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COMPUTER PROGRAM OF IODINE REMOVAL
IN THE LWR CONTAINMENT VESSEL
UNDER LOCA CONDITIONS, MIRA-PB

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Gunji NISHIO, Tomohiko TAMURA* and
Mitsugu TANAKA

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Computer Program of Iodine Removal in the LWR Containment Vessel
under LOCA Conditions, MIRA-PB

Gunji NISHIO, Tomohiko TAMURA* and Mitsugu TANAKA

Division of Reactor Safety, Tokai Research Establishment, JAERI

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LWR plants have a containment system for reactor safety consisting of spray and air cleaning filter. R.L.Ritzman of Battelle Columbus Lab. developed computer code MIRAP/MIRAB for predicting iodine removal by containment system for PWR and BWR; which has some problem, however. The computer code MIRA-PB prepared by the authors is a modification of MIRAP/MIRAB.

Keywords: Computer code, Containment vessel, Iodine removal, Spray
LWR, LOCA, Program

* Mitsui Eng. and Ship. Co., LTD

軽水炉格納容器系によるヨウ素除去の計算コード
(MIRA-PB)

日本原子力研究所東海研究所安全工学部
西尾 軍治・田村 友彦*・田中 貢

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軽水型発電炉では、想定事故に対する工学的安全防護施設の一部として、原子炉格納容器系が設置されている。PWRおよびBWRを対象とした格納容器スプレイによるヨウ素除去の計算コードとして、RitzmanはMIRAP/MIRABコードを報告したが、この計算コードは格納容器内の気相および液相の濃度の算出方法、基礎式の取り扱い方などいくつかの問題がある。また、プログラム上の不備も多く、実用には供しにくい。そこで、これらの点を修正し、計算コードMIRAP/MIRABのもつ機能に加えて、新たにPWRのセミダブル型およびダブル型格納容器の計算も実施できる計算コード(MIRA-PB)を作成した。

本報告書は、計算コードMIRA-PBのプログラムリストについてのみ記載した。

* 三井造船株式会社

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Computer Program of Iodine Removal in the LWR Containment Vessel under
LOCA Conditions - MIRA-PB -

1. Introduction

In the safety evaluation of the LWR, it is postulated that an instantaneous break occurs in the primary coolant-system piping. The containment spray system is designed to protect the release of radioactive materials from the reactor containment vessel to the environment by washing out fission products, especially radioiodine and the suppression of pressure in the containment vessel in the event of LOCA.

The computer code of MIRAP/MIRAB was developed in the Battelle Columbus Laboratories for predicting the iodine removal in the containment vessel¹⁾. The code consists of two programs for the PWR and BWR, considering the iodine removal effects of natural deposition, the spray washout, filtration, leakage to atmosphere, and scrubbing in the wetwell pool of BWR. The MIRAP/MIRAB considers simultaneous phenomena about iodine removal, but some errors are found in the calculated results, such as iodine concentration in the containment vessel, iodine removal rate by spray and iodine partition coefficients. Due to the errors, the iodine partition coefficient becomes 2-times compared with those of Parsly's theory. Consequentially, the MIRAP/MIRAB code will give non-conservative for the calculated results. Therefore, the new computer code named MIRA-PB²⁾ has been programmed in JAERI, by modifying the program of MIRAP/MIRAB.

2. Contents of the new code MIRA-PB

MIRA-PB

This is the main program, controlling the subroutines for iterative calculation of iodine removal with the lapse of time in the event of the LOCA conditions.

Computer Program of Iodine Removal in the LWR Containment Vessel under
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1. Introduction

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The computer code of MIRAP/MIRAB was developed in the Battelle Columbus Laboratories for predicting the iodine removal in the containment vessel¹⁾. The code consists of two programs for the PWR and BWR, considering the iodine removal effects of natural deposition, the spray washout, filtration, leakage to atmosphere, and scrubbing in the wetwell pool of BWR. The MIRAP/MIRAB considers simultaneous phenomena about iodine removal, but some errors are found in the calculated results, such as iodine concentration in the containment vessel, iodine removal rate by spray and iodine partition coefficients. Due to the errors, the iodine partition coefficient becomes 2-times compared with those of Parsly's theory. Consequentially, the MIRAP/MIRAB code will give non-conservative for the calculated results. Therefore, the new computer code named MIRA-PB²⁾ has been programmed in JAERI, by modifying the program of MIRAP/MIRAB.

2. Contents of the new code MIRA-PB

MIRA-PB

This is the main program, controlling the subroutines for iterative calculation of iodine removal with the lapse of time in the event of the LOCA conditions.

The main program calls Subroutine INPUT for the input data, Subroutine DATAT for the determination of iodine absorption to spray droplets and the size distribution of spray droplets, and Subroutine INPT1 for the time-dependent input data. The iodine release into the containment vessel, the variation of sump water volume, and the spray flow rate are also considered. The time step of iteration and the interval of output in the Runge-Kutta-Gill calculation are set. Subroutines for the iodine removal, PROP, SPRAY, PACO, RATES, and the Subroutines of integration IRKG and RKG are called. Finally, the Subroutine OUTPT is called to output the calculated results.

INPUT

This subroutine reads the input data on 15 input cards, and converts MKS units into cgs units.

INPT1

This subroutine reads the time-dependent input data, TB1, TSL, TIM1, TSPIN, TL2, SNS1, SIM1, Q12, ARAS, ARAI, AW1, and AD1, respectively. Values of TB1, TS1, TIM1, TSPIN, TL2, SNS1, SIM1, and Q12 are calculated by the linear approximation method over the time on the logarithmic scale.

DATAT

DATAT provides the size distribution of spray droplets expressed by weight fraction. The subroutine gives the necessary values for the calculation of iodine absorption such as SN, DMLS, and TABLE.

PROP

The subroutine provides the physical properties of the systems and the iodine forms which are used in other subroutines.

SPRAY

The subroutine provides the parameters about the spray-droplet motion by calling Subroutine STEP. The coalescence of spray droplets and the capture efficiency of aerosol particles are also calculated.

STEP

The subroutine calculates the trajectory of spray droplets and average gas phase mass-transfer coefficient of iodine to spray droplets.

PACO

The subroutine calculates the partition coefficient of iodine taking into consideration the equilibrium hydrolysis constants for each iodine species, depending on liquid pH and temperature in the containment vessel. Partition coefficient of methyl iodide for both drywell and wetwell is also calculated. The scrubbing efficiency by air-steam flow from drywell to wetwell for iodine removal is obtained also.

RATES

The subroutine gives the rates of iodine deposition on the drywell and wetwell walls, the film sublayer mass-transfer coefficients due to steam condensation and the mass transfer coefficients due to absorption to the liquid film. The subroutine also calculates the settling velocity of aerosol.

IRKG

IRKG gives the initial data needed in RKG. And the subroutine calculates the vector YP at the initial value X0, by calling the Subroutine DIR.

RKG

The subroutine calculates the simultaneous ordinary differential equations by the fourth order Runge-Kutta-Gill method.

DIR

The subroutine computes the differential coefficient YP of variable Y, and calls Subroutine COEFF.

COEFF

This subroutine calculates the removal-rate constants and other parameters depending on concentration and temperature. In the calculation of spray removal coefficient, Subroutine BILIN1 is called for the computation of the liquid-phase mass transfer resistance of iodine. And the subroutine calculates the coefficients of the differential equations needed to calculate the differential coefficient YP in Subroutine DIR. Its coefficients are represented by RL1 - RL22.

BILIN1

This subroutine calculates the value of Z at arbitrary values of X and Y by liner approximation from the Table of Z as variable X and Y. Z corresponds to the variable TABLE, X to the SN and Y to the DMLS. The effect of spray efficiency (1 - E) is given as a function of Sherwood number and non-dimensional time. Spray efficiency (1 - E) is obtained for 11 - spray-droplet groups and Subroutine BILIN1 is called in the Subroutine COEFF.

OUTPT

The subroutine calculates the gas-water concentration ratio of inorganic iodine, and also the cumulative weight of iodine in each part. During the time, the concentrations of inorganic iodine, organic iodide, and iodic aerosol in gaseous and liquid phases are output. Similarly, the cumulative weights, the partition coefficients, the efficiency of spray droplets are also obtained.

```

ISN  ST-NO          SOURCE PROGRAM
C      MIRA-PB      *****
C
C
C
C
1      DIMENSION Y(18),YP(18),ABC(18),WT(11)
2      DIMENSION DTT(12),ND(12),NPT(12)
3      COMMON
*      V1 ,AL1 ,VL1 ,VW1 ,AW1 ,AD1 ,QF1 ,EC1 ,EM1 ,EP1 ,V2 ,VL2 ,
*      V3 ,QE1 ,QE2 ,QE3 ,EMIX,QE1D,EPSC,EPSP,HT ,SNS1,Q12 ,
*      BC1 ,BM1 ,BP1 ,Q12,QSP ,EFF ,DL12,DLCH31 ,RHOLI0 ,
*      PHT ,PHFT,PHST,PHLT,AK1 ,AK2 ,AK3 ,AK4 ,AK1S,AK2S,AK3S,AK4S.
*      AKC1,AKM1,AKS1,AKL1,AKW1,AKA1,PTERV ,QW1 ,QW2 ,QA ,
*      CG ,CL ,CW ,HC1 ,HC2 ,HX ,H ,HM1 ,HM2 ,E1 ,E2 ,CLO ,
*      RL1 ,RL2 ,RL3 ,RL4 ,RL5 ,RL6 ,RL7 ,RL8 ,RL9 ,RL10,RL11,RL12,
*      RL13,RL14,RL15,RL16,RL17,RL18,RL19,RL20,RL21,RL22,
*      TI(11) ,D(11) ,QL(11) ,EFPS(11) ,VGAV(11) ,VGAVM(11),
*      SN(17) ,DMLS(30) ,TABLE(17,30)
4      10 Q12 = 0,
5      TB1 = 0,
6      CALL INPUT (V1,VL1X,VL1F,PHF,PHS,AL1,AW1,AD1, V2,VL2 ,PHL,V3,
*              QE1,QE2,QE3,EMIX,EPSC,EPSP,HT,RETZ,RETL,
*              ALP,BET,GAM,QS,QW,TSP,HTSU,RAD,HT,PARAD,ICOAT,
*              DMEAN,SIGMAG,ANGLE,DORIF,ITYPE,NONQZ,DTT,ND,NPT,
*              QF1,EC1,EM1,EP1,CLO,
*              DXFILM,QE1D,VSP,PH,QCORE,690)
7      CALL DATAT (WT,SN,DMLS,TABLE,17,30)
C      READ 10, (WT(I), I=1,11)
C      10 FORMAT (6F11,5/5F11,5)
C      READ 12, (SN(L), L=1,17)
C      READ 12, (DMLS(M), M=1,30)
C      12 FORMAT (8F10,4)
C      READ 13, ((TABLE(L,M),L=1,17),M=1,30)
C      13 FORMAT((2(10X,6F10,8/10X,5F10,8))
C      PRINT 99, ((SN(I),I=1,17),(DMLS(I),I=1,30),
C      * ((TABLE(L,M),L=1,17),M=1,30) )
C      99 FORMAT((('0',10(1PE12,3)'/ ' ,7(1PE12,3)))
8      SUMT = 0.0
9      H = 0,
10     HX = 0,
11     HC1 = 0,
12     HC2 = 0,
13     E1 = 0,
14     E2 = 0,
15     TOTJ = 0,
16     TOLD = 25,
17     TMJA = B1*(RETL-RETZ)
18     VL1 = VL1X
19     QA = QS-QW
20     DO 20 I=1,18
21     20 Y(I) = 0,
22     IF( V2 ,NE, 0. ) GO TO 24
23     IF( V3 ,NE, 0. ) GO TO 22
24     N = 11
25     GO TO 26
26     22 N = 14

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ISN  ST-NO          SOURCE PROGRAM      ( FTMAIN )
27                                     GO TO 26
28      24 N      = 18
29      26 CONTINUE
30      XO = 0.
31      SNAP=0.
32      CALL OUTPT (SNAP,SUMT,V1,V2,V3,VW1,VL1,VL2,AD1,AW1,Y,
*          H,HX,HC1,HC2,E1,E2,TB1)
33      DO 80 J=1,12
34      NDT = ND(J)
35      IF( NDT .EQ. 0 )          GO TO 90
36      NP  = NPT(J)
37      DT  = DTT(J)
38      DO 80 NS=1,NDT
39      30 SUMT = SUMT + DT
C
40      CALL INPT1 (SUMT,TB1,TS1,TIM1,TL2,TSPIN,SNS1,Q12,AD1,AW1,
*          VW1,DXFILM,TRISE,V2,J,NS, &10 )
C
41      IF( SUMT .LE. RETZ )      GO TO 42
42      IF( SUMT .GT. RETL )      GO TO 42
43      BC1 = ALP*B1
44      BM1 = BET*B1
45      BP1 = GAM*B1
46                                     GO TO 44
47      42 BC1 = 0.
48      BM1 = 0.
49      BP1 = 0.
50      44 TNEW = TB1
51      IF( SUMT .GT. TSP )      GO TO 52
52      QSP = 0.
53      QL12 = 0.
54      QW1 = 0.
55      QW2 = 0.
56                                     GO TO 56
57      52 IF( VL1 .GE. VL1F )      GO TO 54
58      VL10 = VL1
59      VL1 = VL1X+QS*(SUMT-TSP)+QCORE*SUMT
60      IF( VL1 .GE. VL1F ) VL1 = VL1F
61      Y(6) = Y(6)*VL10/VL1
62      Y(7) = Y(7)*VL10/VL1
63      53 CONTINUE
64      SS = VSP-QCORE*SUMT-QS*(SUMT-TSP)
65      IF( SS .LT. 0. )          GO TO 54
66      QSP = QS
67      QL12 = 0.
68      QW1 = QW
69      QW2 = 0.
70                                     GO TO 56
71      54 QSP = 0.
72      QL12 = QS
73      QW1 = 0.
74      QW2 = QW
75      QCORE = 0.
76      56 CONTINUE
77      DTEMP = ABS(TOLD-TNEW)
78      IF( NS,EQ.1 ,AND. J,EQ.1 ) GO TO 60

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ISN   ST-NO          SOURCE PROGRAM      ( FTMAIN )
 79           IF( DTEMP ,LT. 5. )          GO TO 70
 80   60 CALL PROP      (TB1,RHOLI0,RHOAIR,RHOSTM,RHOATM,P,PAIR,PTOTAL,
      1ETA,ETAIR,ETAMIX,DAIR,DIWTR,DIMIX,SMITNO,FRAIR,DMAIR,DMWTR,
      2DMMIX,SNOMI,ETASOL,DLI2,DLCH3I)
 81           CALL SPRAY (VGAV(1),VGAVM(1),          TI(1),QA ,TB1,DMEAN,
      1ANGLE,SIGMAG,ITYPE,DORIF,NONOZ,RAD,WT(1),HT,D(1),QL(1),PARAD,
      2ETAMIX,FRAIR,TRISE,RHOATM,EFPS(1),SMITNO,DIMIX,SNOMI,DMMIX,
      3RHOLI0)
 82           CALL PACO (TB1,TL2,PHF,PHS,PHFT,PHST,AK1,AK2,AK3,AK4,AK1S,
      1AK2S,AK3S,AK4S,HM1,HM2,P,PAIR,PHL,PHLT,EFF,PH,PHT,V2)
 83           CALL RATES (TB1,TS1,          HTSU,PARAD,ICOAT,ETAMIX,RHOATM,P,
      1DIMIX,SMITNO,DMMIX,SNOMI,RHOLI0,ETASOL,SNS1,
      2 AKC1,AKM1,AKA1,AKS1,AKL1,AKW1,PTERV,DLI2,TIM1)
 84           TOLD = TB1
 85   70 CONTINUE
 86           IF( NS ,NE. 1 )                GO TO 71
 87           IF( SUMT ,LE. 1,E4 )          GO TO 74
 88                                           GO TO 76
 89   71 CONTINUE
 90           IF( SUMT ,LE. RETZ )           GO TO 76
 91           IF( SUMT ,GT. RETL )           GO TO 72
 92           IF( SUMT ,GT. RETZ+DT )        GO TO 76
 93                                           GO TO 74
 94   72 IF( SUMT ,GT. RETL+DT )             GO TO 76
 95   74 XO = SUMT-DT
 96           CALL IRKG (N,Y,YP,ABC,X0, &10 )
 97   76 DELX = DT
 98           CALL RKG (N,DELX,Y,YP,ABC, &10 )
 99           IF( MOD(NS,NP) ,NE. 0 )        GO TO 80
100           CALL OUTPT (SNAP,SUMT,V1,V2,V3,VW1,VL1,VL2,AD1,AW1,Y,
      * H,HX,HC1,HC2,E1,E2,TB1)
101   80 CONTINUE
102                                           GO TO 10
103   88 PRINT 89
104   90 STOP
      C
      C
105   89 FORMAT (20X,'ABNORMAL EXIT DUE TO TIME MISMATCH')
106           END

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ISN   ST-NO           SOURCE PROGRAM
1     C               FUNCTION BILINI(X,Y,Z,NX,NY,NDX,NDY,ARGX,ARGY,IEX)
      C               BIVARIATE LINEAR INTERPOLATION FUNCTION SUBPROGRAM
      C               CALLING SEQUENCE ...
      C               BILINI(X,Y,Z,NX,NY,NDX,NDY,ARGX,ARGY,IEX)
      C               WHERE X IS A LINEAR ARRAY OF THE FIRST INDEPENDENT VARIABLE
      C                   THE VALUES OF X ARE LISTED IN INCREASING SEQUENCE
      C                   Y IS A LINEAR ARRAY OF THE SECOND INDEPENDENT VARIABLE
      C                   THE VALUES OF Y ARE LISTED IN INCREASING SEQUENCE
      C                   Z IS A TWO DIMENSIONAL ARRAY OF THE DEPENDENT VARIABLE
      C                   ITS DIMENSIONS ARE DETERMINED BY NDX AND NDY
      C                   NX IS THE NUMBER OF X VALUES
      C                   NY IS THE NUMBER OF Y VALUES
      C                   NDX IS THE DIMENSION OF THE X-COORDINATE OF THE Z ARRAY
      C                   NDY IS THE DIMENSION OF THE Y-COORDINATE OF THE Z ARRAY
      C                   NOTE = NX*NDX AND NY*NDY
      C                   ARGX IS THE X FUNCTION ARGUMENT
      C                   ARGY IS THE Y FUNCTION ARGUMENT
      C                   IF X OR Y ARE NOT WITHIN THE RANGE OF THE TABLE, LINEAR
      C                   EXTRAPOLATION WILL BE PERFORMED
      C                   IEX INDICATES WHETHER LINEAR EXTRAPOLATION HAS BEEN
      C                   PERFORMED
      C                   IEX =1, INDICATES IT HAS BEEN PERFORMED
      C                   IEX =0, INDICATES IT HAS NOT BEEN PERFORMED
2     C               DIMENSION X(1), Y(1), Z(NDX,NDY)
3     C               IEX=0
4     C               I = 2
5     C               IF(ARGX - X(1) ) 75, 80, 10
6     C               10 I = NX
7     C               IF(X(I) - ARGX ) 75, 80, 20
8     C               20 IL = 1
9     C               IU = NX
10    C               30 IF(IU - IL - 1 ) 70, 10, 40
11    C               40 I = (IL + IU)/2
12    C               IF( ARGX - X(I) ) 50, 80, 60
13    C               50 IU = I
14    C               GO TO 30
15    C               60 IL = I
16    C               GO TO 30
17    C               70 I = IU
18    C               GO TO 80
19    C               75 IEX=1
20    C               80 J = 2
21    C               IF(ARGY - Y(1)) 180, 160, 90
22    C               90 J = NY
23    C               IF(Y(J) - ARGY) 180, 160, 100
24    C               100 JL = 1
25    C               JU = NY
26    C               110 IF(JU - JL - 1) 150, 150, 120
27    C               120 J = (JL + JU)/2
28    C               IF(ARGY - Y(J)) 130, 160, 140
29    C               130 JU = J
30    C               GO TO 110
31    C               140 JL = J
32    C               GO TO 110
33    C               150 J = JU
34    C               160 YDEN = Y(J)-Y(J-1)
35    C               TEMP = ((Z(I,J)-Z(I,J-1))*ARGY+Z(I,J-1)*Y(J)-Z(I,J)*Y(J-1))/YDEN

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ISN	ST-NO	SOURCE PROGRAM	(BILIN1)
36		TEMP1= ((Z(I-1,J)-Z(I-1,J-1))*ARGY+Z(I-1,J-1)*Y(J)-Z(I-1,J)*Y(J-1)	
		1)/YDEN	
37		BILIN1= ((TEMP-TEMP1)*ARGX+TEMP1*X(I)-TEMP*X(I-1))/(X(I)-X(I-1))	
38		RETURN	
39	180	IEX=1	
40		GO TO 160	
41		END	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN   ST-NO           SOURCE PROGRAM
1     SUBROUTINE COEFF (*)
2     DIMENSION E(11),SH(11),THETA(11),AM(11),AP(11)
3     COMMON
*     V1 ,AL1 ,VL1 ,VW1 ,AW1 ,AD1 ,QF1 ,EC1 ,EM1 ,EP1 ,V2 ,VL2 ,
*     V3 ,QE1 ,QE2 ,QE3 ,EMIX,QE1D,EPSC,EPSM,EPSP,HT ,SNS1,Q12 ,
*     BC1 ,BM1 ,BP1 ,Q12,QSP ,EFF ,DLI2,DLCH3I ,RHOLI0 ,
*     PHT ,PHFT,PHST,PHLT,AK1 ,AK2 ,AK3 ,AK4 ,AK1S,AK2S,AK3S,AK4S,
*     AKC1,AKM1,AKS1,AKL1,AKW1,AKA1,PTERV ,QW1 ,QW2 ,QA ,
*     CG ,CL ,CW ,HC1 ,HC2 ,HX ,H ,HM1 ,HM2 ,E1 ,E2 ,CLO ,
*     RL1 ,RL2 ,RL3 ,RL4 ,RL5 ,RL6 ,RL7 ,RL8 ,RL9 ,RL10,RL11,RL12,
*     RL13,RL14,RL15,RL16,RL17,RL18,RL19,RL20,RL21,RL22,
*     TI(11) ,D(11) ,QL(11) ,EFPS(11) ,VGAV(11) ,VGAVM(11),
*     SN(17) ,DMLS(30) ,TABLE(17,30)
C     CALCULATION OF 12 PARTITION COEFFICIENTS
4     IF( CG ,EQ, 0, ) GO TO 12
5     C12A0 = CG*AK1
6     HIONC = EXP(-2,303*PHFT)
7     YX = ((AK3*C12A0)/HIONC + AK4*C12A0)/(1, + AK2*C12A0)
8     IF( YX ,LT, 0, ) GO TO 92
9     CIMIN = SQRT(YX)
10    C13 = AK2*C12A0*CIMIN
11    CH10 = (AK3*C12A0)/(HIONC*CIMIN)
12    CH20I = AK4*C12A0/CIMIN
13    TOTC12 = C12A0 + 0,5*(CH10 + CH20I + CIMIN + 3,*C13)
14    HC1 = TOTC12/CG
15                                     GO TO 14
16    12 HC1 = 1,
C     ABOVE VALUE FOR HC1 USED ONLY WHEN CG = 0
17    14 CONTINUE
18    XX = AKC1+AKA1
19    IF( XX ,EQ, 0, ) GO TO 16
20    RL1 = AD1*AKC1*AKA1/XX + AW1*(AKC1+AKS1)+Q12+QE1
21                                     GO TO 18
22    16 RL1 = AW1*(AKC1+AKS1)+Q12+QE1
23    18 CONTINUE
C
24    IF( QSP ,EQ, 0, ) GO TO 30
C     CALCULATE FRESH SPRAY GUEFFICIENT FOR 12
25    IF( CG ,EQ, 0, ) GO TO 22
26    C12A0 = CG*AK1
27    HIONC = EXP(-2,303*PHT)
28    YX = ((AK3*C12A0)/HIONC + AK4*C12A0)/(1, + AK2*C12A0)
29    IF( YX ,LT, 0, ) GO TO 92
30    CIMIN = SQRT(YX)
31    C13 = AK2*C12A0*CIMIN
32    CH10 = (AK3*C12A0)/(HIONC*CIMIN)
33    CH20I = AK4*C12A0/CIMIN
34    TOTC12 = C12A0 + 0,5*(CH10 + CH20I + CIMIN + 3,*C13)
35    H = TOTC12/CG
36                                     GO TO 24
37    22 H = 1,
38    24 CONTINUE
39    SAM = 0,
40    DO 26 I=1,11
41    THETA(I) = (DLI2*TI(I)*4,)/(D(I)*D(I))
42    26 E(I) = 0,
43    DO 28 I=1,11

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ISN  ST-NO          SOURCE PROGRAM      ( COEFF )
44      SH(I) = VGAV(I)*D(I)/(2,*H*DLI2)
45      IF(SH(I),GT,1000,) SH(I) = 1000,
46      SUM1 = BILINI(SN,DMLS,TABLE,17,30,17,30,SH(I),THETA(I),IEX)
47      IF(SUM1 .GE, 0.99 )          GO TO 27
48      IF(SUM1 .LT. 0. ) SUM1 = 0,
49      E(I) = 1.-SUM1
50      AM(I) = QL(I)*E(I)*H
51                                          GO TO 28
52      27 AM(I) = QL(I)*VGAV(I)*TI(I)*6./D(I)
53      28 SAM = SAM + AM(I)
54      E1 = SAM/(QA*H)
55      RL1 = RL1+SAM
56      RL3 = 0,
57      RL10 = SAM
58      RL13 = SAM/H
59      RL15 = QA-SAM/H
60      30 IF( QL12 .EQ. 0. )          GO TO 40
C  CALCULATE RECYCLE SPRAY COEFFICIENT FOR I2
61      HIONC = EXP(-2.303*PHST)
62      IF( CL .EQ. 0. )          GO TO 31
63      HX = AK1*AK3/(HIONC*CL)
64                                          GO TO 32
65      31 HX = 1.E6
66      32 CONTINUE
67      IF( CG .EQ. 0. )          GO TO 33
68      C12A0 = CG*AK1
69      YX = ((AK3*C12A0)/HIONC + AK4*C12A0)/(1. + AK2*C12A0)
70      IF ( YX .LT. 0. )          GO TO 92
71      CIMIN = SQRT(YX)
72      C13 = AK2*C12A0*CIMIN
73      CH10 = (AK3*C12A0)/(HIONC*CIMIN)
74      CH201 = AK4*C12A0/CIMIN
75      TOTC12 = C12A0 + 0.5*(CH10 + CH201 + CIMIN + 3.*C13)
76      H = TOTC12/CG
77                                          GO TO 34
78      33 H = 1.
79      34 CONTINUE
80      IF(H.LT,HX) HX = H
81      SAM = 0.
82      DO 36 I=1,11
83      THETA(I) = (DLI2*TI(I)*4.)/(D(I)*D(I))
84      36 E(I) = 0,
85      DO 38 I=1,11
86      SH(I) = VGAV(I)*D(I)/(2,*HX*DLI2)
87      IF(SH(I),GT,1000,) SH(I) = 1000,
88      SUM1 = BILINI(SN,DMLS,TABLE,17,30,17,30,SH(I),THETA(I),IEX)
89      IF (SUM1,GT,0.99) GO TO 37
90      IF(SUM1 .LT. 0. ) SUM1 = 0,
91      E(I) = 1.-SUM1
92      AM(I) = QL(I)*E(I)*HX
93                                          GO TO 38
94      37 AM(I) = QL(I)*VGAV(I)*TI(I)*6./D(I)
95      38 SAM = SAM+AM(I)
96      E2 = SAM/(QA*HX)
97      RL1 = RL1+SAM
98      RL3 = SAM/HX
99      RL10 = SAM

```

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN   ST-NO          SOURCE PROGRAM      ( COEFF )
100      RL13 = 0.
101      RL15 = 0.
      C      PRINT 99, HX, (AM(I), WL(I), E(I), VGAV(I), TI(I), D(I), THETA(I),
      C      *      SH(I), I=1,11)
      C 99 FORMAT('0', F10,2 /(' ', 8(1PE10,2)) )
102      40 CONTINUE
      C CALCULATION OF RL2 , RL3 , AND RL4
103      RL2 = AW1*AKC1/HC1
104      RL4 = Q12+QE1
105      IF( QSP.EQ.0. ,AND, WL12.EQ.0. ) GO TO 48
      C CALCULATION OF CH3I SPRAY REMOVAL CONSTANT
106      SAM = 0.
107      DO 42 I=1,11
108      THETA(I) = (DLCH3I*TI(I)*4.)/(D(I)*D(I))
109      42 E(I) = 0.
110      DO 44 I=1,11
111      SH(I) = VGAVM(I)*D(I)/(2.*HM1*DLCH3I)
112      IF(SH(I).GT.1000,) SH(I) = 1000.
113      SUM1 = BILIN1(SN,DMLS, TABLE, 17,30,17,30, SH(I), THETA(I), IEX)
114      IF(SUM1.GE.0.99) GO TO 45
115      IF( SUM1 .LT. 0. ) SUM1 = 0.
116      E(I) = 1.-SUM1
117      AM(I) = WL(I)*E(I)*HM1
118                                     GO TO 44
119      45 AM(I) = WL(I)*VGAVM(I)*TI(I)*6./D(I)
120      44 SAM = SAM + AM(I)
121      RL4 = RL4+SAM
122      RL5 = SAM/HM1
123      RL14 = SAM
124      SAP = 0.
125      DO 46 I=1,11
126      AP(I) = 3.*HT*EFPS(I)*WL(I)/(2.*D(I))
127      46 SAP = SAP + AP(I)
128      RL6S = SAP
      C      PRINT 98, HM1, (AM(I), WL(I), E(I), VGAVM(I), THETA(I), SH(I), I=1,11)
      C 98 FORMAT('0', F10,2 /(' ', 6(1PE10,2)) )
129                                     GO TO 50
130      48 RL3 = 0.
131      RL5 = 0.
132      RL6S = 0.
133      RL10 = 0.
134      RL13 = 0.
135      RL14 = 0.
136      RL15 = 0.
137      50 CONTINUE
      C CALCULATE OTHER RATE COEFFICIENTS
138      RL6 = Q12+AW1*AKS1+AL1*PTERV+QE1+RL6S
139      RL7 = AW1*(AKC1+AKS1)
140      RL8 = AW1*AKS1
141      XX = AKL1+AKW1
142      IF( XX .EQ. 0. ) GO TO 51
143      RL9 = AW1*(AKC1/HC1+SNS1/RHOLI@+AKL1*AKW1/XX) +QW1+QW2
144                                     GO TO 52
145      51 RL9 = AW1*(AKC1/HC1+SNS1/RHOLI@) +QW1+QW2
146      52 RL12 = AW1*SNS1/RHOLI@ +QW1+QW2
147      RL11 = AL1*PTERV+RL6S
148      XX = AKC1+AKA1

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM          ( COEFF )
149          IF( XX ,EQ, 0. )          GO TO 53
150          RL16 = AD1/(AD1+Aw1)*AKC1*AKA1/XX
151          GO TO 54
152          53 RL16 = 0.
153          54 XX = AKL1+AKW1
154          IF( XX ,EQ, 0. )          GO TO 55
155          RL17 = Aw1/(AD1+Aw1)*AKL1*AKW1/XX
156          GO TO 56
157          55 RL17 = 0.
158          56 CONTINUE

C
159          IF( V2 ,EQ, 0. )          GO TO 90
C
C
C
160          HIONC = EXP(-2,303*PHLT)
161          IF( CL ,EQ, 0. )          GO TO 62
162          HY = AK1S*AK3S/(HIONC*CL)
163          62 CI2A0 = CG*AK1S
164          IF( CI2A0 ,EQ, 0. )          GO TO 64
165          YX = ((AK3S*CI2A0)/HIONC+AK4S*CI2A0)/(1.+AK2S*CI2A0)
166          IF( YX ,LT, 0. )          GO TO 92
167          CIMIN = SQRT(YX)
168          CI3 = AK2S*CI2A0*CIMIN
169          CH10 = (AK3S*CI2A0)/(HIONC*CIMIN)
170          CH201 = AK4S*CI2A0/CIMIN
171          TOTCI2 = CI2A0 + 0.5*(CH10 + CH201 + CIMIN + 3.*CI3)
172          HC2 = TOTCI2/CG
173          IF (CL,EQ,0.) HY=HC2
174          IF (HY,LT,HC2) HC2=HY
175          GO TO 66
176          64 HC2 = 0.
177          66 CONTINUE
178          RL18 = @12*V2/(V2+EFF*HC2*VL2)
179          RL19 = @12*V2/(V2+EFF*HM2*VL2)
180          RL20 = @12*(1.-EFF)
181          RL21 = @12*EFF*HC2*VL2/(V2+EFF*HC2*VL2)
182          RL22 = @12*EFF*HM2*VL2/(V2+EFF*HM2*VL2)
C
C
C
183          90 RETURN
184          92 PRINT 1, YX
185          * 1 FORMAT('0','***** MIKA CODE ERROR MESSAGE *****'
* /' ','(SUB, COEFF) SORT  NEGATIVE ARG (YX) =',1PE12,4 )
186          RETURN 1
187          END

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM
1      SUBROUTINE DATAT(WT,SN,DMLS,TABLE,L,M)
2      DIMENSION WT(1),SN(1),DMLS(1),TABLE(L,M),A1(11),A2(17),A3(30),
      *          T1(17,30)
3      DATA
      * A1,A2,A3
      * / ,01222 , ,02774 , ,06554 , ,12100 , ,17470 , ,19740 ,
      *   ,17470 , ,12100 , ,06554 , ,027740 , ,01222 ,
      *   ,01, ,02, ,05, ,10, ,20, ,50, 1.0, 2.0, 4.0, 8.0, 10., 12.,
      *   15., 20., 25., 30., 1000. ,
      *   ,0010 , ,0015 , ,002, ,004, ,007, ,01 , ,015, ,02, ,04, ,07, ,1 ,
      *   ,15, ,20, ,30, ,40, ,50, ,60, ,70, ,80, ,90, 1.0, 1.2, 1.5,
      *   1.8, 2.0, 3.0, 4.0, 6.0, 8.0, 10. /
4      DATA
      * ((T1(I,J),I=1,17),J=1,5)
      * /0.99996739,,99993926,,99985006,,99970028,,99940247,,99851767,
      *   0.99767135,,99427955,,98907370,,97997501,,97598594,,97231676,
      *   0.96734022,,96022450,,95429095,,94928448,,89595254,
      *   0.99995239,,99990931,,99977522,,99955090,,99910492,,99778284,
      *   0.99563110,,99151121,,98394630,,97109297,,96560611,,96063921,
      *   0.95402494,,94481174,,93734770,,93120290,,87339417,
      *   0.99993740,,99987934,,99970040,,99940163,,99880784,,99705087,
      *   0.99420184,,98878402,,97886321,,96266131,,95585200,,94976619,
      *   0.94177809,,93087396,,92223077,,91524315,,85461204,
      *   0.99987744,,99975950,,99940137,,99880549,,99762320,,99414543,
      *   0.98857092,,97819119,,96010163,,93208088,,92109369,,91161952,
      *   0.89966552,,88419779,,87260184,,86363424,,79790509,
      *   0.99978752,,99957982,,99895338,,99791347,,99585489,,98983950,
      *   0.98332170,,96300692,,93408649,,89238486,,87703669,,86424407,
      *   0.84867367,,82944080,,81566933,,80538031,,73777907/
5      DATA
      * ((T1(I,J),I=1,17),J=6,10)
      * /0.99969762,,99940023,,99850591,,99702356,,99409489,,98558317,
      *   0.97225676,,94846123,,91002115,,85751373,,83906462,,82404704,
      *   0.80620619,,76482052,,76993695,,75984161,,69148624,
      *   0.99954783,,99910106,,99776112,,99554427,,99117689,,97857993,
      *   0.95314593,,92532686,,87310506,,80662126,,78458647,,76715139,
      *   0.74781247,,72366880,,70791286,,69662057,,63040701,
      *   0.99939809,,99880207,,99701740,,99406924,,98827549,,97167374,
      *   0.94638308,,90332164,,83926766,,76216429,,73773228,,71879692,
      *   0.69735625,,67306828,,65700438,,64564670,,58126926,
      *   0.99879946,,99760755,,99405145,,98820430,,97680665,,94483228,
      *   0.89885407,,82365575,,72474269,,62381142,,59438574,,57329244,
      *   0.55048938,,52594315,,51039508,,49970410,,44297249,
      *   0.99790243,,99581939,,98962490,,97949458,,95994051,,90644625,
      *   0.83179575,,72186103,,59217410,,47762317,,44861058,,42807015,
      *   0.40662185,,38435685,,37066323,,36141874,,31437676/
6      DATA
      * ((T1(I,J),I=1,17),J=11,15)
      * /0.99780635,,99403501,,98522163,,97087561,,94341902,,86991132,
      *   0.77136493,,63516074,,48889585,,37327010,,34601182,,32719311,
      *   0.30795398,,28840929,,27659490,,26870393,,22952125,
      *   0.99551482,,99106875,,97793000,,95669302,,91656610,,81254417,
      *   ,68110260,,51526216,,35882713,,25178936,,22870721,,21323932,
      *   0.19781244,,18253077,,17347895,,16750921,,13873364,
      *   0.99402560,,98811165,,97069425,,94272500,,89050511,,75910096,
      *   0.60181008,,41889986,,26471357,,17118986,,15243891,,14016886,
      *   0.12817131,,11652619,,10974218,,10531483,,08450443

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(DATA)
		* 0,99105390,,98222416,,95638458,,91540401,,84060763,,66263623,	
		* 0,47012409,,27738799,,14466033,,07957318,,06810172,,06090090,	
		* 0,05410071,,04773406,,04413395,,04182860,,03147546,	
		* 0,98809111,,97637182,,94228632,,88887653,,79351223,,57845760,	
		* 0,36731805,,18378130,,07914036,,03783370,,03046053,,02649023,	
		* 0,02285963,,01957241,,01776456,,01662722,,01173076/	
7		DATA	
		* ((T1(I,J),I=1,17),J=16,20)	
		* /0,98513718,,97055437,,92839595,,86311802,,74905616,,50497600,	
		* 0,28700052,,12177184,,04330148,,01723764,,01362576,,01152357,	
		* 0,00965982,,00802580,,00715091,,00660981,,00437214,	
		* 0,98219208,,96477158,,91471035,,83810599,,70709082,,44082918,	
		* 0,22424593,,08068503,,02369268,,00882348,,00609520,,00501292,	
		* 0,00408199,,00329105,,00287852,,00262760,,00162953,	
		* 0,97925579,,95902324,,90122648,,81381878,,66747656,,38483094,	
		* 0,17521314,,05346225,,01296362,,00373464,,00272656,,00218070,	
		* 0,00172494,,00134952,,00115872,,00184455,,00060733,	
		* 0,47632827,,95330915,,88794139,,79023538,,63008167,,33594612,	
		* 0,13690169,,03542401,,00709314,,00173834,,00121967,,00094864,	
		* 0,00072892,,00055338,,00046643,,00041524,,00022636,	
		* 0,97340950,,94762911,,87485213,,76733540,,59478181,,29327112,	
		* 0,10686727,,02347190,,00388107,,00080913,,00054559,,00041267,	
		* 0,00030802,,00022692,,00018776,,00016507,,00008436/	
8		DATA	
		* ((T1(I,J),I=1,17),J=21,25)	
		* /0,97049946,,94198292,,86195583,,74509903,,56145959,,25601709,	
		* 0,08357821,,01555245,,00212355,,00037662,,00024406,,00017952,	
		* 0,00013016,,00009305,,00007558,,00006562,,00003144,	
		* 0,96470546,,93079124,,83673073,,70254075,,50031112,,19510494,	
		* 0,05102433,,00682810,,00063575,,00008160,,00004884,,00003397,	
		* 0,00002324,,00001565,,00001225,,00001037,,00000436,	
		* 0,95607924,,91425256,,80027045,,64321743,,42084545,,12979777,	
		* 0,02433906,,00198633,,00010414,,00000823,,00000437,,00000280,	
		* 0,00000175,,00000108,,00000080,,00000065,,00000022,	
		* 0,94753016,,89800774,,76539892,,58890345,,35400151,,08635077,	
		* 0,01160994,,00057783,,00001706,,00000083,,00000039,,00000023,	
		* 0,00000013,,00000007,,00000005,,00000004,,00000001,	
		* 0,94187329,,88733853,,74299955,,55526669,,31544727,,06580600,	
		* 0,00708785,,00025369,,00000511,,00000018,,00000008,,00000004,	
		* 0,00000002,,00000001,,00000001,,00000001,,0 /	
9		DATA	
		* ((T1(I,J),I=1,17),J=26,30)	
		* /0,91409148,,83586407,,64046013,,41379882,,17722910,,01691461,	
		* 0,00060108,,00000414,,00000001,,0 ,0 ,0	
		* 0,0 ,0 ,0 ,0 ,0	
		* 0,88712913,,78737564,,55207190,,30837337,,09957339,,00434769,	
		* 0,00005097,,00000007,,00000000,,00000000,,00000000,,00000000,	
		* 0,00000000,,00000000,,00000000,,00000000,,0	
		* 0,83556684,,69867404,,41020668,,17125849,,03143112,,00028724,	
		* 0,00000037,,00000000,,00000000,,00000000,,00000000,,00000000,	
		* 0,00000000,,00000000,,00000000,,00000000,,0	
		* 0,78700150,,61996509,,30479639,,09511026,,00992148,,00001898,	
		* 0,00000000,,00000000,,00000000,,00000000,,00000000,,00000000,	
		* 0,00000000,,00000000,,00000000,,00000000,,0	
		* 0,74125890,,55012308,,22647325,,05282051,,00313179,,00000125,	
		* 0,00000000,,00000000,,00000000,,00000000,,00000000,,00000000,	
		* 0,00000000,,00000000,,00000000,,00000000,,0 /	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(DATAT)
10		DO 10 I=1,11	
11	10	WT(I)= A1(I)	
12		DO 20 I=1,17	
13	20	SN(I)= A2(I)	
14		DO 30 I=1,30	
15	30	DMLS(I)= A3(I)	
16		DO 40 J=1,30	
17		DO 40 I=1,17	
18	40	TABLE(I,J) = T1(I,J)	
19		RETURN	
20		END	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM
1      SUBROUTINE DIR (Y,YP, * )
2      DIMENSION Y(1),YP(1)
3      COMMON
*      V1 ,AL1 ,VL1 ,VW1 ,AW1 ,AD1 ,QF1 ,EC1 ,EM1 ,EP1 ,V2 ,VL2 ,
*      V3 ,WE1 ,WE2 ,WE3 ,EMIX,WE1D,EPSC,EPSM,EPSP,HT ,SNS1,Q12 ,
*      EC1 ,BM1 ,BP1 ,Q12,WSP ,EFF ,DL12,DLCH31 ,RHOLIQ ,
*      PHT ,PHFT,PHST,PHLT,AK1 ,AK2 ,AK3 ,AK4 ,AK1S,AK2S,AK3S,AK4S,
*      AKC1,AKM1,AKS1,AKL1,AKW1,AKA1,PTERV ,QW1 ,QW2 ,QA ,
*      CG ,CL ,CW ,HC1 ,HC2 ,HX ,H ,HM1 ,HM2 ,E1 ,E2 ,CLO ,
*      RL1 ,RL2 ,RL3 ,RL4 ,RL5 ,RL6 ,RL7 ,RL8 ,RL9 ,RL10,RL11,RL12,
*      RL13,RL14,RL15,RL16,RL17,RL18,RL19,RL20,RL21,RL22,
*      TI(11) ,D(11) ,Q(11) ,EFPS(11) ,VGAV(11) ,VGAVM(11),
*      SN(17) ,DMLS(30) ,TABLE(17,30)
4      IF ( V2 ,NE, 0 ) GO TO 30
C
5      CX = 1000,/(2.*126.9044)
6      CG = Y(2)*CX
7      CW = Y(5)*CX
8      CL = Y(6)*CX
9      CALL COEFF ( 690 )
10     YP( 2 ) = (BC1-RL1*Y(2)+RL2*Y(5)+RL3*Y(6)+RL13*CLO)/V1
11     YP( 3 ) = (BM1-RL4*Y(3)+RL5*Y(7))/V1
12     YP( 4 ) = (BP1-RL6*Y(4))/V1
13     IF ( V*1 ,EQ, 0, ) GO TO 12
14     YP( 5 ) = (RL7*Y(2)+RL8*Y(4)-RL9*Y(5)+QW2*Y(6)+QW1*CLO)/VW1
15                                     GO TO 14
16     12 YP(5) = 0.
17     14 CONTINUE
18     IF ( VL1 ,EQ, 0, ) GO TO 16
19     YP( 6 ) = (RL10*Y(2)+RL11*Y(4)+RL12*Y(5)-(RL3+QW2)*Y(6)
*      +RL15*CLO)/VL1
20     YP( 7 ) = (RL14*Y(3)-RL5*Y(7))/VL1
21                                     GO TO 18
22     16 YP( 6 ) = 0.
23     YP( 7 ) = 0.
24     18 CONTINUE
25     YP( 8 ) = RL16*Y(2)+RL17*Y(5)
26     IF ( V3 ,NE, 0 ) GO TO 20
27     YP( 9 ) = QF1*(EC1*Y(2)+EM1*Y(3)+EP1*Y(4))
28     YP(10) = WE1*((1,-EPSC)*Y(2)+(1,-EPSM)*Y(3)+(1,-EPSP)*Y(4))
29     YP(11) = WE1*(EPSC*Y(2)+EPSM*Y(3)+EPSP*Y(4))
30                                     GO TO 40
C
31     20 YP( 9 ) = QF1*(EC1*Y(2)+EM1*Y(3)+EP1*Y(4))
32     YP(10) = WE3*((1,-EPSC)*Y(12)+(1,-EPSM)*Y(13)+(1,-EPSP)*Y(14))
*      + WE1*WE1D*(Y(2)+Y(3)+Y(4))
33     YP(11) = WE2*(EPSC*Y(12)+EPSM*Y(13)+EPSP*Y(14))
34     V3X = V3*EMIX
35     YP(12) = (QE1*(1,-QE1D)*Y(2)-(QE2*EPSC+QE3*(1,-EPSC))*Y(12))/V3X
36     YP(13) = (QE1*(1,-QE1D)*Y(3)-(QE2*EPSM+QE3*(1,-EPSM))*Y(13))/V3X
37     YP(14) = (QE1*(1,-QE1D)*Y(4)-(QE2*EPSP+QE3*(1,-EPSP))*Y(14))/V3X
38                                     GO TO 40
C
39     30 CX = 1000,/(2.*126.9044)

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FACOM 230-75 M7 FORTHAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN      ST-NO          SOURCE PROGRAM      ( DIR      )
40          CG      = Y(2)*CX
41          CW      = Y(5)*CX
42          CL      = Y(12)*CX
43          CALL COEFF ( &90 )
44          YP( 2) = (BC1-RL1*Y(2)+RL2*Y(5)+RL3*Y(12))/V1
45          YP( 3) = (BM1-RL4*Y(3)+RL5*Y(13))/V1
46          YP( 4) = (BP1-RL6*Y(4))/V1
47          IF( VW1 .EQ. 0. )                GO TO 32
48          YP( 5) = (RL7*Y(2)+RL8*Y(4)-RL9*Y(5)+QW2*Y(12))/VW1
49                                          GO TO 34
50          32 YP(5) = 0.
51          34 CONTINUE
52          IF( VL1 .EQ. 0. )                GO TO 36
53          YP( 6) = (RL10*Y(2)+RL11*Y(4)+RL12*Y(5)-QL12*Y(6)
*          + (QL12-QW2-RL3)*Y(12))/VL1
54          YP( 7) = (RL14*Y(3)-QL12*Y(7)+(QL12-RL5)*Y(13))/VL1
55                                          GO TO 38
56          36 YP( 6) = 0.
57          YP( 7) = 0.
58          38 CONTINUE
59          YP( 8) = RL16*Y(2)+RL17*Y(5)
60          YP( 9) = (RL18*Y(2)-WE2*Y(9))/V2
61          YP(10) = (RL19*Y(3)-WE2*Y(10))/V2
62          YP(11) = (RL20*Y(4)-WE2*Y(11))/V2
63          YP(12) = (RL21*Y(2)+W12*EFF*Y(4)+QL12*Y(6)-QL12*Y(12))/VL2
64          YP(13) = (RL22*Y(3)+WL12*Y(7)-QL12*Y(13))/VL2
65          V3X = V3*EMIX
66          YP(14) = (QE1*Y(2)+QE2*Y(9)-QE3*Y(14))/V3X
67          YP(15) = (QE1*Y(3)+QE2*Y(10)-QE3*Y(15))/V3X
68          YP(16) = (QE1*Y(4)+QE2*Y(11)-QE3*Y(16))/V3X
69          YP(17) = QE3*((1.-EPSC)*Y(14)+(1.-EPSM)*Y(15)+(1.-EPSP)*Y(16))
70          YP(18) = QE3*(EPSC*Y(14)+EPSM*Y(15)+EPSP*Y(16))
71          40 CONTINUE
C          IF( Y(1),LE, 5, .OR, Y(1),GE, 100, ) GO TO 97
C          PRINT 99
C          PRINT 98,RL1,RL2,RL3,RL4,RL5,RL6,RL7,RL8,RL9,RL10,RL11,RL12,RL13,
C          *          RL14,RL15,RL16,RL17,RL18,RL19,RL20,RL21,RL22
C          PRINT 98,(Y(I),I=1,18),(YP(I),I=1,18)
C          99 FORMAT('0','RL1--RL22,Y(1)--Y(18),YP(1)--YP(18)')
C          98 FORMAT('0',10(1PE13,4) )
C          97 CONTINUE
72          RETURN
73          90 RETURN 1
74          END

```


FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

```

1      SUBROUTINE INPUT(V1,VL1X,VL1F,PHF,PHS,AL1,AW1,AD1,      V2,VL2 ,
*      PHL,V3 ,QE1,QE2,QE3,EMIX,EPSC,EPSM,EPSP,B1,RETZ,RETL,
*      ALP,BET,GAM,WS,OW,TSP,HTSU,RAD,HT,PARAD,ICOAT,
*      DMEAN,SIGMAG,ANGLE,DORIF,ITYPE,NONOZ,DTT,ND,NPT,
*      QF1,EC1,EM1,EP1,CLO,
*      DXFILM,QE1D,VSP,PH,@CORE,*)
2      DIMENSION DTT(1),ND(1),NPT(1)
3      INTEGER MIRA,HEAD,TITL(12)
4      DATA MIRA /'MIRA'/
5      10 READ (5,1,END=92) HEAD,TITL
6      IF( HEAD .NE. MIRA )      GO TO 10
7      READ 2, V1,AL1,VL1X,VL1F,PHS
8      READ 2, DXFILM,PHF
9      READ 2, QF1,EC1,EM1,EP1
10     READ 2, V2,VL2,PHL,V3
11     READ 2, QE1,QE2,QE3,EMIX,QE1D
12     READ 2, EPSC,EPSM,EPSP
13     READ 2, B1,RETZ,RETL,ALP,BET,GAM
14     READ 2, WS,OW,TSP
15     READ 2, VSP,PH,CLO,@CORE
16     READ 3, HTSU,RAD,HT,PARAD,ICOAT
17     READ 3, DMEAN,SIGMAG,ANGLE,DORIF,ITYPE,NONOZ
18     READ 4, (DTT(I),I=1,12),
*      (ND(I),I=1,12),
*      (NPT(I),I=1,12)

C
19     PRINT 100,TITL
20     PRINT 102
21     PRINT 110
22     IF( V2 .NE. 0, )      GO TO 40
23     PRINT 111,V1
24     PRINT 113,AL1
25     PRINT 115,VL1X
26     PRINT 117, VL1F
27     PRINT 119,PHS
28     PRINT 121,DXFILM
29     PRINT 122,PHF
30     PRINT 131,QF1
31     PRINT 132,EC1
32     PRINT 133,EM1
33     PRINT 134,EP1
34     PRINT 216
35     PRINT 214,V3
36     PRINT 311,QE1
37     PRINT 313,QE2
38     PRINT 315,QE3
39     PRINT 317,EMIX
40     PRINT 319,QE1D
41     PRINT 321,EPSC
42     PRINT 322,EPSM
43     PRINT 323,EPSP
44     PRINT 511,B1
45     PRINT 512,RETZ
46     PRINT 513,RETL
47     PRINT 514,ALP
48     PRINT 515,BET

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(INPUT)
49		PRINT 516.GAM	
50		PRINT 521.0S	
51		PRINT 522.0W	
52		PRINT 523.TSP	
53		PRINT 531.VSP	
54		PRINT 532.PH	
55		PRINT 533.CLO	
56		PRINT 534.0CORE	
57			GO TO 60
58	40	CONTINUE	
59		PRINT 112.V1	
60		PRINT 114.AL1	
61		PRINT 116.VL1X	
62		PRINT 118.VL1F	
63		PRINT 120.PHS	
64		PRINT 121.DXFILM	
65		PRINT 122.PHF	
66		PRINT 135	
67		PRINT 211.V2	
68		PRINT 212.VL2	
69		PRINT 213.PHL	
70		PRINT 215.V3	
71		PRINT 312.0E1	
72		PRINT 314.0E2	
73		PRINT 316.0E3	
74		PRINT 318.EMIX	
75		PRINT 321.EPSC	
76		PRINT 322.EPSM	
77		PRINT 323.EPSP	
78		PRINT 511.B1	
79		PRINT 512.RETZ	
80		PRINT 513.RETL	
81		PRINT 514.ALP	
82		PRINT 515.BET	
83		PRINT 516.GAM	
84		PRINT 521.0S	
85		PRINT 522.0W	
86		PRINT 523.TSP	
87		PRINT 535	
	C		
	C		
	C		
88	60	CONTINUE	
89		PRINT 541.HTSU	
90		PRINT 542.RAD	
91		PRINT 543.HT	
92		PRINT 544.PARAD	
93		PRINT 545.ICOAT	
94		PRINT 551.DMEAN	
95		PRINT 552.SIGMAG	
96		PRINT 553.ANGLE	
97		PRINT 554.DORIF	
98		PRINT 555.ITYPE	
99		PRINT 556.NONOZ	
100		PRINT 611.(DTT(I),I=1,12)	
101		PRINT 621.(ND(I),I=1,12)	
102		PRINT 631.(NPT(I),I=1,12)	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN   ST-NO          SOURCE PROGRAM      ( INPUT )
      C
      C
      C
103      V1   = V1*1,E6
104      V2   = V2*1,E6
105      V3   = V3*1,E6
106      VL1X = VL1X*1,E6
107      VL1F = VL1F*1,E6
108      VL2   = VL2*1,E6
109      AL1   = AL1*1.E4
110      QF1   = QF1*1.E6/3600.
111      QS    = QS*1.E6/3600.
112      QW    = QW*1.E6/3600.
113      VSP   = VSP*1.E6
114      QCORE = QCORE*1.E6/3600.
115      HTSU  = HTSU*100.
116      RAD   = RAD*100.
117      HT    = HT*100.
118      PARAD = PARAD*1.E-4
119      DMEAN = DMEAN*1.E-4
120      QE1   = QE1*V1/8.64E+6
121      IF( V2 .EQ. 0. )          GO TO 80
122      QE2   = QE2*V2/8.64E+6          GO TO 82
123
124      80 QE2 = QE2*V3/8.64E+6
125      82 QE3 = QE3*V3/8.64E+6
126      90 RETURN
127      92 RETURN 1

      C
      C
      C
128      1 FORMAT( A4.5X,12A4 )
129      2 FORMAT( 5X,6E10.0 )
130      3 FORMAT( 5X,4E10,0.2110 )
131      4 FORMAT( 5X,12F5.0/5X,12I5/5X,12I5 )
132      100 FORMAT('1' // 33X,58(' ') // 33X,'*** ',12A4,' ***'
* // 33X,58(' ') )
133      102 FORMAT('0' /// 33X,'*** PROGRAM MIRA-PB PRINT OUT OF ',
* 'INITIAL DATA ***' )
134      110 FORMAT('0',10X,'DATA NO.',5X,'NAME',14X,'UNIT COMMENT' )
135      111 FORMAT(15X,'1010 V1 =',1PE11,3,' M**3',7X,'(VESSEL VOLUME)')
136      112 FORMAT(15X,'1010 V1 =',1PE11,3,' M**3',7X,'(DRYWELL FREE ',
* 'VOLUME)') )
137      113 FORMAT(24X,' A11 =',1PE11,3,' M**2',7X,'(SURFACE AREA OF SUMP ',
* 'POOL)') )
138      114 FORMAT(24X,' AL1 =',1PE11,3,' M**2',7X,'(SURFACE AREA OF ',
* 'DRYWELL POOL)') )
139      115 FORMAT(24X,' VL1X =',1PE11,3,' M**3',7X,'(INITIAL VOLUME OF SUMP)')
140      116 FORMAT(24X,' VL1X =',1PE11,3,' M**3',7X,'(INITIAL VOLUME OF ',
* 'DRYWELL POOL)') )
141      117 FORMAT(24X,' VL1F =',1PE11,3,' M**3',7X,'(VOLUME LIMIT OF SUMP)')
142      118 FORMAT(24X,' VL1F =',1PE11,3,' M**3',7X,'(VOLUME LIMIT OF ',
* 'DRYWELL POOL)') )
143      119 FORMAT(24X,' PHS =',1PE11,3,12X,'(PH OF SUMP LIQUID)') )
144      120 FORMAT(24X,' PHS =',1PE11,3,12X,'(PH OF DRYWELL POOL)') )
145      121 FORMAT(15X,'1020 DXFILM =',1PE11,3,' CM',9X,'(THICKNESS OF ',
* 'LIQUID FILM)') )

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(INPUT)
146	122	FORMAT(24X,' PHF =',1PE11.3,12X,'(PH OF LIQUID FILM)')	
147	131	FORMAT(15X,'1030 QF1 =',1PE11.3,' M**3/HOUR (RECIRC. ',	
	*	'FILTER FLOW)')	
148	132	FORMAT(24X,' EC1 =',1PE11.3,12X,'(RECIRC. FILTER 12 EFFICIENCY)')	
149	133	FORMAT(24X,' EM1 =',1PE11.3,12X,'(RECIRC. FILTER CH3I EFF.)')	
150	134	FORMAT(24X,' EP1 =',1PE11.3,12X,'(RECIRC. FILTER PART. EFF.)')	
151	135	FORMAT(15X,'1030')	
152	211	FORMAT(15X,'2010 V2 =',1PE11.3,' M**3',7X,'(WETWELL FREE ',	
	*	'VOLUME)')	
153	212	FORMAT(24X,' VL2 =',1PE11.3,' M**3',7X,'(WETWELL POOL VOLUME)')	
154	213	FORMAT(24X,' PHL =',1PE11.3,12X,'(PH OF WETWELL LIQUID)')	
155	214	FORMAT(24X,' V3 =',1PE11.3,' M**3',7X,'(FREE VOLUME OF ANNULUS)')	
156	215	FORMAT(24X,' V3 =',1PE11.3,' M**3',7X,'(FREE VOLUME OF REFUEL. ',	
	*	'BLDG.)')	
157	216	FORMAT(15X,'2010')	
158	311	FORMAT(15X,'3010 QE1 =',1PE11.3,' V/O/DAY (VESSEL LEAK ',	
	*	'RATE)')	
159	312	FORMAT(15X,'3010 QE1 =',1PE11.3,' V/O/DAY (LEAK RATE OF ',	
	*	'DRYWELL)')	
160	313	FORMAT(24X,' QE2 =',1PE11.3,' V/O/DAY (RECIRC. RATE OF ',	
	*	'ANNULUS)')	
161	314	FORMAT(24X,' QE2 =',1PE11.3,' V/O/DAY (LEAK RATE OF WETWELL)')	
162	315	FORMAT(24X,' QE3 =',1PE11.3,' V/O/DAY (EXHAUST RATE OF ',	
	*	'ANNULUS)')	
163	316	FORMAT(24X,' QE3 =',1PE11.3,' V/O/DAY (EXHAUST RATE OF ',	
	*	'REFUEL. BLDG.)')	
164	317	FORMAT(24X,' EMIX =',1PE11.3,12X,'(MIXING EFFIC. IN ANNULUS)')	
165	318	FORMAT(24X,' FMIX =',1PE11.3,12X,'(MIXING EFFIC. IN REFUEL. ',	
	*	'BLDG.)')	
166	319	FORMAT(24X,' QE1D =',1PE11.3,12X,'(FRACTION OF DOME SURFACE AREA)')	
167	321	FORMAT(15X,'3020 EPSC =',1PE11.3,12X,'(EXHAUST FILTER EFF. ',	
	*	'FOR 12)')	
168	322	FORMAT(24X,' EPSM =',1PE11.3,12X,'(EXHAUST FILTER EFF. FOR CH3I)')	
169	323	FORMAT(24X,' EPSP =',1PE11.3,12X,'(EXHAUST TILTER EFF. FOR PART.)')	
170	511	FORMAT(15X,'5010 B1 =',1PE11.3,' G/SEC',6X,'(TOTAL IODINE ',	
	*	'MASS RELEASE RATE)')	
171	512	FORMAT(24X,' RETZ =',1PE11.3,' SEC',8X,'(STARTING TIME FOR ',	
	*	'RELEASE)')	
172	513	FORMAT(24X,' RETL =',1PE11.3,' SEC',8X,'(ENDING TIME FOR RELEASE)')	
173	514	FORMAT(24X,' ALP =',1PE11.3,12X,'(FRACTION AS I?)')	
174	515	FORMAT(24X,' BET =',1PE11.3,12X,'(FRACTION AS CH3I)')	
175	516	FORMAT(24X,' GAM =',1PE11.3,12X,'(FRACTION AS PART.)')	
176	521	FORMAT(15X,'5020 QS =',1PE11.3,' M**3/HOUR (SPRAY FLOW ',	
	*	'RATE)')	
177	522	FORMAT(24X,' QW =',1PE11.3,' M**3/HOUR (SPRAY FLOW RATE ON ',	
	*	'VESSEL WALL)')	
178	523	FORMAT(24X,' TSP =',1PE11.3,' SEC',8X,'(SPRAY STARTING TIME)')	
179	531	FORMAT(15X,'5030 VSP =',1PE11.3,' M**3',7X,'(VOLUME OF ',	
	*	'FRESH SPRAY LIQ.)')	
180	532	FORMAT(24X,' PH =',1PE11.3,12X,'(PH OF FRESH SPRAY LIQ.)')	
181	533	FORMAT(24X,' CLU =',1PE11.3,' G/CM**3 (CONCENTRATION OF ',	
	*	'FRESH SPRAY LIQ.)')	
182	534	FORMAT(23X,' QCORE =',1PE11.3,' M**3/HOUR (FRESH LIQ. FLOW TO ',	
	*	'CORE)')	
183	535	FORMAT(15X,'5030')	
184	541	FORMAT(15X,'5040 HTSU =',1PE11.3,' M',10X,'(HEIGHT OF ',	
	*	'VESSEL WALL)')	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(INPUT)
185	542	FORMAT(24X,' RAD =',1PE11.3,' M',10X,'(RADIUS OF VESSEL)')
186	543	FORMAT(24X,' HT =',1PE11.3,' M',10X,'(SPRAY FALL HEIGHT)')
187	544	FORMAT(23X,' PARAD =',1PE11.3,' MICRONS	(SPRAY DROP MEAN SIZE)')
188	545	FORMAT(23X,' ICOAT =',15.18X,'(VESSEL PAINT I.D.)')
189	551	FORMAT(15X,'5050 DMEAN =',1PE11.3,' MICRONS	(SPRAY DROP ',
		* 'MEAN SIZE)')
190	552	FORMAT(22X,'SIGMAG =',1PE11.3,12X,'(STANDARD DEVIATION)')
191	553	FORMAT(23X,'ANGLE =',1PE11.3,' DEG',8X,'(NOZZLE INCL, ANGLE)')
192	554	FORMAT(23X,'DORIF =',1PE11.3,' CM',9X,'(NOZZLE ORFICE DIA.)')
193	555	FORMAT(23X,'ITYPE =',15	.18X,'(NOZZLE TYPE)')
194	556	FORMAT(23X,'NUNOZ =',15	.18X,'(NUMBER OF NOZZLES)')
195	611	FORMAT(15X,'6010 DTT =',12(F5.0),5X,'(TIME STEP)')
196	621	FORMAT(15X,'6020 ND =',12(15),5X,'(ITERATION NUM25R)')
197	631	FORMAT(15X,'6030 NPT =',12(15),5X,'(PRINT INTERVAL)')
198		END	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM
1      SUBROUTINE INPT1(SUMT,TB1,TS1,TIM1,TL2,TSPIN,SNS1,Q12,AD1,AW1,
*      VWJ,DXFILM,TRISE,V2,J,NS, * )
C
2      IF( J,NE, 1 )          GO TO 30
3      IF( NS,NE, 1 )        GO TO 30
C
4      IF( V2,NE, 0. )        GO TO 10
5      READ (5,1,END=90) TOTI,TB1N,TS1N,TIM1N,TSPN,SNS1N,SIM1,ARAS,ARAI
6      PRINT 3, TOTI,TB1N,TS1N,TIM1N,TSPN,SNS1N,SIM1,ARAS,ARAI
7      ARAS = ARAS*1.E4
8      ARAI = ARAI*1.E4
9      AW1  = ARAS
10     VW1  = AW1*DXFILM
11     AD1  = 0.
12     IF( SIM1,EQ, 0. ) AD1 = ARAI
13     IF( VW1,EQ, 0. ) AW1 = 0.
14                                     GO TO 20
15     10 READ (5,2,END=90) TOTI,TB1N,TS1N,TL2N,SNS1N,Q12N,AW1,AD1
16     PRINT 4, TOTI,TB1N,TS1N,TL2N,SNS1N,Q12N,AW1,AD1
17     Q12N = Q12N*1.E6/3600.
18     AW1  = AW1*1.E4
19     AD1  = AD1*1.E4
20     VW1  = AW1*DXFILM
21     IF( VW1,EQ, 0. ) AW1 = 0.
22     20 IF( TOTI,EQ, 0. )          GO TO 90
23     TB1  = TB1N
24     TS1  = TS1N
25     SNS1 = SNS1N
26     IF( V2,NE, 0. )          GO TO 22
27     TIM1 = TIM1N
28     TSPIN= TSPN
29     TRISE= TB1-TSPIN
30                                     GO TO 80
31     22 TL2 = TL2N
32     Q12  = Q12N
33     TRISE= TB1-TL2
34     TIM1 = TB1
35                                     GO TO 80
C
36     30 IF( TOTI,GT, SUMT )        GO TO 50
37     TOT10= TOTI
38     TB10 = TB1N
39     TS10 = TS1N
40     TIM10= TIM1N
41     TSPO = TSPN
42     SNS10= SNS1N
43     TL20 = TL2N
44     Q120 = Q12N
45     IF( V2,NE, 0. )          GO TO 40
46     READ (5,1,END=90) TOTI,TB1N,TS1N,TIM1N,TSPN,SNS1N,SIM1,ARAS,ARAI
47     PRINT 3, TOTI,TB1N,TS1N,TIM1N,TSPN,SNS1N,SIM1,ARAS,ARAI
48     ARAS = ARAS*1.E4
49     ARAI = ARAI*1.E4
50     AW1  = ARAS

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM      ( INPT1 )
51      VW1 = AW1*DXFILM
52      AD1 = 0.
53      IF( SIM1 .EQ. 0. ) AD1 = ARAI
54                                GO TO 50
55      40 READ (5,2,END=90) TOT1,TB1N,TS1N,TL2N,SNS1N,@12N,AW1,AD1
56      PRINT 4, TOT1,TB1N,TS1N,TL2N,SNS1N,@12N,AW1,AD1
57      AW1 = AW1*1.E4
58      AD1 = AD1*1.E4
59      VW1 = AW1*DXFILM
60      IF( VW1 .EQ. 0. ) AW1 = 0.
61      @12N = @12N*1.E6/3600.
C
C
C
62      50 CONTINUE
63      XX = (ALOG(SUMT)-ALOG(TOT10))/(ALOG(TOT1)-ALOG(TOT10))
C      XX = (SUMT-TOT10)/(TOT1-TOT10)
64      TB1 = TB10+(TB1N-TB10)*XX
65      TS1 = TS10+(TS1N-TS10)*XX
66      SNS1 = SNS10+(SNS1N-SNS10)*XX
67      IF( V2 .NE. 0. ) GO TO 60
68      TIM1 = TIM10+(TIM1N-TIM10)*XX
69      TSPIN = TSP0+(TSPN-TSP0)*XX
70      TRISE = TB1-TSPIN
71                                GO TO 80
72      60 TL2 = TL20+(TL2N-TL20)*XX
73      @12 = @120+(@12N-@120)*XX
74      TRISE = TB1-TL2
75      TIM1 = TB1
76      80 RETURN
77      90 PRINT 5, SUMT
78      RETURN 1
C
79      1 FORMAT( 5X,E10,0,4F5,0,4E10,0 )
80      2 FORMAT( 5X,E10,0,3F5,0,5X,4E10,0 )
81      3 FORMAT('0','*** PROGRAM MIRA-PB PRINT OUT OF TIME DEPENDENT '
*      'DATA ***' /
*      ' TOT1 =',1PE11,3,' TB1 =',1PE11,3,' TS1 =',1PE11,3,
*      ' TIM1 =',1PE11,3,' TSPIN=',1PE11,3,' SNS1 =',1PE11,3 /
*      ' SIM1 =',1PE11,3,' ARAS =',1PE11,3,' ARAI =',1PE11,3 )
82      4 FORMAT('0','*** PROGRAM MIRA-PB PRINT OUT OF TIME DEPENDENT '
*      'DATA ***' /
*      ' TOT1 =',1PE11,3,' TB1 =',1PE11,3,' TS1 =',1PE11,3,
*      ' TL2 =',1PE11,3,' SNS1 =',1PE11,3,' @12 =',1PE11,3 /
*      ' AW1 =',1PE11,3,' AD1 =',1PE11,3 )
83      5 FORMAT('0','***** MIRA CODE ERROR MESSAGE *****' /
*      ' ',',',TIME DEPENDENT DATA ARE NOTHING AT TIME =',1PE11,3 )
84      END

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM
1		SUBROUTINE IRKG (N,Y,YP,W,X0, *)
2		DIMENSION Y(1),YP(1),W(1)
3		Y(1)=X0
4		YP(1)=1,0
5		CALL DIR (Y,YP, &90)
6		DO 10 I=1,N
7	10	W(I)=0,0
8		RETURN
9	90	PRINT 1, (Y(I),I=1,N)
10	1	FORMAT('0',Y(1)---Y(N) /(' ',10(1PE12,4)))
11		RETURN 1
12		END

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

```

ISN  ST-NO          SOURCE PROGRAM
  1          SUBROUTINE OUTPT(SNAP,SUMT,V1,V2,V3,VW1,VL1,VL2,AD1,AW1,Y,
    *          H,HX,HC1,HC2,E1,E2,TB1)
  2          DIMENSION Y(1)
  3          IF( V2 .NE. 0. )          GO TO 400
    C
    C
  4          SUMT1= SUMT/60.
  5          SUMT2= SUMT1/60.
  6          SUMT3= SUMT2/24.
  7          IF( Y(2) .EQ. 0. )          GO TO 31
  8          HQ   = Y(6)/Y(2)          GO TO 32
  9
 10         31 HQ   = 0.
 11         32 CONTINUE
 12         95 GMG=(Y(2)+Y(3)+Y(4))*V1
 13         GMG3 = V3*(Y(12)+Y(13)+Y(14))
 14         GMW=Y(5)*VW1
 15         GML  = VL1*(Y(6)+Y(7))
 16         GMA  = Y(8)*(AD1+AW1)
 17         TMBJ = GMG+GMG3+GMW+GML+GMA+Y(9)+Y(10)+Y(11)
 18         IF( SNAP .EQ. 0. ) PRINT 210
 19         PRINT 420, SUMT,SUMT1,SUMT2,SUMT3
 20         PRINT 220, TB1
 21         PRINT 230
 22         PRINT 231, Y(2),Y(5),Y(6),Y(8),Y(12)
 23         PRINT 232, Y(3),Y(7),Y(13)
 24         PRINT 233, Y(4),Y(14)
 25         PRINT 440
 26         PRINT 241, GMG,GMW,GML,GMA
 27         PRINT 242, Y(9),Y(11),Y(10),TMBJ
 28         PRINT 250, HQ,H,HX,HC1
 29         PRINT 260, E1,E2
 30         SNAP = SNAP+1
 31         IF( SNAP .GE. 3. ) SNAP = 0.          GO TO 90
 32
 33         400 CONTINUE
 34         IF( SNAP .EQ. 0. ) PRINT 410
 35         SUMT1= SUMT/60.
 36         SUMT2= SUMT1/60.
 37         SUMT3= SUMT2/24.
 38         GMG1 = V1*(Y(2)+Y(3)+Y(4))
 39         GMG2 = V2*(Y(9)+Y(10)+Y(11))
 40         GMG3 = V3*(Y(14)+Y(15)+Y(16))
 41         GMW1 = VW1*Y(5)
 42         GML1 = VL1*(Y(6)+Y(7))
 43         GML2 = VL2*(Y(12)+Y(13))
 44         GMA1 = Y(8)*(AD1+AW1)
 45         TMBI = GMG1+GMG2+GMG3+GMW1+GML1+GML2+GMA1+Y(17)+Y(18)
 46         X1   = (Y(2)*V1+Y(9)*V2)/(V1+V2)
 47         X2   = (Y(6)*VL1+Y(12)*VL2)/(VL1+VL2)
 48         IF ( X1 .EQ. 0. )          GO TO 601
 49         HQ   = X2/X1          GO TO 602
 50
 51         601 HQ   = 0.
 52         602 CONTINUE
 53         PRINT 420, SUMT,SUMT1,SUMT2,SUMT3
 54         PRINT 430

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN   ST-NO          SOURCE PROGRAM      ( OUTPT )
55     PRINT 431, Y(2),Y(9),Y(14),Y(5),Y(6),Y(8),Y(12)
56     PRINT 432, Y(3),Y(10),Y(15),Y(7),Y(13)
57     PRINT 433, Y(4),Y(11),Y(16)
58     PRINT 440
59     PRINT 441, GMG1,GMG2,GMG3
60     PRINT 442, GML1,GML2,GMA1
61     PRINT 443, GMW1,Y(18),Y(17),TMB1
62     PRINT 450, H0,HX,HC1,HC2
63     PRINT 460, E2
64     SNAP = SNAP+1
65     IF( SNAP .EQ. 3, ) SNAP = 0,
66     90 RETURN
67     210 FORMAT('1' //
*       ' ',32X,'*** PROGRAM MIRAPB PWR - IODINE REMOVAL '
*       'ANALYSIS ****',10X,'RELEASE = 1.0' /
*       ' ',32X,'*** FINAL DATA...IODINE CONCNS. AND ACCUMLS. ',
*       'VERSUS TIME ****' )
68     220 FORMAT(' ',60X,'GAS TEMPERATURE =',1PE11.3,' DEG C' )
69     230 FORMAT(' ',10X,'IODINE CONCENTRATION IN GRAMS-1/CC OR 50 CM' /
*       ' ',7X,'FORM GAS PHASE LIQ. FILM SUMP LIQ ',
*       'SURFACE ANNULUS' )
70     231 FORMAT(' ',7X,'12',5X,1PE11.3,4X,1PE11.3,4X,1PE11.3,4X,1PE11.3,
*       4X,1PE11.3 )
71     232 FORMAT(' ',7X,'CH3I',3X,1PE11.3,19X,1PE11.3,19X,1PE11.3 )
72     233 FORMAT(' ',7X,'PART',3X,1PE11.3,49X,1PE11.3 )
73     241 FORMAT(' ',7X,
*       'AIRBORNE =',1PE11.3,6X,'FILM =',1PE11.3,6X,'SUMP =',
*       1PE11.3,6X,'WALL =',1PE11.3 )
74     242 FORMAT(' ',7X,'RECIRC FILTER =',1PE11.3,6X,'EXHAUST FILTER =',
*       1PE11.3,6X,'LEAKAGE =',1PE11.3,10X,'TOTAL IODINE =',
*       1PE11.3 )
75     250 FORMAT('0', 'ELEMENTAL IODINE PARTITION COEFFICIENT'
*       '2X,'SYSTEM =',1PE9.2,2X,'FRESH SPRAY =',1PE9.2,
*       2X,'RECYCLE SPRAY =',1PE9.2,2X,'LIQUID FILM =',1PE9.2)
76     260 FORMAT('0', 'ELEMENTAL IODINE AVERAGE ABSORPTION EFFICIENCY '
*       'FRESH SPRAY =',
*       1PE10.2,5X,'RECYCLE SPRAY =',1PE9.2 )
77     410 FORMAT('1' //
*       ' ',32X,'*** PROGRAM MIRAPB BWR - IODINE REMOVAL '
*       'ANALYSIS ****',10X,'RELEASE = 1.0' /
*       ' ',32X,'*** FINAL DATA...IODINE CONCNS. AND ACCUMLS. ',
*       'VERSUS TIME ****' )
78     420 FORMAT('0' /
*       ' ',10X,'***** TOTAL TIME =',1PE11.3,' SECONDS',5X,1PE11.3,
*       'MINUTES',5X,1PE11.3,' HOURS',5X,1PE11.3,' DAYS',
*       20(' ') )
79     430 FORMAT('0', 'GAS PHASE CONCENTRATIONS, LIQUID '
*       'AND SURFACE CONCENTRATIONS IN GRAMS-1/CC OR 50 CM' /
*       ' ',7X,'FORM DRYWELL WETWELL REFUEL',
*       'BLDG, DRYWELL FILM DRYWELL POOL DRYWELL ',
*       'WALLS WETWELL POOL' )
80     431 FORMAT(' ',7X,
*       '12',5X,1PE11.3,4X,1PE11.3,4X,1PE11.3,10X,1PE11.3,4X,
*       1PE11.3,4X,1PE11.3,4X,1PE11.3 )
81     432 FORMAT(' ',7X,'CH3I',3X,1PE11.3,4X,1PE11.3,4X,1PE11.3,
*       25X,1PE11.3,19X,1PE11.3 )
82     433 FORMAT(' ',7X,'PART',3X,1PE11.3,4X,1PE11.3,4X,1PE11.3 )

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(OUTPT)
83	440	FORMAT('0',' IODINE ACCUMULATIONS IN GRAMS')	
84	441	FORMAT (8X,'AIRBORNE IN DRYWELL =',1PE11.3,6X,'AIRBORNE IN WETWELL 1 =',1PE11.3,6X,'AIRBORNE IN REFUEL,BLDG, =',1PE11.3)	
85	442	FORMAT (8X,'DRYWELL POOL =',1PE11.3,7X,'WETWELL POOL =',1PE11.3,9X 1,'DRYWELL WALLS =',1PE11.3)	
86	443	FORMAT (8X,'DRYWELL LIQ. FILM =',1PE10.3,3X,'BLDG,EXHAUST FILTER = 1',1PE10.3,3X,'FILTERED LEAKAGE =',1PE10.3,5X,'TOTAL IODINE =',1PE 210.3)	
87	450	FORMAT('0','ELEMENTAL IODINE PARTITION COEFFICIENT')	
	*	3X,'SYSTEM =',1PE9.2,	
	*	3X,'RECYCLE SPRAY =',1PE9.2,3X,'LIQUID FILM =',1PE9.2,	
	*	3X,'WETWELL =',1PE9.2)	
88	460	FORMAT('0','ELEMENTAL IODINE AVERAGE ABSORPTION EFFICIENCY	'
	*	'RECYCLE SPRAY =',1PE9.2)	
89		END	

FACUM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM
 1      SUBROUTINE PACO (TB1,TL2,PHF,PHS,PHFT,PHST,AK1,AK2,AK3,AK4,AK1S,
      1AK2S,AK3S,AK4S,HM1,HM2,P,PAIR,PHL,PHLT,EFF,PH,PHT,V2)
  C    CALCULATION OF PH AT TEMPERATURE FOR SPRAY AND CONDENSATE
 2      TDRY = TB1+273.16
 3      REFPHT = -2.740962060625967E0 + (1.523327657381906E-02)*TDRY +
      1(2.201479283944370E 03)/TDRY + (1.402521247931774E-17)*TDRY*TDRY
 4      PHT = PH*REFPHT/9.1845
 5      PHFT = PHF*REFPHT/9.1845
 6      PHST = PHS*REFPHT/9.1845
  C    CALCULATION OF HYDROLYSIS CONSTANTS
  C    CALCULATION OF AK1
 7      IF(TDRY.GT.385.5) GO TO 1001
 8      Z = -2.45603475424395E 02 + (3.57310223743172E 01)*ALOG(TDRY) +
      1(1.50088340394797E 04)/TDRY
 9      GO TO 1002
10     1001 Z = -349.957+49.657*ALOG(TDRY)+21729.5/TDRY
11     1002 AK1 = EXP(Z)
  C    CALCULATION OF AK3
12     Z = -6.965252198805E-02 - 8.401417242757E 03/TDRY
13     AK3 = EXP(Z)
14     AK2 = EXP(- 111.98 + 16.725*ALOG(TDRY) + 6952.3/TDRY)
15     AK4 = 1.2E-11 + (3.6E-13)*(TDRY - 298.16)
  C    CALCULATION OF METHYL IODIDE PARTITION COEFF
16     HM1 = (1.7E-5)*EXP(7210./(1.986*TDRY))
17     IF( V2 .EQ. 0. ) GO TO 90
  C
  C
  C    CALCULATION OF PH AT TEMP. FOR SPRAY,CONDENSATE FILM,AND WETWELL POOL
18     TWET = TL2+273.16
19     REFPHT = -2.740962060625967E0 + (1.523327657381906E-02)*TWET +
      1(2.201479283944370E 03)/TWET + (1.402521247931774E-17)*TWET*TWET
20     PHLT = PHL*REFPHT/9.1845
  C    CALCULATION OF HYDROLYSIS CONSTANTS
  C    CALCULATION OF AK1S
21     IF(TWET.GT.385.5) GO TO 2001
22     Z = -2.49603475424395E 02 + (3.57310223743172E 01)*ALOG(TWET) +
      1(1.50088340394797E 04)/TWET
23     GO TO 2002
24     2001 Z = -2.45241883602302E 01 + 4.26732749381276*ALOG(TWET) +
      1(7.287350258351257E 02)/TWET
25     2002 AK1S= EXP(Z)
26     Z = -6.965252198805E-02 - 8.401417242757E 03/TWET
27     AK3S= EXP(Z)
28     AK2S= EXP(- 111.98 + 16.725*ALOG(TWET) + 6952.3/TWET)
29     AK4S= 1.2E-11 + (3.6E-13)*(TWET - 298.16)
  C    CALCULATION OF METHYL IODIDE PARTITION COEFF
30     HM2 = (1.7E-5)*EXP(7210./(1.986*TWET))
31     AMF = PAIR*29./(PAIR*29.+P*18.)
32     EFF = 1.-AMF
33     90 RETURN
34     END

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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1      SUBROUTINE PROP (TB1,RHOLI0,RHOAIR,RHUSTM,RHOATM,P,PAIR,PTOTAL,
      1ETA,ETAAIR,ETAMIX,DAIR,DIWTR,DIMIX,SMITNO,FRAIR,DMAIR,DMWTR,
      2DMMIX,SNOMI,ETASOL,DLI2,DLCH3I)
      C THIS CONTAINS THE PHYSICAL PROPERTY CALCULATIONS FOR SPRAY-2
      C SOURCES FOR THE EQUATIONS USED ARE MAINLY KEENAN + KEYES )THERMODYNAMI
      C PERTIES OF STEAM) WILEY, 1936 (K+K) AND THE 3RD + 4TH EDITIONS OF THE
      C CAL ENGINEERS HANDBOOK ) MCGRAW-HILL 1950-1963 (PERRY3 OR PERRY4)
      C CALCULATION OF VAPOR PRESSURE OF WATER (K+K EQ (12) P 14)
2      TEMPK = TB1+273.16
3      X = 647.27 - TEMPK
4      TOP = 3.2437814 + (5.86826E-3)*X + (1.1702379E-8)*(X**3)
5      DENOM = 1. + (2.1878462E-3)*X
6      PHI1X = TOP/DENOM
7      PHI2X = (2.302585*X*PHI1X)/TEMPK
8      PHIP = EXP(PHI2X)
9      P = 218.167/PHIP
      C CALCULATE SP VOL OF LIQUID (EMPIRICAL EQ FIT TO DATA IN TABLE 3-46. PE
10     VLIQ = 1.0018 + 0.0002615*(TEMPK - 293.16) + (3.219E-6)*((TEMPK -
      1 293.16)**2)
11     RHOLI0 = 1./VLIQ
      C SINCE THE MASS OF AIR IN THE CONTAINMENT IS FIXED RHOAIR IS INDEPENDEN
12     RHOAIR = 0.001185
      C CALCULATION OF STEAM DENSITY (K+K EQ(13) P 15)
13     TAU = 1./TEMPK
14     TAUSW = TAU*TAU
15     G1TAU = 82.546*TAU - (1.6246E5)*TAUSW
16     G2TAU = 0.21828 - (1.2697E5)*TAUSW
17     G3TAU = 3.635E-4 - (6.768E64)*(TAU**24)
18     BZERO = 1.89 - 2641.6*TAU*(10.** (80870.*TAUSW))
19     B = BZERO + (BZERO**2)*(G1TAU*TAU*P) + (BZERO**4)*G2TAU*((TAU*P)
      1**3) + (BZERO**13)*G3TAU*((TAU*P)**12)
20     V = (4.55504*TEMPK)/P + B
21     RHOSIM = 1./V
22     RHOATM = RHOAIR + RHUSTM
      C CALCULATE VISCOSITY OF STEAM (K+K EQ(20) P 23)
23     TOP = (1.851E-5)* SQRT(TEMPK)
24     DENOM = 1. + 680.1*TAU
25     ETAO = TOP/DENOM
26     F1OFP = (P*1.E-4)*(0.03103 - (3.65E-5)*P)
27     ETA = ETAO + F1OFP
      C CALCULATE VISCOSITY OF AIR (PERRY3 EQ(2) P370)
28     ETAAIR = (1.709E-4)*((TEMPK/273.16)**0.768)
      C CALCULATE MIXTURE VISCOSITY (PERRY4 EQ(3-108) P 3-230)
29     PAIR = 1.*TEMPK/298.0
30     PTOTAL = P + PAIR
31     FRSTM = P/PTOTAL
32     FRAIR = PAIR/PTOTAL
33     TOP = FRSTM*ETA*4.242641 + FRAIR*ETAAIR*5.385165
34     DENOM = FRSTM*4.242641 + FRAIR*5.385165
35     ETAMIX = TOP/DENOM
      C CALCULATE DIFFUSION COEFFICIENT OF IODINE IN AIR (PERRY4 EQ(14-57) P 1
      C SUBSCRIPT 1=IODINE , 2=AIR , 3=STEAM , 4=METHYL IODIDE
36     EPS1K = 550,
37     EPS2K = 97,
38     EPS3K = 363,
39     EPS4K = 400,
40     EPS12K = SQRT(EPS1K*EPS2K)

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM      ( PROP  )
41    EPS13K = SQRT(EPS1K*EPS3K)
42    EPS24K = SQRT(EPS2K*EPS4K)
43    EPS34K = SQRT(EPS3K*EPS4K)
44    C EMPIRICAL FIT TO DATA IN TABLE 14-45 P 14-21 PERRY4
45    COLINT = 0.3674 + 0.3478*EPS12K*TAU
46    RAIR = 3.617
47    RI = 4.982
48    RIAIR = 0.5*(RI + RAIR)
49    FOFM = SQRT((1./254.) + (1./29.00))
50    B = (10.7 - 2.46*FOFM)*1.E-4
51    PFUNT = TEMPK**1.5
52    TOP = B*PFUNT*FOFM
53    DENOM = PTOTAL*(RIAIR**2)*COLINT
54    DIAIR = TOP/DENOM
55    C CALCULATE DIFFUSION COEFFICIENT OF IODINE IN STEAM
56    COLINT = 0.3674 + 0.3478*EPS13K*TAU
57    R* = 2.655
58    RI* = 0.5*(RI + R*)
59    FOFM* = SQRT((1./254.) + (1./18.00))
60    B* = (10.7 - 2.46*FOFM*)*1.E-4
61    TOP* = B*PFUNT*FOFM*
62    DENOM* = PTOTAL*(RI**2)*COLINT
63    DIWTR = TOP*/DENOM*
64    C CALCULATE DIFFUSIVITY OF I IN AIR-STEAM, USING EQ(6) IN C.R. WILKE, CH
65    C PROGR V46, PP95-104(1950) YA IS ASSUMED TO BE 0
66    DIMIX = 1./((FRAIR/DIAIR) + (FRSTM/DIWTR))
67    SMITNO = ETAMIX/(RHOATM*DIMIX)
68    C CALCULATION OF METHYL IODIDE DIFFUSIVITIES
69    COLINT = 0.3674 + 0.3478*EPS24K*TAU
70    RM = 4.68
71    RMAIR = 0.5*(RM+RAIR)
72    FOFM = SQRT((1./142.)+(1./29.))
73    b = (10.7-2.46*FOFM)*1.E-4
74    TOP = B*PFUNT*FOFM
75    DENOM = PTOTAL*(RMAIR**2)*COLINT
76    DMAIR = TOP/DENOM
77    COLINT = 0.3674 + 0.3478*EPS34K*TAU
78    RM* = 0.5*(RM + R*)
79    FOFM* = SQRT((1./142.)+(1./18.))
80    B* = (10.7 - 2.46*FOFM*)*1.E-4
81    TOP* = B*PFUNT*FOFM*
82    DENOM* = PTOTAL*(RM**2)*COLINT
83    DMWTR = TOP*/DENOM*
84    DMMIX = 1./((FRAIR/DMAIR)+(FRSTM/DMWTR))
85    SNOMI = ETAMIX/(RHOATM*DMMIX)
86    T = TEMPK = 273.16
87    C CALCULATE DIFFUSIVITY OF I2 IN WATER (PERRY4 PP14-21 TO 14-24)
88    C FOR WATER VISCOSITY CALCULATION SEE PERRY4 TABLE3-267 " 3-201
89    TFUNC = T - 8.435
90    ETAINV = 2.1482*(TFUNC + SQRT(6078.4 + TFUNC*TFUNC)) - 120.
91    ETASOL = 1./ETAINV
92    DLF = (7.4E-10)*TEMPK*ETAINV* SQRT(2.6*18.00)
93    DL12 = DLF/(71.5**0.6)
94    C CALCULATE CH3I DIFFUSIVITY IN WATER
95    DLCH3I = DLF/(62.9**0.6)
96    RETURN
97    END

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM
1      SUBROUTINE RATES(TB1,TS1,      HTSU,PARAD,ICOAT,ETAMIX,RHOATM,P,
      1DIMIX,SMITNO,DMMIX,SNOMI,RHOLI@,ETASOL,SNS1,
      2      AKC1,AKM1,AKA1,AKS1,AKL1,AKW1,PTERV,DLI2,TIM1)
C     CALCULATION OF GAS PHASE MASS TRANSFER COEFFS
2      TNEW = TB1+273.16
3      TDIFF = ABS(TB1-TS1)
CJA   GRASNO = HTSU**3*TDIFF*980.*RHOATM/(ETAMIX**2*TB1)
4      GRASNO = HTSU**3*TDIFF*980.*RHOATM**2/(ETAMIX**2*TNEW)
5      GLIM = 1.0E+9
6      IF(GRASNO.GT.GLIM) GO TO 10
7      AKC1 = 0.59*DIMIX*(GRASNO*SMITNO)**0.25/HTSU
8      AKM1 = 0.59*DMMIX*(GRASNO*SNOMI)**0.25/HTSU
9      GO TO 12
10     10 AKC1 = 0.13*DIMIX*(GRASNO*SMITNO)**0.333/HTSU
11     11 AKM1 = 0.13*DMMIX*(GRASNO*SNOMI)**0.333/HTSU
12     12 CONTINUE
C     CALCULATION OF DRY WALL DEPOSITION VELOCITY FOR 12
13     TIM1K = TIM1+273.16
14     GO TO (21,22,23,24,25) ,ICOAT
15     21 AKA1 = 5.9*EXP(-950./(1.986*TIM1K))
16     GO TO 28
17     22 AKA1 = 1900.*EXP(-7600./(1.986*TIM1K))
18     GO TO 28
19     23 AKA1 = .096*EXP(-4700./(1.986*TIM1K))
20     GO TO 28
21     24 AKA1 = 0.35
22     GO TO 28
23     25 AKA1 = 0.08
24     28 CONTINUE
C     CALCULATE STEAM FLUX MASS TRANSFER COEFF
C     THE SWEEP EFFECT OF CONDENSING STEAM IS OVERESTIMATE.
C     THIS EFFECT IS SMALL, SEE BNWL-b-417, 27 PAGE
CJA   AKS1 = 82.05*SNS1*TNEW/(18.*P)
25     AKS1 = 0.
C     CALCULATE LIQUID FILM MASS TRANSFER COEFF FOR 12
26     IF(SNS1.EQ.0.) GO TO 29
27     WVAP = 550.
28     TCONW = 0.0016
29     RATIO = WVAP/TCONW
30     TERM1 = 0.75*RATIO*SNS1
31     TERM2 = 3.*ETASOL*HTSU*SNS1/(980.*RHOLI@*RHOLI@)
32     DTFILM = TERM1*TERM2**.333
33     PARA = 980.*RHOLI@*RHOLI@*RATIO/(4.*ETASOL*DTFILM*HTSU)
34     AKL1 = 1.333*DLI2*PARA**.25
35     GO TO 30
36     29 AKL1 = 0.
37     30 CONTINUE
C     CALCULATE LIQUID PHASE DEPOSITION VELOCITY FOR 12
38     TS1K = TS1+273.16
39     GO TO(31,32,33,34,35) ,ICOAT
40     31 AKW1 = 27.*EXP(-6800./(1.986*TS1K))
41     GO TO 38
42     32 AKW1 = 1.5E+6*EXP(-14000./(1.986*TS1K))
43     GO TO 38
44     33 AKW1 = 1.0E+9*EXP(-20000./(1.986*TS1K))
45     GO TO 38
46     34 AKW1 = 0.44*EXP(-3200./(1.986*TS1K))

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(RATES)
47			GO TO 38
48	35	AKW1 = 0,00155	
49	38	CONTINUE	
50	C	CALCULATE PARTICLE TERMINAL SETTLING VELOCITY	
51		PTERV = 980.*PARAD*PARAD/(4.5*ETAMIX)	
52		RETURN	
		END	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM
1		SUBROUTINE RKG (N,DELX,Y,YP,Q, *)
2		DIMENSION Y(1),YP(1),Q(1),A(4),B(4),C(4)
3		DATA A/0.5,0.2928932,1.7071066,0.16666666/,B/2.0,1.0,1.0,2.0/,
	1	C/0.5,0.2928932,1.7071066,0.5/
4		DO 20 J=1,4
5		CALL DIR (Y,YP, &90)
6		DO 10 I=1,N
7		TEMP=A(J)*(YP(I)-B(J)*Q(I))
8		Y(I)=Y(I)+DELX*TEMP
9	10	Q(I)=Q(I)+3.0*TEMP-C(J)*YP(I)
	C	
10		IF(Y(2) .LT. 1.E-16) Y(2) = 1.E-16
	C	
	C	IF(Y(1),LE. 7190. .OR, Y(1),GE. 7450.) GO TO 97
	C	PRINT 99
	C	PRINT 98, (Y(I),I=1,16),(YP(I),I=1,18),(Q(I),I=1,18)
	C	99 FORMAT('0','Y(1)--Y(18),YP(1)--YP(18),Q(1)--Q(18)')
	C	98 FORMAT(' ',10(1PE13,4) / 8(1PE13,4))
	C	97 CONTINUE
11		20 CONTINUE
12		RETURN
13		90 PRINT 1, (Y(I),I=1,N)
14	1	FORMAT('0','Y(1)---Y(N)' /(' ',10(1PE12,4)))
15		RETURN 1
16		END

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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1      SUBROUTINE SPRAY (VGAV,VGAVM,      TI,QA,TB1,DMEAN,ANGLE,SIGMAG,
2      1 ITYPE,DORIF,NONOZ,RAD,WT,HT,D,QL,PARAD,ETAMIX,FRAIR,TRISE,
3      2 RHOATM,EFPS,SMITNO,DIMIX,SNOMI,DMMIX,RHOLIQ)
4      DIMENSION DROPV(11),DROPS(11),W(11),DMDT(11,11),DNDT(11,11),
5      1 AN(11),SDNDT(11),AN2(11),W2(11),WTFR(11),VGAV(11),VGAVM(11),
6      2 VTER(11),TI(11),D(11),QL(11),EFPS(11),WT(11)
7      DO 2 I=1,11
8      VGAV(I) = 0,
9      VGAVM(I) = 0,
10     VTER(I) = 0,
11     2 TI(I) = 0,
12     TEMPK = TB1+273.16
13     PHI = 0.01745329*(ANGLE/2.)
14     DO 4 I=1,11
15     4 D(I) = DMEAN*EXP((((I-1)/2.)-2.5)*ALOG(SIGMAG))
16     IF(ITYPE.EQ.1) GO TO 5
17     AORIF = 0.36*0.7854*(      DORIF **2)
18     GO TO 6
19     5 AORIF = 0.7854*(      DORIF **2)
20     6 QORIF = QA/NONOZ
21     AL = QA/(3.141593*RAD*RAD)
22     DO 10 J=1,11
23     DROPV(J) = 0.5235988*(D(J)**3)
24     10 DROPS(J) = AL*WT(J)/DROPV(J)
25     DO 9 I=1,11
26     9 CALL STEP      (I,D(I),PHI,AORIF,QORIF,RAD,HT,ETAMIX,RHOATM,SMITNO,
27     1 DIMIX,SNOMI,DMMIX,RHOLIQ,VTER(I),TI(I),VGAV(I),VGAVM(I))
28     DO 11 J = 1,11
29     11 W(J) = AL*WT(J)*TI(J)/HT
30     DO 12 J = 1,11
31     DO 12 I = 1,11
32     DMDT(I,J) = 0,
33     DNDT(I,J) = 0,
34     12 AN(J) = W(J)*HT/DROPV(J)
35     20 DO 13 I = 2,11
36     IM1 = I - 1
37     DO 14 J = 1,IM1
38     DX = D(I) + D(J)
39     IF (VTER(I),LE,VTER(J)) GO TO 14
40     DMDT(I,J) = 0.7859*(DX**2)*W(J)*(VTER(I)-VTER(J))
41     14 DNDT(I,J) = DMDT(I,J)*AN(I)/DROPV(J)
42     13 CONTINUE
43     DO 15 J = 1,11
44     15 SDNDT(J) = 0,
45     DO 16 J = 1,11
46     DO 16 I = 1,11
47     16 SDNDT(J) = SDNDT(J) + DNDT(I,J)
48     DO 17 I = 1,11
49     IF (SDNDT(I),LE,DROPS(I))GO TO 17
50     W(I) = 0.9*W(I)
51     17 CONTINUE
52     IF(SDNDT(1)/DROPS(1),LE,1.001)GO TO 18
53     DO 19 J = 1,11
54     19 AN(J) = W(J)*HT/DROPV(J)
55     GO TO 20
56     18 CONTINUE
57     DO 60 J = 1,11

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(SPRAY)
53		AN2(J) = DROPSC(J) - SDNDT(J)	
54	60	W2(J) = AN2(J)*DROPV(J)	
55		WEIGHT = 0.	
56		DO 51 I = 1,11	
57	51	WEIGHT = WEIGHT + W2(I)	
58		DO 52 I = 1,11	
59		WTFR(I) = W2(I)/WEIGHT	
60	52	QL(I) = QA*WTFR(I)	
61		DO 80 I=1,11	
62		STOPD = 2.*HT*PARAD*PARAD/(9.*ETAMIX*TI(I))	
63		STK = 2.*STOPD/D(I)	
64		IF(STK.LT.0,2) GO TO 72	
65		EPAC = STK**2/(STK+0.25)**2	
66		GO TO 73	
67	72	EPAC = 0.	
68	73	EINT = 6.*PARAD/D(I)	
69		SLIP = 1. -0.061*FRAIR	
70		EDIP = 2.*SLIP*D(I)*TRISE/(3.*RHOATM*HT*550.)	
71		IF(EPAC.GT.EINT) GO TO 75	
72		EFPS(I) = EINT	
73		GO TO 76	
74	75	EFPS(I) = EPAC	
75	76	IF(EFPS(I).GT.EDIP) GO TO 80	
76		EFPS(I) = EDIP	
77	80	CONTINUE	
78		RETURN	
79		END	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM
  1          SUBROUTINE STEP (I,D,PHI,AORIF,@ORIF,RAD,HT,ETAMIX,RHOATM,SMITNO,
            1DIMIX,SNOMI,DMMIX,RHOLI@,VTER,TI,VGAV,VGAVM)
C IN THIS SUBROUTINE A STEPWISE CALCULATION IS MADE OF THE DROP TRAJECTO
C DROPS ARE ASSUMED TO ORIGINATE AT THE NOZZLE WITH AN INITIAL VELOCITY
C MAGNITUDE IS DETERMINED BY THE VOLUME IS DETERMINED BY THE VOLUME DISC
C AND THE LIQUID CROSS-SECTION IN THE NOZZLE (THE NOZZLE MAY HAVE AN AIR
C AND WHOSE DIRECTION IS DETERMINED BY THE INCLUDED ANGLE OF THE SPRAY C
C RATED BY THE NOZZLE (THE NOZZLE IS ASSUMED TO POINT DOWN)
C SET INITIAL VALUES OF VARIABLES
  2          TIME = 0.
  3          X = 0.
  4          Y = 0.
  5          VGIT = 0.
  6          K = 1
  7          DELTAT = .01
  8          VTER = 0.
  9          V = @ORIF/AORIF
10          VX = V* SIN(PHI)
11          VY = V* COS(PHI)
12          DELVX = 0.
13          DELVY = 0.
14          TEST = 0.
C RVK = RECIPROCAL KINEMATIC VISCOSITY
15          RVK = RHOATM/ ETAMIX
16          TOPCON = (-3.*RHOATM)/(4.*RHOLI@*D)
17          SMJ = 0.6*(SMITNO**0.333)
18          DID = DIMIX/D
19          SMIM = 0.6*(SNOMI**0.333)
20          DIDM = DMMIX/D
21          VGI = 0.
22          300 RENNO = D *V*RVK
C DRAG COEFFICIENTS ARE TAKEN FROM DALLAVALLE )MICROMERITICS)
23          IF(RENNO .LE.500.)GO TO 304
24          CSUBR = 0.44
25          GO TO 305
26          304 IF(RENNO .LE.2.) GO TO 306
27          CSUBR = 18.5/(RENNO **0.6)
28          GO TO 305
29          306 CSUBR = 24./RENNO
30          305 TOP = TOPCON*V*CSUBR
31          307 DELVY = (980. + TOP*VY)*DELTAT
32          TEST = ABS(DELVY /VY)
33          IF(TEST,LT,0.01) GO TO 308
34          DELTAT = DELTAT/2.
35          IF(DELTAT,LT,1.E-6) GO TO 397
36          GO TO 307
37          308 VY = VY + DELVY
38          Y = Y + (VY - .5*DELVY )*DELTAT
39          DELVX = TOP*VX*DELTAT
40          VX = VX + DELVX
41          X = X + (VX - .5*DELVX )*DELTAT
42          SNI = 2.0 + SMJ* SQRT(RENNO)
43          VGI = SNI*DID
44          VGIT = VGI*DELTAT
45          SNIM = 2.0 + SMIM*SQRT(RENNO)
46          VGIM = SNIM*DIDM
47          VGITM = VGIM*DELTAT

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

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ISN  ST-NO          SOURCE PROGRAM      ( STEP  )
48      TIME = TIME + DELTAT
49      V = SQRT(VX**2 + VY**2)
50      IF(DELVY )400,399,500
51      400 NSTEP = 1
52      DO 401 K = 2,500
53      402 RENNO = D *V*RVK
54      IF(RENNO ,LE,500,)GO TO 403
55      CSUBR = 0,44
56      GO TO 404
57      403 IF(RENNO ,LE,2,) GO TO 405
58      CSUBR = 18,5/(RENNO **0,6)
59      GO TO 404
60      405 CSUBR = 24,/RENNO
61      404 TOP = TOPCON*V*CSUBR
C      CONVERGENCE CRITERION
62      IF((980, + TOP*VY),GT,-10,) GO TO 407
63      DELVY = -0,01*VY
64      411 DELTAT = DELVY/(980, + TOP*VY)
65      414 DELVX = TOP*VX*DELTAT
C      SOMETIMES VX TRIES TO OSCILLATE AROUND 0, THIS IS TO FORCE IT TO 0,
66      IF( ABS(DELVX),GT,VX) GO TO 408
67      X = X + (VX + 0,5*DELVX)*DELTAT
68      Y = Y + (VY + 0,5*DELVY)*DELTAT
C      IN THE SMALLER SYSTEMS, THE DROPS MAY HIT THE WALL OR THE FLOOR
C
69      IF(X,GT,RAD) GO TO 409
70      IF(Y,GT,HT) GO TO 410
71      VX = VX + DELVX
72      IF(VX,LT,.1)VX = 0,
73      412 SNI = 2, + SMI* SQRT(RENNO)
74      VGI = SNI*DID
75      VGIT = VGIT + VGI*DELTAT
76      SNIM = 2,0 + SMIM*SQRT(RENNO)
77      VGIM = SNIM*DIDM
78      VGITM = VGITM + VGIM*DELTAT
79      TIME = TIME + DELTAT
80      401 V = SQRT (VX**2 + VY**2)
C      A NORMAL TERMINATION OF THE DO LOOP INDICATES FAILURE TO CONVERGE
81      GO TO 397
82      408 DELVY = DELVY/2,
83      IF(DELTAT,GE,,00001) GO TO 411
84      X = X + 0,5*VX*DELTAT
85      VX = 0,
86      VY = VY + DELVY
87      Y = Y + (VY - ,5*DELVY)*DELTAT
88      GO TO 412
89      409 X = X - (VX + 0,5*DELVX)*DELTAT
90      Y = Y - (VY + 0,5*DELVY)*DELTAT
91      DELTAX = RAD - X
92      DELTAT = DELTAX/VX
93      X = RAD
94      TIME = TIME + DELTAT
95      VGIT = VGIT + VGI*DELTAT
96      VGITM = VGITM + VGIM*DELTAT
97      Y = Y + VY*DELTAT
98      GO TO 399
99      410 Y = Y - (VY + 0,5*DELVY)*DELTAT

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FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(STEP)
100		X = X - (VX + 0,5*DELVX)*DELTAT	
101		Z = HT - Y	
102		DELTAT = Z/VY	
103		Y = HT	
104		X = X + (VX + 0,5*DELVX)*DELTAT	
105		TIME = TIME + DELTAT	
106		VGIT = VGIT + VGI*DELTAT	
107		VGITM = VGITM + VGIM*DELTAT	
108		GO TO 399	
109	407	IF(VX.LT,1,) GO TO 413	
110		DELVY = 0,	
111		VTER = VY	
112		DELTAT = 0.01	
113		GO TO 414	
114	413	Z = HT - Y	
115		DELTAT = Z/VY	
116		TIME = TIME + DELTAT	
117		Y = HT	
118		VGIT = VGIT + VGI*DELTAT	
119		VGITM = VGITM + VGIM*DELTAT	
120		VTER = VY	
121		X = X + VX*DELTAT	
122		GO TO 399	
123	500	NSTEP = 1	
124		DO 501 K = 2,500	
125	502	RENNO = D *V*RVK	
126		IF(RENNO .LE.500,) GO TO 503	
127		CSUBR = 0.44	
128		GO TO 504	
129	503	IF(RENNO .LE.2,)GO TO 505	
130		CSUBR = 18.5/(RENNO **0,6)	
131		GO TO 504	
132	505	CSUBR = 24./RENNO	
133	504	TOP = TOPCON*V*CSUBR	
134		IF((980. + TOP*VY).LT,10.) GO TO 507	
135		DELVY = 0.01*VY	
136	511	DELTAT = DELVY/(980. + TOP*VY)	
137	514	DELVX = TOP*VX*DELTAT	
138		IF(ABS(DELVX),GT,VX) GO TO 508	
139		X = X + (VX + 0.5*DELVX)*DELTAT	
140		Y = Y + (VY + 0.5*DELVY)*DELTAT	
	C	IF(X.GT,RAD) GO TO 509	
141		IF(Y.GT,HT) GO TO 510	
142		VX = VX + DELVX	
143		IF(VX.L T.,1)VX = 0,	
144		VY = VY + DELVY	
145	512	SNI = 2. + SMI* SQR(RENNO)	
146		VGI = SNI*DID	
147		VGIT = VGIT + VGI*DELTAT	
148		SNIM = 2.0 + SMIM*SQR(RENNO)	
149		VGIM = SNIM*DIDM	
150		VGITM = VGITM + VGIM*DELTAT	
151		TIME = TIME + DELTAT	
152	501	V = SQR(VX**2 + VY**2)	
153		GO TO 397	
154	508	DELVY = DELVY/2,	
155		IF(DELTAT,GE,,00001) GO TO 511	

FACOM 230-75 M7 FORTRAN-IV H COMPILER (OPT2) SOURCE PROGRAM LIST

ISN	ST-NO	SOURCE PROGRAM	(STEP)
156		X = X + 0.5*VX*DELTAT	
157		VX = 0.	
158		VY = VY + DELVY	
159		Y = Y + (VY - 0.5*DELVY)*DELTAT	
160		GO TO 512	
161	509	X = X - (VX + 0.5*DELVX)*DELTAT	
162		Y = Y - (VY + 0.5*DELVY)*DELTAT	
163		DELTAX = RAD - X	
164		DELTAT = DELTAX/VX	
165		X = RAD	
166		TIME = TIME + DELTAT	
167		VGIT = VGIT + VGI*DELTAT	
168		VGITM = VGITM + VGIM*DELTAT	
169		Y = Y + VY*DELTAT	
170		GO TO 399	
171	510	Y = Y - (VY + 0.5*DELVY)*DELTAT	
172		X = X - (VX + 0.5*DELVX)*DELTAT	
173		Z = HT - Y	
174		DELTAT = Z/VY	
175		Y = HT	
176		X = X + (VX + 0.5*DELVX)*DELTAT	
177		TIME = TIME + DELTAT	
178		VGIT = VGIT + VGI*DELTAT	
179		VGITM = VGITM + VGIM*DELTAT	
180		GO TO 399	
181	507	IF(VX.LT.1.) GO TO 513	
182		DELVY = 0.	
183		VTER = VY	
184		DELTAT = .01	
185		GO TO 514	
186	513	Z = HT - Y	
187		DELTAT = Z/VY	
188		TIME = TIME + DELTAT	
189		Y = HT	
190		VGIT = VGIT + VGI*DELTAT	
191		VGITM = VGITM + VGIM*DELTAT	
192		VTER = VY	
193		X = X + VX*DELTAT	
194		GO TO 399	
195	397	PRINT 396	
196	396	FORMAT('0','***** MIHA CODE ERROR MESSAGE *****' /	
		* ' ', '(SUB. STEP) ',	
		* 'THE CALCULATION FAILED TO CONVERG TO TERMINAL VELOCITY')	
197	399	VGAV = VGIT/TIME	
198		VGAVM = VGITM/TIME	
199		TI = TIME	
200		RETURN	
201		END	