR ROL   IF T > 576.5 DEG K                                    -1420
C                                                                       -1430
                                                                        -1440
      DATA RH0,RH1,RH2,RH3,RH4 /-1.1755984E6,8.1437361E3,-2.1136559E1,  -1450
     1         2.4381598E-2,-1.0549747E-5 /                             -1460
      DATA RH22,RH33,RH44 /-4.2273118E1,7.3144794E-2,-4.2198988E-5/     -1470
C       RH22 = 2.*RH2    RH33 = 3.*RH3     RH44 = 4.*RH4                -1480
C                                                                       -1490
      DATA RP0,RP1,RP2 /-14.643890,1.1283357E-3,1.2670366E-2/           -1500
C                                                                       -1510
      DATA SP0,SP1,SP2,SP3 / -42.0218,.2116,-4.4587E-4,3.251E-7/        -1520
      DATA SP22,SP33 /-8.9174E-4,9.753E-7/                              -1530
C                                                                       -1540
C    FOR EL  IF TL < 576.5 DEG K                                        -1550
      DATA SL0,SL1,SL2,SL3,SL4 /-460.26818E3,-2.8634045E3,27.450693,    -1560
     1         -4.8108323E-2,3.2059316E-5/                              -1570
      DATA SL22,SL33,SL44 /54.901386,-.14432497,1.2823726E-4/           -1580
C      SL22 = 2.* SL2,   SL33 = 3.* SL3                                 -1590
C    FOR EL  IF TL > 576.5 DEG K                                        -1600
      DATA SH0,SH1,SH2,SH3,SH4 /1.2426455E9,-8.6082251E6,2.2364564E4,   -1610
     1         -2.5815959E1,1.1178766E-2/                               -1620
      DATA SH22,SH33,SH44 /4.4729128E4,-77.447877,4.4715064E-2/         -1630
C      SH22 = 2.* SH2,   SH33 = 3.* SH3                                 -1640
C                                                                       -1650
C    FOR VAPOR                                                          -1660
      DATA A11,A12,A13 /1.2959E-3,  593.59, 1.6847E-3/                  -1670
C                                                                       -1680
      DATA  HALF,ZERO,ONE,TWO  /0.5, 0., 1., 2./                        -1690
C                                                                       -1700
C  ---------------------------------------                              -1710
C                                                                       -1720
C     CHECK THAT P, TL, TV, ARE WITHIN RANGE OF FITS                    -1730
C                                                                       -1740
       TLSAVE = TL                                                      -1750
       IF(TL.GT.647.) TL = 647.                                         -1760
      IF (P.GE.1.0E+3.AND.P.LE.190.0E+5) GO TO 5                        -1770
        IERR = 1                                                        -1780
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        RETURN                                                          -1790
    5 IF (TL.GE.280.0.AND.TL.LE.647.0) GO TO 10                         -1800
        IERR = 2                                                        -1810
        RETURN                                                          -1820
   10 IF(TV.GE.280.0) GO TO 20                                          -1830
        IERR = 3                                                        -1840
        RETURN                                                          -1850
   20 IERR = 0                                                          -1860
C                                                                       -1870
C    CALCULATE SATURATION PROPERTIES                                    -1880
C                                                                       -1890
C       1. TSAT    SATURATION TEMPERATURE                               -1900
C       2. DTSDP    DERIVATIVE OF TSAT WRT PRESSURE                     -1910
C       3. ES      SATURATION INTERNAL ENERGY                           -1920
C       4. DPES    DERIVATIVE OF ES WRT PRESSURE                        -1930
C       5. GAMS    GAMMA SUB S                                          -1940
C       6. DPGAMS  DERIVATIVE OF GAMS WRT PRESSURE                      -1950
C       7. CPS     C SUB PS                                             -1960
C       8. DPCPS   DERIVATIVE OF CPS WRT PRESSURE                       -1970
C       9. GAMSM   GAMS-ONE                                             -1980
C      10. HVS     VAPOR SATURATION ENTHALPY                            -1990
C      11. HLS     LIQUID SATURATION ENTHALPY                           -2000
C                                                                       -2010
      TSAT = TSC1* P**TSEXP                                             -2020
      HVS = HV0 + P*(HV1 + P*(HV2 + P*(HV3 + P*HV4)))                   -2030
      HLS = HL0 + P*(HL1 + P*(HL2 + P*(HL3 + P*(HL4 + P*HL5))))         -2040
      PINV = ONE/ P                                                     -2050
      DTSDP = TSAT*TSEXP*PINV                                           -2060
      TSAT = TSAT + TSC2                                                -2070
C                                                                       -2080
      T1 = ONE - TSAT*TCRINV                                            -2090
      CPS = CPS1* T1**CPSEXP                                            -2100
      DPCPS = CPS2*CPS/T1 *DTSDP                                        -2110
C                                                                       -2120
      IF (P.GT.P20B) GO TO 150                                          -2130
        T2 = ONE/ (G13+P)                                               -2140
        T1 = T2*G12                                                     -2150
        ES = G11 + T1                                                   -2160
        DPES = -T1*T2                                                   -2170
        GAMS = G14 + P*(G15 + P*G16)                                    -2180
        DPGAMS = G15+G17*P                                              -2190
        GO TO 200                                                       -2200
  150 CONTINUE                                                          -2210
        ES = G21+(G23*P+G22)*P                                          -2220
        DPES = G22+G27*P                                                -2230
        GAMS = G24+(G26*P+G25)*P                                        -2240
        DPGAMS = G25 + G28*P                                            -2250
  200 GAMSM = GAMS - ONE                                                -2260
C                                                                       -2270
C                                                                       -2280
C     CALCULATE LIQUID PROPERTIES                                       -2290
C                                                                       -2300
C                                                                       -2310
C       1. INTERNAL ENERGY AND ITS DERIVATIVES                          -2320
C                                                                       -2330
      DP=P - 150.E5                                                     -2340
      DELDP = -EXP(SP0+TL*(SP1+TL*(SP2+TL*SP3)))                        -2350
      DEL = DELDP * DP                                                  -2360
      IF (TL.GE.576.5) GO TO 210                                        -2370
        EL = SL0 + TL*(SL1 + TL*(SL2 + TL*(SL3+TL*SL4))) + DEL          -2380
        DELDT = SL1 + TL*(SL22 + TL*(SL33+TL*SL44))                     -2390
     1           + DEL * (SP1 + TL*(SP22 + TL*SP33))                    -2400
        GO TO 220                                                       -2410
  210 CONTINUE                                                          -2420
        EL =(SH0 + TL*(SH1 + TL*(SH2 + TL*(SH3+ TL*SH4)))) + DEL        -2430
        DELDT = (SH1 + TL*(SH22 + TL*(SH33 + TL*SH44)))                 -2440
     1          + DEL * (SP1 + TL*(SP22 +TL*SP33))                     -2450
  220 CONTINUE                                                          -2460
C                                                                       -2470
C       2. DENSITY AND ITS DERIVATIVES                                  -2480
C                                                                       -2490
      DRLDP = EXP(RP0 + RP1*EXP(RP2 * TL))                              -2500
      DRL = DRLDP * DP                                                  -2510
          IF (TL.GE.576.5) GO TO 230                                    -2520
      ROL = RL0 + TL*(RL1 + TL*(RL2+ TL*RL3)) + DRL                     -2530
      DRLDT = RL1 + TL*(RL22 + TL*RL33) + DRL*RP1*RP2*EXP(RP2*TL)       -2540
      GO TO 240                                                         -2550
 230  CONTINUE                                                          -2560
      ROL = RH0 + TL*(RH1 + TL*(RH2 + TL*(RH3 + TL*RH4))) + DRL         -2570
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      DRLDT = RH1 + TL*(RH22 + TL*(RH33 + TL*RH44)) +                   -2580
     1        DRL*RP1*RP2*EXP(RP2*TL)                                   -2590
240   CONTINUE                                                          -2600
       TL = TLSAVE                                                      -2610
C                                                                       -2620
C     CALCULATE VAPOR PROPERTIES                                        -2630
C                                                                       -2640
      DT = TV-TSAT                                                      -2650
      IF (DT.LE.ZERO) GO TO 250                                         -2660
C                                                                       -2670
C     SUPERHEATED VAPOR                                                 -2680
C                                                                       -2690
C        1. BETA A WORKING PARAMETER                                    -2700
C        2. CAPK A WORKING PARAMETER                                    -2710
C        3. DBETAP  DERIVATIVE OF BETA WRT PRESSURE                     -2720
C        4. DCAPKP  DERIVATIVE OF CAPK WRT PRESSURE                     -2730
C        5. DEVDT                                                       -2740
C        6. DEVDP                                                       -2750
C        7. ROV                                                         -2760
C        8. DRVDE                                                       -2770
C        9. DRVDP                                                       -2780
C                                                                       -2790
      T1 = ONE/(A11*CPS-ONE)                                            -2800
      T1SQ = T1*T1                                                      -2810
      BETA = TSAT*TSAT*(ONE - T1SQ)                                     -2820
      T2 = TSAT*T1                                                      -2830
      DE = A12*(DT+SQRT(TV*TV-BETA)-T2)                                 -2840
      EV = ES + DE                                                      -2850
      CAPK = A13*DE+TSAT+T2                                             -2860
      DBETAP = TWO*(BETA*DTSDP+T2*T2*T2*A11*DPCPS)/TSAT                 -2870
      DCAPKP = -A13*DPES + (ONE + T1)*DTSDP                             -2880
     1  -TSAT*A11*T1SQ*DPCPS                                           -2890
      T3 = ONE-BETA/(CAPK*CAPK)                                         -2900
      DEVDT = ONE/(HALF*T3*A13)                                         -2910
      DEVDP = -HALF*(T3*DCAPKP+DBETAP/CAPK)*DEVDT                       -2920
      T4 = ONE/(GAMSM*ES+CCM*DE)                                        -2930
      ROV = P*T4                                                        -2940
      DRVDE = -ROV*CCM*T4                                               -2950
      DRVDT = DRVDE*DEVDT                                               -2960
      DRVDP = ROV*(PINV-(ES*DPGAMS+(GAMSM-CCM)*DPES)*T4)                -2970
     1   + DRVDE*DEVDP                                                  -2980
      GO TO 300                                                         -2990
  250 CONTINUE                                                          -3000
C                                                                       -3010
C     SUBCOOLED VAPOR                                                   -3020
C                                                                       -3030
      DEVDT = CPS * CCI                                                 -3040
      DE = DT * DEVDT                                                   -3050
      EV = ES + DE                                                      -3060
      T1 = ONE/ CPS                                                     -3070
      DEVDP = -(DTSDP -CC*T1*(DPES +DE*DPCPS*T1) )*DEVDT                -3080
      T1 = ONE/ GAMSM                                                   -3090
      T2 = ONE/ EV                                                      -3100
      ROV = P *T1*T2                                                    -3110
      DRVDE = -ROV *T2                                                  -3120
      DRVDT = DRVDE * DEVDT                                             -3130
      DRVDP = ROV *(PINV - DPGAMS*T1) + DRVDE*DEVDP                     -3140
C                                                                       -3150
  300 CONTINUE                                                          -3160
      RETURN                                                            -3170
      END                                                               -3180
C.....................................................................
C  ***********************************************************************
      FUNCTION RHOF(TBA)
C  ***********************************************************************
      RHOF=-4276.+53.24*TBA-.1953*TBA**2+3.097E-4*TBA**3-1.824E-7*TBA**4
      RETURN
      END
C  ***********************************************************************
      FUNCTION RHOG(TBA,PB)
C  ***********************************************************************
C  UNIT = KG/M**3
      RHOG = .576+PB*1.E6*(2.483E-5-1.41E-12*PB*1.E6)+(PB*1.E6/TBA)*(-2.
     1616E-2+1.016E-9*PB*1.E6+7.589/TBA)
      RETURN
      END
C  ***********************************************************************
      FUNCTION CP(TBA)
C  ***********************************************************************
```

```
C  UNIT = J/KG K
      CP = 4028.+128.8/(1.-TBA/650.)+4.674/((1.-TBA/650.)**2)
      RETURN
      END
C  ***********************************************************************
      FUNCTION TKCOOL(TBA,P)
C  ***********************************************************************
C  UNIT = W/M K
      TKCOOL = .686+7.3E-10*P*1.E6-5.87E-6*(TBA-415.)**2
      RETURN
      END
C  ***********************************************************************
      FUNCTION UF(TBA)
C  ***********************************************************************
C  UNIT = KG/M SEC
      UF = 25.3/(-8.58E4+91.*TBA+TBA**2)
      RETURN
      END
C  ***********************************************************************
      FUNCTION UG(TBA)
C  ***********************************************************************
      UG = 11.4/(1.37E6-844.*TBA-TBA**2)
      RETURN
      END
C  ***********************************************************************
      FUNCTION ENTHAF(PB)
C  ***********************************************************************
C  UNIT = KJ/KG
      PB = PB*1.4507772E2
      IF(PB.LT.400..OR.PB.GT.2500.) GO TO 7997
      ENTHAF = (3.19328213E2+3.04661960E-1*PB-9.85841140E-5*PB**2+1.7101
     11786E-8*PB**3)*2.325837743
      GO TO 7999
 7997 WRITE(6,7998)
 7998 FORMAT(3X,'THE PRESSURE IS OUT OF THE RANGE OF VALIDITY OF THE SAT
     1URATED LIQUID ENTHALPY CORRELATION')
 7999 PB = PB*6.8928571E-3
      RETURN
      END
C  ***********************************************************************
      FUNCTION ENTHAG(PV)
C  ***********************************************************************
      PV = PV*1.4507772E2
      IF(PV.LT.450..OR.PV.GT.2300.) GO TO 8997
      ENTHAG = (1.20742535E3+7.84021105E-3*PV-2.39800695E-5*PV**2+1.0924
     16887E-9*PV**3)*2.32587743
      GO TO 8999
 8997 WRITE(6,8998)
 8998 FORMAT(3X,'THE PRESSURE IS OUT OF THE RANGE OF VALIDITY OF THE SAT
     1URATED VAPOR ENTHALPY CORRELATION')
 8999 PV = PV*6.8928571E-3
      RETURN
      END
```