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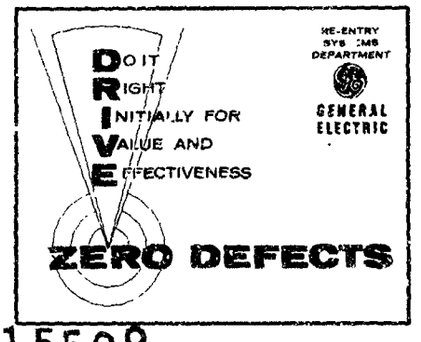
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FACILITY FORM 602

GENERAL ELECTRIC

DOCUMENT NO. 65SD526

Thermodynamics Fundamentals
Memo No. 036
Revision A (October 25, 1965)

COATING SELECTION PROGRAM

PART III

PROGRAM LISTING

FINAL REPORT ON NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONTRACT NASw-960

PERFORMED BY:

THE GENERAL ELECTRIC COMPANY
RE-ENTRY SYSTEMS DEPARTMENT

FOR

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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APRIL 15, 1965

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ABSTRACT

A rational and direct method has been developed for selecting the optical coating pattern for the external surface of a spacecraft, such that the spacecraft temperatures are as close as possible to the midpoint of their preselected ranges. The temperature control is maintained passively by radiation and conduction, using no active control devices. The complete range in mission environments is considered in the optimization procedure.

The selection technique has been programmed for use on the GE 600 Series, IBM 7094, or any other computer that uses the standard IBM Fortran IV system.

FOREWORD

This document is a three-part final report on the Coating Selection Program. Part I describes the theory and basis for selection of: (1) the iteration scheme used to solve the heat balance equations; and (2) the optimization scheme. Part II describes the computer program, including the details of each subroutine and the details of input and output. Part II therefore includes the user's manual. Part III presents the Program Listing. Parts II and III have both been revised (Revision A) under a contract extension to incorporate descriptions of the first two month's usage, as well as a new Program Listing with improvements as found advisable during these two months.

The work reported herein was sponsored by the National Aeronautics and Space Administration and was monitored by Mr. Conrad Mook, of NASA-Headquarters, and Mr. Robert Kidwell, Jr., of NASA's Goddard Space Flight Center.

The chief contributors to the work reported were Mr. Frederick A. Costello, Engineer, who developed the techniques, Mr. Thomas P. Harper, Analyst, who converted the techniques to computer form, both of the Re-entry Systems Department's Thermodynamics Technology Component, and Miss Barbara Aston, Programmer-Analyst, from the Spacecraft Department, who programmed the techniques for computer usage.

PART III

PROGRAM LISTING

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```
$IBFTC MAIN     FULIST,REF,DD                                                   0000010
C       MAIN                                                                    0000020
C                       COMMON ASSOCIATED WITH INPUT                            0000030
        COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                0000040
        COMMON BOLTZ                                                            0000050
        COMMON CONDUC(34,44),CONVER(6)                                          0000060
        COMMON DELMIN,DELTA                                                     0000070
        COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                     0000080
        COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                      0000090
        COMMON KOAT(34)                                                         0000100
        COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORS,NSTOP(5)                    0000110
        COMMON QFX(34,20)                                                       0000120
        COMMON RADTN(34,44)                                                     0000130
        COMMON SOLFX(34,20)                                                     0000140
        COMMON T(44,20),TEMMAX(44),TINIL(44),TITLE(12),TL(34),TU(34)            0000150
C                       SINGLE CELL COMMON                                      0000160
        COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,        0000170
       1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,       0000180
       2       NOS,USMRD,DSMRD,USTRN,DSTRN                                      0000190
C                       COMPUTED ARRAY COMMON                                   0000200
        COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                  0000210
        COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),            0000220
       1       DESTH(34)                                                        0000230
        COMMON EMLOW(34,5),EPS(34,40)                                           0000240
        COMMON IS(40)                                                           0000250
        COMMON KS(40)                                                           0000260
        COMMON LS(40)                                                           0000270
        COMMON NN(34)                                                           0000280
        COMMON PBA(34),PBE(34)                                                  0000290
        COMMON R(34)                                                            0000300
        COMMON SCRAT(34),SUMKT(34,20)                                           0000310
        COMMON TM(34,34)                                                        0000320
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0000330
        COMMON INT,IOT                                                          0000340
C       INT IS THE INPUT TAPE                                                   0000350
        INT=5                                                                   0000360
C       IOT IS THE OUTPUT TAPE                                                  0000370
        IOT=6                                                                   0000380
    3   CALL INPUT                                                              0000390
        IRK=0                                                                   0000400
        NSTEP=0                                                                 0000410
        IMAX2=0                                                                 0000420
        KMAX2=0                                                                 0000430
        LMAX2=0                                                                 0000440
        CALL START                                                              0000450
        CALL ARANGE                                                             0000460
        CALL TRANSM                                                             0000470
        ITNT=0                                                                  0000480
        CALL INVRSE(ITNT)                                                       0000490
        NTNT=ITNT                                                               0000500
        IF(NTNT.EQ.2) GO TO 3                                                   0000510
```

```
      LR = 1                                                            0000520
      LG = 1                                                            0000530
      KRET=0                                                            0000540
      CALL MRD1(KRET)                                                   0000550
      IF(KRET.EQ.2) GO TO 3                                             0000560
      CALL OUTPUT(1)                                                    0000570
      BETA1 = BETA                                                      0000580
      IMAX1 = IMAX                                                      0000590
      KMAX1 = KMAX                                                      0000600
      LMAX1 = LMAX                                                      0000610
      DO 10 I = 1,NEXND                                                 0000620
      DES(I,1) = EMIS(I)                                                0000630
      DALS(I,1) = ALPA(I)                                               0000640
      ALS(I,1) = ALPA(I)                                                0000650
   10 EPS(I,1) = EMIS(I)                                                0000660
      IS(1) = IMAX                                                      0000670
      KS(1) = KMAX                                                      0000680
      LS(1) = LMAX                                                      0000690
      DELT = DELTA                                                      0000700
   15 ITNT=5                                                            0000710
      CALL MRD2(ITNT)                                                   0000720
      NTNT=ITNT                                                         0000730
      IF(NTNT.EQ.2) GO TO 3                                             0000740
   20 CALL CNTR(ICNT)                                                   0000750
      IF(ICNT.EQ.2) GO TO 3                                             0000760
      IF(ICNT.EQ.1) GO TO 35                                            0000770
   25 IF (BETA.GT.BETA1) GO TO 30                                       0000780
      CALL ADVNCE                                                       0000790
      DELT=USMRD*DELT                                                   0000800
      GO TO 15                                                          0000810
   30 ITNT=0                                                            0000820
      CALL STEP(ITNT)                                                   0000830
      NTNT=ITNT                                                         0000840
      IF(NTNT.EQ.2) GO TO 3                                             0000850
      GO TO 20                                                          0000860
   35 CALL TEST(IMRD2)                                                  0000870
      ITEST = IMRD2                                                     0000880
      IF(ITEST.EQ.0) GO TO 15                                           0000890
      CALL TREND(ITEST)                                                 0000900
      IF((LR-ITEST).LT.3) GO TO 40                                      0000910
      ITNT=7                                                            0000920
      CALL MRD2(ITNT)                                                   0000930
      NTNT=ITNT                                                         0000940
      IF(NTNT.EQ.0) GO TO 20                                            0000950
   40 CALL TREND2(KRET)                                                 0000960
      IF(KRET.EQ.2) GO TO 3                                             0000970
      IF (BETA.GE.BETA1) GO TO 48                                       0000980
      DO 45 I = 1,NEXND                                                 0000990
      DALPHS(I)=DALPHS(I)+DASTH(I)*USTRN                                0001000
   45 DEMISS(I)=DEMISS(I)+DESTH(I)*USTRN                                0001010
      CALL ADVNCE                                                       0001020
```

```
      IRK=1                                                    0001030
      GO TO 40                                                 0001040
   48 CALL BACK(IRK)                                           0001050
      IF(IRK.EQ.2) GO TO 3                                     0001060
      GO TO 15                                                 0001070
      END                                                      0001080
```

```
$IBFTC ADVNCE  FULIST,REF,DD                                                    0001090
      SUBROUTINE ADVNCE                                                         0001100
C                       COMMON ASSOCIATED WITH INPUT                            0001110
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0001120
      COMMON BOLTZ                                                              0001130
      COMMON CONDUC(34,44),CONVER(6)                                            0001140
      COMMON DELMIN,DELTA                                                       0001150
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0001160
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0001170
      COMMON KOAT(34)                                                           0001180
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                      0001190
      COMMON QFX(34,20)                                                         0001200
      COMMON RADTN(34,44)                                                       0001210
      COMMON SOLFX(34,20)                                                       0001220
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0001230
C                       SINGLE CELL COMMON                                      0001240
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0001250
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,         0001260
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0001270
C                       COMPUTED ARRAY COMMON                                   0001280
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0001290
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0001300
     1       DESTH(34)                                                          0001310
      COMMON EMLOW(34,6),EPS(34,40)                                             0001320
      COMMON IS(40)                                                             0001330
      COMMON KS(40)                                                             0001340
      COMMON LS(40)                                                             0001350
      COMMON NN(34)                                                             0001360
      COMMON PBA(34),PBE(34)                                                    0001370
      COMMON R(34)                                                              0001380
      COMMON SCRAT(34),SUMKT(34,20)                                             0001390
      COMMON TM(34,34)                                                          0001400
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0001410
      COMMON INT,IOT                                                            0001420
      LR1 = LR                                                                  0001430
      BETA1 = BETA                                                              0001440
      IMAX1 = IMAX                                                              0001450
      KMAX1 = KMAX                                                              0001460
      LMAX1 = LMAX                                                              0001470
      DO 10 J = 2,LR1                                                           0001480
      IS(J) = 0                                                                 0001490
      KS(J) = 0                                                                 0001500
      LS(J) = 0                                                                 0001510
      DO 10 I = 1,NEXND                                                         0001520
      ALS(I,J) = 0.                                                             0001530
      EPS(I,J)=0.                                                               0001540
      DES(I,1)=DES(I,2)                                                         0001550
   10 DALS(I,1)=DALS(I,2)                                                       0001560
      LG = LG+1                                                                 0001570
      LR = 1                                                                    0001580
      IS(1) = IMAX                                                              0001590
```

```
      KS(1) = KMAX                                                      0001600
      LS(1) = LMAX                                                      0001610
      DO 20 I = 1,NEXND                                                 0001620
      ALS(I,1)=DALS(I,1)                                                0001630
   20 EPS(I,1)=DES(I,1)                                                 0001640
      RETURN                                                            0001650
      END                                                               0001660
```

```
$IBFTC ARANGE  DD,REF,FULIST
      SUBROUTINE ARANGE                                                 0001670
C                     COMMON ASSOCIATED WITH INPUT                      0001680
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                          0001690
      COMMON BOLTZ                                                      0001700
      COMMON CONDUC(34,44),CONVER(6)                                    0001710
      COMMON DELMIN,DELTA                                               0001720
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)               0001730
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                0001740
      COMMON KOAT(34)                                                   0001750
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)              0001760
      COMMON QFX(34,20)                                                 0001770
      COMMON RADTN(34,44)                                               0001780
      COMMON SOLFX(34,20)                                               0001790
      COMMON T(44,20),TEMMAX(44),TINTL(44),TLE(,2),TL(34),TU(34)        0001800
C                     SINGLE CELL COMMON                                0001810
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,  0001820
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,  0001830
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                0001840
C                     COMPUTED ARRAY COMMON                             0001850
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                            0001860
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),      0001870
     1       DESTH(34)                                                  0001880
      COMMON EMLOW(34,6),EPS(34,40)                                     0001890
      COMMON IS(40)                                                     0001900
      COMMON KS(40)                                                     0001910
      COMMON LS(40)                                                     0001920
      COMMON NN(34)                                                     0001930
      COMMON PBA(34),PBE(34)                                            0001940
      COMMON R(34)                                                      0001950
      COMMON SCRAT(34),SUMKT(34,20)                                     0001960
      COMMON TM(34,34)                                                  0001970
C                     COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES  0001980
      COMMON INT,IOT                                                    0001990
      JJ2=NNODE+NCTN                                                    0002000
      DO 10 I=1,NNODE                                                   0002010
      RADTN(I,I)=0.                                                     0002020
      CONDUC(I,I)=0.                                                    0002030
      DO 10 J=1,JJ2                                                     0002040
      IF(I.EQ.J) GO TO 10                                               0002050
      RADTN(I,I)=RADTN(I,I)+RADTN(I,J)                                  0002060
      RADTN(I,J)=-RADTN(I,J)                                            0002070
      CONDUC(I,I)=CONDUC(I,I)+CONDUC(I,J)                               0002080
      CONDUC(I,J)=-CONDUC(I,J)                                          0002090
   10 CONTINUE                                                          0002100
      JJ1=NNODE+1                                                       0002110
      DO 20 K=1,NORB                                                    0002120
      DO 20 I=1,NNODE                                                   0002130
      SUMKT(I,K)=0.                                                     0002140
      IF(NCTN.EQ.0) GO TO 20                                            0002150
      DO 15 J=JJ1,JJ2                                                   0002160
                                                                        0002170
```

```
   15 SUMKT(I,K)=SUMKT(I,K)+CONDUC(I,J)*T(J,K)+RADTN(I,J)*(T(J,K))**4      0002180
   20 CONTINUE                                                            0002190
      DO 30 K=1,NORB                                                      0002200
      DO 30 I=1,NNODE                                                     0002210
   30 SUMKT(I,K)=QFX(I,K)-SUMKT(I,K)                                      0002220
   50 RETURN                                                              0002230
      END                                                                 0002240
```

```
$IBFTC BACK    FULIST,REF,DD                                                  0002250
      SUBROUTINE BACK(IRK)                                                    0002260
C                     COMMON ASSOCIATED WITH INPUT                          0002270
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                0002280
      COMMON BOLTZ                                                            0002290
      COMMON CONDUC(34,44),CONVER(6)                                          0002300
      COMMON DELMIN,DELTA                                                     0002310
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                     0002320
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                      0002330
      COMMON KOAT(34)                                                         0002340
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                    0002350
      COMMON QFX(34,20)                                                       0002360
      COMMON RADTN(34,44)                                                     0002370
      COMMON SOLFX(34,20)                                                     0002380
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)            0002390
C                     SINGLE CELL COMMON                                      0002400
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,        0002410
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,       0002420
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                      0002430
C                     COMPUTED ARRAY COMMON                                   0002440
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                  0002450
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),            0002460
     1       DESTH(34)                                                        0002470
      COMMON EMLOW(34,6),EPS(34,40)                                           0002480
      COMMON IS(40)                                                           0002490
      COMMON KS(40)                                                           0002500
      COMMON LS(40)                                                           0002510
      COMMON NN(34)                                                           0002520
      COMMON PBA(34),PBE(34)                                                  0002530
      COMMON R(34)                                                            0002540
      COMMON SCRAT(34),SUMKT(34,20)                                           0002550
      COMMON TM(34,34)                                                        0002560
C                     COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0002570
      COMMON INT,IOT                                                          0002580
      DO 10 I = 1,NEXND                                                       0002590
      DALPHS(I)=.4*DALPHS(I)                                                  0002600
      DEMISS(I)=.4*DEMISS(I)                                                  0002610
      DALS(I,2)=DALS(I,1)+DALPHS(I)                                           0002620
   10 DES(I,2)=DES(I,1)+DEMISS(I)                                             0002630
      CALL LIM                                                                0002640
      KRET=1                                                                  0002650
      CALL MRD1(KRET)                                                         0002660
      IF(KRET.EQ.2) GO TO 38                                                  0002670
      CALL OUTPUT(4)                                                          0002680
      IF (BETA.GE.BETA1) GO TO 20                                             0002690
      CALL ADVNCE                                                             0002700
      GO TO 36                                                                0002710
   20 IF(IRK.EQ.0) GO TO 27                                                   0002720
      SUMA = 0.                                                               0002730
      SUME = 0.                                                               0002740
      DO 25 I = 1,NEXND                                                       0002750
```

```
      SUMA=SUMA+(DALPHS(I))**2                                          0002760
   25 SUME=SUME+(DEMISS(I))**2                                          0002770
      DELT=2.5*DSTRN*(SQRT(SUMA+SUME))                                  0002780
      IF (DELT.GE.DELMIN) GO TO 30                                      0002790
      IRK=2                                                             0002800
      WRITE(IOT,101)                                                    0002810
      WRITE(IOT,100)                                                    0002820
      GO TO 40                                                          0002830
   27 LR=LR+1                                                           0002840
      IRK=1                                                             0002850
      GO TO 34                                                          0002860
   30 DO 32 J=2,LR                                                      0002870
      IS(J)=0                                                           0002880
      KS(J)=0                                                           0002890
      LS(J)=0                                                           0002900
      DO 32 I=1,NEXND                                                   0002910
      ALS(I,J)=0.                                                       0002920
   32 EPS(I,J)=0.                                                       0002930
      LR=1                                                              0002940
      IRK=0                                                             0002950
   34 DO 35 I = 1,NEXND                                                 0002960
      DALS(I,2)=DALS(I,1)                                               0002970
      DES(I,2)=DES(I,1)                                                 0002980
      ALS(I,LR)=DALS(I,1)                                               0002990
      EPS(I,LR)=DES(I,1)                                                0003000
      EMIS(I)=DES(I,1)                                                  0003010
   35 ALPHA(I)=DALS(I,1)                                                0003020
      NSTEP = 1                                                         0003030
      LG = LG+1                                                         0003040
      IMAX = IMAX1                                                      0003050
      KMAX=KMAX1                                                        0003060
      LMAX=LMAX1                                                        0003070
      IS(LR)=IMAX1                                                      0003080
      KS(LR)=KMAX1                                                      0003090
      LS(LR)=LMAX1                                                      0003100
      BETA=BETA1                                                        0003110
      CALL MRD1(KRET)                                                   0003120
      IF(KRET.EQ.2) GO TO 38                                            0003130
      CALL OUTPUT(4)                                                    0003140
   36 IF(LG.LE.MAXG) GO TO 40                                           0003150
   38 IRK=2                                                             0003160
   40 RETURN                                                            0003170
  100 FORMAT(37HSTEP SIZE LESS THAN MINIMUM STEP SIZE)                  0003180
  101 FORMAT(1H1)                                                       0003190
      END                                                               0003200
```

```
$IBFTC CNTR    FULIST,REF,DD                                                    0003210
       SUBROUTINE CNTR(ICNT)                                                    0003220
C                        COMMON ASSOCIATED WITH INPUT                           0003230
       COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                 0003240
       COMMON BOLTZ                                                             0003250
       COMMON CONDUC(34,44),CONVER(6)                                           0003260
       COMMON DELMIN,DELTA                                                      0003270
       COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                      0003280
       COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                       0003290
       COMMON KOAT(34)                                                          0003300
       COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                     0003310
       COMMON QFX(34,20)                                                        0003320
       COMMON RADTN(34,44)                                                      0003330
       COMMON SOLFX(34,20)                                                      0003340
       COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)             0003350
C                        SINGLE CELL  COMMON                                    0003360
       COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,         0003370
      1        BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,       0003380
      2        NOS,USMRD,DSMRD,USTRN,DSTRN                                      0003390
C                        COMPUTED ARRAY COMMON                                  0003400
       COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                   0003410
       COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),             0003420
      1        DESTH(34)                                                        0003430
       COMMON EMLOW(34,6),EPS(34,40)                                            0003440
       COMMON IS(40)                                                            0003450
       COMMON KS(40)                                                            0003460
       COMMON L (40)                                                            0003470
       COMMON MN(34)                                                            0003480
       COMMON PBA(34),PBF(34)                                                   0003490
       COMMON R(34)                                                             0003500
       COMMON SCRAT(34),SUMKT(34,20)                                            0003510
       COMMON TM(34,34)                                                         0003520
C                        COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES       0003530
       COMMON INT,IOT                                                           0003540
       DIMENSION XX(34),YY(34)                                                  0003550
       LR1=LR                                                                   0003560
       LG2 = LG+1                                                               0003570
       DO 10 I = 1,NEXND                                                        0003580
       DALS(I,2)=DALS(I,1)-DALPHS(I)                                            0003590
       DES(I,2)=DES(I,1)-DEMISS(I)                                              0003600
       XX(I)=DES(I,2)                                                           0003610
    10 YY(I)=DALS(I,2)                                                          0003620
       CALL LIM                                                                 0003630
       DO 12 I=1,NEXND                                                          0003640
       ALS(I,LR1)=DALS(I,2)                                                     0003650
    12 EPS(I,LR1)=DES(I,2)                                                      0003660
       KRET=1                                                                   0003670
       CALL MRD1(KRET)                                                          0003680
       IF(KRET.EQ.2) GO TO 30                                                   0003690
       CALL OUTPUT(2)                                                           0003700
       IF ((IMAX1.EQ.IMAX).AND.(KMAX1.EQ.KMAX).AND.(LMAX1 .EQ. LMAX)) GO        0003710
```

```
     1TO 25                                                                    0003720
      JJ2=LR1-1                                                                0003730
      DO 15 I=1,NEXND                                                          0003740
      DALS(I,1)=DALS(I,2)                                                      0003750
      DES(I,1)=DES(I,2)                                                        0003760
      DO 15 J=1,JJ2                                                            0003770
      ALS(I,J)=ALS(I,J)+DALS(I,2)-YY(I)                                        0003780
   15 EPS(I,J)=EPS(I,J)+DES(I,2)-XX(I)                                         0003790
      ICNT=1                                                                   0003800
      LG=LG2                                                                   0003810
      BETA1 = BETA                                                             0003820
      IMAX1 = IMAX                                                             0003830
      KMAX1 = KMAX                                                             0003840
      LMAX1 = LMAX                                                             0003850
      GO TO 35                                                                 0003860
   25 ICNT=0                                                                   0003870
      IF(LG.GT.MAXG) GO TO 30                                                  0003880
      GO TO 35                                                                 0003890
   30 ICNT=2                                                                   0003900
   35 RETURN                                                                   0003910
      END                                                                      0003920
```

```
$IBFTC INVRSE  OD,REF,FULIST                                                    0003930
      SUBROUTINE INVRSE(ICNT)                                                   0003940
C                       COMMON ASSOCIATED WITH INPUT                            0003950
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0003960
      COMMON BOLTZ                                                              0003970
      COMMON CONDUC(34,44),CONVER(6)                                            0003980
      COMMON DELMIN,DELTA                                                       0003990
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0004000
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0004010
      COMMON KOAT(34)                                                           0004020
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                      0004030
      COMMON QFX(34,20)                                                         0004040
      COMMON RADTN(34,44)                                                       0004050
      COMMON SOLFX(34,20)                                                       0004060
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0004070
C                       SINGLE CELL COMMON                                      0004080
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0004090
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,         0004100
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0004110
C                       COMPUTED ARRAY COMMON                                   0004120
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0004130
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0004140
     1       DESTH(34)                                                          0004150
      COMMON EMLOW(34,6),EPS(34,40)                                             0004160
      COMMON IS(40)                                                             0004170
      COMMON KS(40)                                                             0004180
      COMMON LS(40)                                                             0004190
      COMMON NN(34)                                                             0004200
      COMMON PBA(34),PBE(34)                                                    0004210
      COMMON R(34)                                                              0004220
      COMMON SCRAT(34),SUMKT(34,20)                                             0004230
      COMMON TM(34,34)                                                          0004240
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0004250
      COMMON INT,IOT                                                            0004260
      DIMENSION EMAX(34),X(34),ERROR(34)                                        0004270
      IA1=NNODE+1                                                               0004280
      IA2=NNODE+NCTN                                                            0004290
      IF(NCTN.EQ.0) GO TO 11                                                    0004300
      DO 10 I=IA1,IA2                                                           0004310
      TMAX1=T(I,1)                                                              0004320
      IF(NORB.EQ.1) GO TO 9                                                     0004330
      DO 5 K=2,NORB                                                             0004340
      IF(TMAX1.GT.T(I,K)) GO TO 5                                               0004350
      TMAX1=T(I,K)                                                              0004360
    5 CONTINUE                                                                  0004370
    9 TEMMAX(I)=TMAX1                                                           0004380
   10 TINTL(I)=TMAX1                                                            0004390
   11 DO 20 I=1,NNODE                                                           0004400
      EMAX1=EMLOW(I,1)                                                          0004410
      IF(I.LE.NEXND) GO TO 12                                                   0004420
      EMAX(I)=0.                                                                0004430
```

```
      GO TO 20                                                          0004440
   12 DO 15 NA=2,4                                                      0004450
      IF(EMAX1.LT.EMLOW(I,NA)) EMAX1=EMLOW(I,NA)                        0004460
   15 CONTINUE                                                          0004470
      EMAX(I)=EMAX1                                                     0004480
   20 CONTINUE                                                          0004490
C                        CALCULATION OF X VALUES                       0004500
      DO 35 I=1,NNODE                                                   0004510
      IF(NOS.EQ.1) GO TO 28                                             0004520
      IF(NCTN.LE.0) GO TO 28                                            0004530
      SUM2=0.                                                           0004540
      DO 25 J=IA1,IA2                                                   0004550
   25 SUM2=SUM2-CONDUC(I,J)                                             0004560
   28 SUM1=0.                                                           0004570
      DO 30 J=1,IA2                                                     0004580
      IF(I.EQ.J) GO TO 30                                               0004590
      SUM1=SUM1+RADTN(I,J)*((TEMMAX(I)+TEMMAX(J))*(TEMMAX(I)**2+TEMMAX(J 0004600
     1)**2)-((TINTL(I)+TINTL(J))*(TINTL(I)**2+TINTL(J)**2)))            0004610
   30 CONTINUE                                                          0004620
      X(I)=4.*EXAREA(I)*EMAX(I)*(TEMMAX(I)**3-TINTL(I)**3)-SUM1         0004630
      IF(NOS.EQ.1) GO TO 35                                             0004640
      ARG1=.5*(X(I)-CONDUC(I,I))                                        0004650
      ARG2=-SUM1-SUM2                                                   0004660
      X(I)=AMAX1(ARG1,SUM2,ARG2,0.)                                     0004670
   35 CONTINUE                                                          0004680
      DO 45 I=1,NNODE                                                   0004690
      SUM1=0.                                                           0004700
      DO 40 J=1,IA2                                                     0004710
      IF(I.EQ.J) GO TO 40                                               0004720
      AT(I,J)=CONDUC(I,J)+RADTN(I,J)*(TINTL(I)+TINTL(J))*(TINTL(I)**2+TI 0004730
     1NTL(J)**2)                                                        0004740
      SUM1=SUM1+AT(I,J)                                                 0004750
   40 CONTINUE                                                          0004760
   45 AT(I,I)=-SUM1+4.*EXAREA(I)*EMAX(I)*TINTL(I)**3+X(I)               0004770
      LER=0                                                             0004780
      DO 55 I=1,NNODE                                                   0004790
      IF(AT(I,I).GT.1.E-14) GO TO 55                                    0004800
      LER=1                                                             0004810
   55 CONTINUE                                                          0004820
      IF(LER.EQ.1) GO TO 80                                             0004830
      DO 65 I=1,NNODE                                                   0004840
      R(I)=0.                                                           0004850
      DO 65 J=1,NNODE                                                   0004860
   65 R(I)=R(I)+AT(I,J)                                                 0004870
      CALL MTINV(AT,NNODE,NNODE,34,SCRAT)                               0004880
      DO 75 I=1,NNODE                                                   0004890
      ERROR(I)=0.                                                       0004900
      DO 75 J=1,NNODE                                                   0004910
   75 ERROR(I)=ERROR(I)+AT(I,J)*R(J)                                    0004920
      WRITE(IOT,103)                                                    0004930
      WRITE(IOT,102)                                                    0004940
```

```
      WRITE(IOT,101)(NN(I),ERROR(I),I=1,NNODE)                          0004950
      GO TO 90                                                          0004960
   80 WRITE(IOT,103)                                                    0004970
      WRITE(IOT,100)                                                    0004980
      WRITE(IOT,101)(NN(I),AT(I,I),I=1,NNODE)                           0004990
      ICNT=2                                                            0005000
   90 RETURN                                                            0005010
  100 FORMAT(9X30HDIAGONAL NOT GREATER THAN ZERO///12X4HNODE,16X,1HB/)   0005020
  101 FORMAT(I15,1PE24.8)                                               0005030
  102 FORMAT(9X18HERROR IN INVERSION///12X4HNODE,14X,5HERROR/)          0005040
  103 FORMAT(1H1)                                                       0005050
      END                                                               0005060
```

```
$IBFTC INPUT   FULIST,REF,DD                                                    0005070
      SUBROUTINE INPUT                                                          0005080
C                       COMMON ASSOCIATED WITH INPUT                            0005090
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0005100
      COMMON BOLTZ                                                              0005110
      COMMON CONDUC(34,44),CONVER(6)                                            0005120
      COMMON DELMIN,DELTA                                                       0005130
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0005140
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0005150
      COMMON KOAT(34)                                                           0005160
      COMMON NCOAT,NCTN,NEXNO,NNODE,NOPTN(5),NORB,NSTOP(5)                      0005170
      COMMON QFX(34,20)                                                         0005180
      COMMON RADTN(34,44)                                                       0005190
      COMMON SOLFX(34,20)                                                       0005200
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0005210
C                       SINGLE CELL COMMON                                      0005220
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0005230
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,         0005240
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0005250
C                       COMPUTED ARRAY COMMON                                   0005260
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0005270
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0005280
     1       DESTH(34)                                                          0005290
      COMMON EMLOW(34,6),EPS(34,40)                                             0005300
      COMMON IS(40)                                                             0005310
      COMMON KS(40)                                                             0005320
      COMMON LS(40)                                                             0005330
      COMMON NN(34)                                                             0005340
      COMMON PBA(34),PBE(34)                                                    0005350
      COMMON R(34)                                                              0005360
      COMMON SCRAT(34),SUMKT(34,20)                                             0005370
      COMMON TM(34,34)                                                          0005380
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0005390
      COMMON INT,IOT                                                            0005400
      DIMENSION NCOL(3),NROW(3),VALUE(8)                                        0005410
    2 READ(INT,101) (TITLE(I),I=1,12)                                           0005420
      WRITE(IOT,300)                                                            0005430
      WRITE(IOT,101) (TITLE(I),I=1,12)                                          0005440
      WRITE(IOT,200)                                                            0005450
C                       ZERO OUT ALL PREVIOUS INPUT                             0005460
  400 DO 250 J1=1,34                                                            0005470
      TINTL(J1)=0.                                                              0005480
      TEMMAX(J1)=0.                                                             0005490
      TL(J1)=0.                                                                 0005500
      TU(J1)=0.                                                                 0005510
      HEATKA(J1)=0.                                                             0005520
      HEATKE(J1)=0.                                                             0005530
      HEATKQ(J1)=0.                                                             0005540
      HEATKS(J1)=0.                                                             0005550
      EXAREA(J1)=0.                                                             0005560
      EMIS(J1)=0.                                                               0005570
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```
      ALPA(J1)=0.                                                       0005580
      KOAT(J1)=0                                                        0005590
      DO 250 J2=1,20                                                    0005600
      ALPFX(J1,J2)=0.                                                   0005610
      EARFX(J1,J2)=0.                                                   0005620
      QFX(J1,J2)=0.                                                     0005630
  250 SOLFX(J1,J2)=0.                                                   0005640
      DO 251 J1=1,4                                                     0005650
      DO 251 J2=1,10                                                    0005660
      ASPEC(J1,J2)=0.                                                   0005670
  251 ESPEC(J1,J2)=0.                                                   0005680
  450 DO 252 J1=1,34                                                    0005690
  460 DO 252 J2=1,44                                                    0005700
      CONDUC(J1,J2)=0.                                                  0005710
      RADTN(J1,J2)=0.                                                   0005720
  252 CONTINUE                                                          0005730
      DO 1000 J1=1,44                                                   0005740
      DO 1000 J2=1,20                                                   0005750
 1000 T(J1,J2)=0.                                                       0005760
      DO 253 J1=1,5                                                     0005770
      CONVER(J1)=0.                                                     0005780
      NSTOP(J1)=0                                                       0005790
  253 NOPTN(J1)=0                                                       0005800
      CONVER(6)=0.                                                      0005810
      BOLTZ=0.                                                          0005820
      DELTA=0.                                                          0005830
      DELMIN=0.                                                         0005840
      NCOAT=0                                                           0005850
      NCTN=0                                                            0005860
      NEXND=0                                                           0005870
      NNODE=0                                                           0005880
      NORB=0                                                            0005890
C                     READ IN TOTAL NUMBERS OF NODES                    0005900
      READ (INT,102)NNODE,NORB,NCTN,NCOAT,NEXND                         0005910
      WRITE(IOT,201) NNODE                                              0005920
      WRITE(IOT,202) NORB                                               0005930
      WRITE(IOT,203) NCTN                                               0005940
      WRITE(IOT,204) NCOAT                                              0005950
      WRITE(IOT,205)NEXND                                               0005960
C                     READ IN STEP SIZES AND S.B. CONSTANT              0005970
      READ(INT,103)DELTA,DELMIN,BOLTZ                                   0005980
      WRITE(IOT,206)DELTA                                               0005990
      WRITE(IOT,207)DELMIN                                              0006000
      WRITE(IOT,208)BOLTZ                                               0006010
C                     READ CONTROL STOPS                                0006020
      READ(INT,104)(NSTOP(I),I=1,5)                                     0006030
      IF((NSTOP(1) .EQ.1) .OR.(NSTOP(2).EQ.1) .OR.(NSTOP(3).EQ.1))      0006040
     1GO TO 254                                                         0006050
      IF(NSTOP(4) .EQ. 0) GO TO 261                                     0006060
  254 WRITE(IOT,209)                                                    0006070
      DO 260 I=1,4                                                      0006080
```

```
      IA=1                                                              0006090
      IF(NSTOP(I).EQ.0) GO TO 260                                       0006100
      GO TO (255,256,257,258),IA                                        0006110
  255 WRITE(IOT,232)                                                    0006120
      GO TO 260                                                         0006130
  256 WRITE(IOT,233)                                                    0006140
      GO TO 260                                                         0006150
  257 WRITE(IOT,234)                                                    0006160
      GO TO 260                                                         0006170
  258 WRITE(IOT,235)                                                    0006180
  260 CONTINUE                                                          0006190
C                     READ PROGRAM OPTION CONTROLS                    0006200
  261 READ(INT,104) (NOPTN(I),I=1,5)                                    0006210
      IF(( NOPTN(1).EQ.0) .AND. (NOPTN(2).EQ.0) .AND.(NOPTN(3).EQ.0))   0006220
     1 GO TO 275                                                        0006230
      WRITE(IOT,210)                                                    0006240
      DO 270 I=1,3                                                      0006250
      IA=I                                                              0006260
      IF(NOPTN(I) .EQ. 0) GO TO 270                                     0006270
      GO TO (264,265,266),IA                                            0006280
  264 WRITE(IOT,236)                                                    0006290
      GO TO 270                                                         0006300
  265 WRITE(IOT,237)                                                    0006310
      GO TO 270                                                         0006320
  266 WRITE(IOT,238)                                                    0006330
  270 CONTINUE                                                          0006340
C                     READ CONVERGENCE CRITERIA CONTROLS              0006350
  275 READ(INT,105) (CONVER(I),I=1,6)                                   0006360
      WRITE(IOT,211) CONVER(1)                                          0006370
      WRITE(IOT,212) CONVER(2)                                          0006380
      DTEMP=CONVER(1)                                                   0006390
      DR=CONVER(2)                                                      0006400
      ITERMX=CONVER(3)                                                  0006410
      MAXG=CONVER(4)                                                    0006420
      NCONV=CONVER(5)                                                   0006430
      NOS=CONVER(6)                                                     0006440
      WRITE(IOT,213) ITERMX,MAXG,NOS                                    0006450
      NN1 = 1                                                           0006460
      IF (NNODE-40) 5,5,4                                               0006470
    4 IF (NNODE-80) 6,6,7                                               0006480
    5 KN = 3                                                            0006490
      NN2 = NNODE                                                       0006500
      GO TO 8                                                           0006510
    6 KN = 2                                                            0006520
      NN2 = NNODE/2                                                     0006530
      GO TO 8                                                           0006540
    7 KN = 1                                                            0006550
      NN2 = NNODE/3                                                     0006560
C                     WRITE NODE SPECIFICATIONS HEADER                0006570
    3 WRITE(IOT,300)                                                    0006580
      WRITE(IOT,214)                                                    0006590
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      WRITE(IOT,215)                                                    0006600
      DO 10 I = NN1,NN2                                                 0006610
      READ(INT,106)ND,TL(ND),TU(ND),ALPA(ND),EMIS(ND),EXAREA(ND),HEATKS( 0006620
     1ND),HEATKA(ND),HEATKE(ND),HEATKQ(ND),TINTL(ND),TEMMAX(ND),KOAT(ND) 0006630
   10 WRITE(IOT,216)ND,TL(ND),TU(ND),ALPA(ND),EMIS(ND),EXAREA(ND),HEATKS 0006640
     1(ND),HEATKA(ND),HEATKE(ND),HEATKQ(ND),TINTL(ND),TEMMAX(ND),KOAT(ND 0006650
     2)                                                                 0006660
      GO TO (11,12,15),KN                                               0006670
   11 KN = 2                                                            0006680
      NN1 = NN2+1                                                       0006690
      NN2 = 2*NN2                                                       0006700
      GO TO 8                                                           0006710
   12 KN = 3                                                            0006720
      NN1 = NN2+1                                                       0006730
      NN2 = NNODE                                                       0006740
      GO TO 8                                                           0006750
   15 KOUNT = 11                                                        0006760
C                     READ CONDUCTION INTER-CONNECTIONS                 0006770
   16 READ(INT,107) (NCOL(I),NROW(I),VALUE(I),I=1,3)                    0006780
      IF (NCOL(1)) 21,21,17                                             0006790
   17 IF(KOUNT-11) 18,18,19                                             0006800
   18 WRITE(IOT, 300)                                                   0006810
      WRITE(IOT,217)                                                    0006820
      WRITE(IOT,218)                                                    0006830
      WRITE(IOT,219)                                                    0006840
   19 KOUNT = KOUNT+1                                                   0006850
      WRITE(IOT,220)(NCOL(I),NROW(I),VALUE(I),I = 1,3)                  0006860
      DO 20 I = 1,3                                                     0006870
      I1 = NCOL(I)                                                      0006880
      I2 = NROW(I)                                                      0006890
   20 CONDUC(I1,I2) = VALUE(I)                                          0006900
      IF (KOUNT-48) 16,15,15                                            0006910
C                     READ RADIATION INTER-CONNECTIONS                  0006920
   21 IF(KOUNT-11) 31,31,29                                             0006930
   29 IF(KOUNT-32) 32,32,30                                             0006940
   30 KOUNT=11                                                          0006950
   31 KFIRST=2                                                          0006960
      GO TO 33                                                          0006970
   32 KOUNT = KOUNT+8                                                   0006980
      KFIRST=1                                                          0006990
   33 READ(INT,107)(NCOL(I),NROW(I),VALUE(I),I = 1,3)                   0007000
      IF (NCOL(1)) 40,40,34                                             0007010
   34 IF(KFIRST .EQ. 1) GO TO 35                                        0007020
      IF(KOUNT-11) 36,35,38                                             0007030
   35 KFIRST=2                                                          0007040
      GO TO 37                                                          0007050
   36 WRITE(IOT,300)                                                    0007060
   37 WRITE(IOT,221)                                                    0007070
      WRITE(IOT,222)                                                    0007080
      WRITE(IOT,219)                                                    0007090
   38 WRITE(IOT,220)(NCOL(I),NROW(I),VALUE(I),I = 1,3)                  0007100
```

```
      KOUNT = KOUNT+1                                                    0007110
      DO 39 I = 1,3                                                      0007120
      I1 = NCOL(I)                                                       0007130
      I2 = NROW(I)                                                       0007140
   39 RADTN(I1,I2) = VALUE(I)                                            0007150
      IF (KOUNT-48) 33,31,31                                             0007160
   40 KOUNT = 7                                                          0007170
C                        READ IN ORBIT                                   0007180
   41 READ(INT,108)KORB                                                  0007190
      KN = 0                                                             0007200
      IF (KORB) 70,70,42                                                 0007210
   42 IF (KOUNT-7) 43,43,44                                              0007220
   43 WRITE (IOT,300)                                                    0007230
   44 WRITE(IOT,223)KORB                                                 0007240
      WRITE(IOT,224)                                                     0007250
      IF (KN) 45,45,52                                                   0007260
C                        READ IN NODE WITH THE CORRESPONDING            0007270
C                        ENVIRONMENTAL AND INTERNAL HEATING             0007280
   45 NN1 = 1                                                            0007290
      IF (NNODE+KOUNT-48) 47,47,46                                       0007300
   46 IF (NNODE+KOUNT-96) 48,48,50                                       0007310
   47 NN2 = NNODE                                                        0007320
      KN = 3                                                             0007330
      GO TO 52                                                           0007340
   48 NN2 = NNODE/2                                                      0007350
      KN = 2                                                             0007360
      GO TO 52                                                           0007370
   50 NN2 = NNODE/3                                                      0007380
      KN = 1                                                             0007390
   52 DO 55 J = NN1,NN2                                                  0007400
      READ(INT,109)NCOL(1),(VALUE(I),I = 1,4)                            0007410
      WRITE(IOT,225)NCOL(1),(VALUE(I),I = 1,4)                           0007420
      KOUNT = KOUNT+1                                                    0007430
      I1 = NCOL(1)                                                       0007440
      SOLFX(I1,KORB) = VALUE(1)                                          0007450
      ALPFX(I1,KORB) = VALUE(2)                                          0007460
      EARFX(I1,KORB) = VALUE(3)                                          0007470
   55 QFX(I1,KORB) = VALUE(4)                                            0007480
      GO TO (57,59,62),KN                                                0007490
   57 NN1 = NN2+1                                                        0007500
      NN2 = 2*NN2                                                        0007510
      KN = 2                                                             0007520
      GO TO 43                                                           0007530
   59 NN1 = NN2+1                                                        0007540
      NN2 = NNODE                                                        0007550
      KN = 3                                                             0007560
      GO TO 43                                                           0007570
   62 IF (KOUNT+NNODE+7-48) 63,63,40                                     0007580
   63 KOUNT = KOUNT+7                                                    0007590
      GO TO 41                                                           0007600
   70 KOUNT = 6                                                          0007610
```

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C                       READ IN KNOWN TEMPERATURE NODES                  0007620
   71 READ(INT,110)NCOL(1),NROW(1),VALUE(1)                              0007630
      IF (NCOL(1)) 85,85,75                                              0007640
   75 IF (KOUNT-6) 77,77,80                                              0007650
   77 WRITE(IOT,300)                                                     0007660
      WRITE(IOT,226)                                                     0007670
   80 WRITE(IOT,227) NCOL(1),NROW(1),VALUE(1)                            0007680
      I1 = NCOL(1)                                                       0007690
      I2 = NROW(1)                                                       0007700
      T(I1,I2) = VALUE(1)                                                0007710
      KOUNT = KOUNT+1                                                    0007720
      IF (KOUNT-48) 71,70,70                                             0007730
C                       READ IN COATING SPECIFICATIONS                   0007740
   85 KOUNT = 6                                                          0007750
   86 READ(INT,111)KOATN,(VALUE(I),I = 1,8)                              0007760
C                       TEST TO SEE IF THERE ARE MORE INPUT VALUES       0007770
      IF (KOATN) 95,95,87                                                0007780
   87 IF (KOUNT-6) 88,88,89                                              0007790
   88 WRITE(IOT,300)                                                     0007800
      WRITE(IOT,228)                                                     0007810
   89 WRITE(IOT,229)KOATN,(VALUE(I),I = 1,8)                             0007820
      KOUNT = KOUNT+1                                                    0007830
      DO 90 I = 1,4                                                      0007840
      NSUB = 2*I                                                         0007850
      ASPEC(I,KOATN) = VALUE(NSUB-1)                                     0007860
   90 ESPEC(I,KOATN) = VALUE(NSUB)                                       0007870
      IF (KOUNT-48) 86,95,85                                             0007880
   95 READ(INT,112) USMRD,DSMRD,USTRN,DSTRN                              0007890
      WRITE(IOT,300)                                                     0007900
      WRITE(IOT,239) USMRD,DSMRD,USTRN,DSTRN                             0007910
      IF(NOPTN(1).EQ.1) GO TO 26                                         0007920
      IF((NSTOP(2).EQ.0) .AND. (NSTOP(3).EQ.0)) GO TO 98                 0007930
      IF(NSTOP(2).EQ.0) GO TO 23                                         0007940
      KSTOP=0                                                            0007950
      DO 22 I=1,NNODE                                                    0007960
      JJ1=I                                                              0007970
      DO 22 J=JJ1,NNODE                                                  0007980
      IF(ABS(CONDUC(I,J)-CONDUC(J,I)) .LT.1.E-4) GO TO 22                0007990
      KSTOP=1                                                            0008000
      WRITE(IOT,300)                                                     0008010
      WRITE(IOT,230) I,J,J,I,CONDUC(I,J),CONDUC(J,I)                     0008020
   22 CONTINUE                                                           0008030
      IF(NSTOP(3).EQ.0) GO TO 25                                         0008040
   23 LSTOP=0                                                            0008050
      DO 24 I=1,NNODE                                                    0008060
      JJ1=I                                                              0008070
      DO 24 J=JJ1,NNODE                                                  0008080
      IF(ABS(RADTN(I,J)-RADTN(J,I)) .LT.1.E-4) GO TO 24                  0008090
      LSTOP=1                                                            0008100
      WRITE(IOT,300)                                                     0008110
      WRITE(IOT,231) I,J,J,I,RADTN(I,J),RADTN(J,I)                       0008120
```

```
   24 CONTINUE                                                                  0008130
   25 IF((LSTOP.EQ.1) .OR. (KSTOP.EQ.1)) GO TO 2                                0008140
      GO TO 98                                                                  0008150
C                       SET K(J,I) AND R(J,I) EQUAL TO                         0008160
C                       K(I,J) AND R(I,J) RESPECTIVELY                         0008170
   26 DO 600   I=1,NNODE                                                        0008180
      DO 600   J=1,NNODE                                                        0008190
      IF(CONDUC(I,J).EQ.CONDUC(J,I)) GOTO 550                                   0008200
      IF(CONDUC(I,J).EQ.0.0.AND.CONDUC(J,I).NE.0.0) GOTO 530                    0008210
      CONDUC(J,I)=CONDUC(I,J)                                                   0008220
      GOTO 550                                                                  0008230
  530 CONDUC(I,J)=CONDUC(J,I)                                                   0008240
  550 IF(RADTN(I,J).EQ.RADTN(J,I)) GOTO 600                                     0008250
      IF(RADTN(I,J).EQ.0.0.AND.RADTN(J,I).NE.0.0) GOTO 580                      0008260
      RADTN(J,I)=RADTN(I,J)                                                     0008270
      GOTO 600                                                                  0008280
  580 RADTN(I,J)=RADTN(J,I)                                                     0008290
  600 CONTINUE                                                                  0008300
   98 RETURN                                                                    0008310
C                       FORMAT STATEMENTS FOR READING INPUT                    0008320
  100 FORMAT (I2)                                                               0008330
  101 FORMAT (12A6)                                                             0008340
  102 FORMAT (5I2)                                                              0008350
  103 FORMAT (F5.3,F7.5,E14.8)                                                  0008360
  104 FORMAT (5I1)                                                              0008370
  105 FORMAT(6F8.5)                                                             0008380
  106 FORMAT(I2,4F6.2,F7.2,4F6.2,2F5.4,I3)                                      0008390
  107 FORMAT (2I5,F12.3,2I5,F12.3,2I5,F12.3)                                    0008400
  108 FORMAT (I3)                                                               0008410
  109 FORMAT (I2,F19.5,3F16.5)                                                  0008420
  110 FORMAT (I2,I3,F16.5)                                                      0008430
  111 FORMAT (I2,8F8.4)                                                         0008440
  112 FORMAT(4F6.3)                                                             0008450
C                       FORMAT STATEMENTS FOR WRITING INPUT                    0008460
  200 FORMAT (///53X25HCOATING SELECTION PROGRAM///)                            0008470
  201 FORMAT (9X18HNUMBER OF NODES  =I4//)                                      0008480
  202 FORMAT (9X18HNUMBER OF ORBITS =I4//)                                      0008490
  203 FORMAT (9X39HNUMBER OF CONSTANT TEMPERATURE NODES  =I4//)                 0008500
  204 FORMAT (9X20HNUMBER OF COATINGS =I3//)                                    0008510
  205 FORMAT (9X26HNUMBER OF EXTERNAL NODES =I3//)                              0008520
  206 FORMAT (9X28HINITIAL STEP SIZE  (DELTA) =F7.3//)                          0008530
  207 FORMAT (9X33HMINIMUM STEP SIZE  (DELTA-MIN)  =F8.5//)                     0008540
  208 FORMAT (9X28HSTEPHAN BOLTZMANN CONSTANT =1PE17.8///)                      0008550
  209 FORMAT(9X24HTHE PROGRAM WILL STOP IF//)                                   0008560
  210 FORMAT(9X16HTHE PROGRAM WILL//)                                           0008570
  211 FORMAT (9X55HALLOWABLE TEMPERATURE ERROR IN SOLVING HEAT BALANCE          0008580
     1 =1PE18.8//)                                                              0008590
  212 FORMAT(9X39HALLOWABLE DEVIATION FROM THE RESIDUAL =1PE18.8//)             0008600
  213 FORMAT(9X58HMAXIMUM NUMBER OF ITERATIONS FOR SOLUTION OF TEMPERATU        0008610
     1RE =I4///9X19HMAXIMUM G ALLOWED =I4//9X52HSTABILITY OPTION FOR SOL        0008620
     1VING HEAT BALANCE EQUATION =I3//)                                         0008630
```

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214 FORMAT (55X18HNODE SPECIFICATION)                                          0008640
215 FORMAT (128H NODE    TEMPERATURE LIMITS       COATING ESTIMATES  EX      0008650
   1TERNALLY          HEAT FLUX MULTIPLIES OF      INITIAL   MAX TEMP       0008660
   2 COATING/9X,118HLOWER          UPPER        ALPHA   EPSILON  EXPOSED     0008670
   3AREA   SOLAR   ALBEDO   EARTH  INTERNAL   TEMP      EXPECTED   NUMB     0008680
   4ER//)                                                                     0008690
216 FORMAT(I4,2F13.5,F10.5,F9.5,1PE14.6,0P2F8.2,F9.2,F8.2,2F11.2,I7)          0008700
217 FORMAT(//51X,28HCONDUCTION INTER-CONNECTIONS///)                          0008710
218 FORMAT (2X4HFROM,4X,2HTO,5X,17HCONDUCTION INTER-,7X,4HFROM,4X,2HTO       0008720
   1,5X,17HCONDUCTION INTER-,7X,10HFROM     TO,5X,17HCONDUCTION INTER-)      0008730
219 FORMAT (2X4HNODE,3X,4HNODE,7X,10HCONNECTION,11X,11HNODE   NODE,7X,       0008740
   110HCONNECTION,11X,11HNODE   NODE,7X,10HCONNECTION//)                      0008750
220 FORMAT (I5,I7,1PE20.7,I12,I7,E20.7,I12,I7,E21.6)                          0008760
221 FORMAT(//52X,27HRADIATION INTER-CONNECTIONS///)                           0008770
222 FORMAT (2X4HFROM,4X,2HTO,6X,16HRADIATION INTER-,7X,4HFROM,4X,2HTO,       0008780
   16X,16HRADIATION INTER-,7X,10HFROM     TO,6X,16HRADIATION INTER-)          0008790
223 FORMAT (24X34HENVIRONMENTAL AND INTERNAL HEATING,12X,5HORBIT15//)         0008800
224 FORMAT (1X18HNODE    SOLAR FLUX,10X,11HALBEDO FLUX,9X,10HEARTH FLU       0008810
   1X,10X,15HHEAT GENERATION//)                                               0008820
225 FORMAT (I4,F14.4,F21.5,F19.4,F22.4)                                       0008830
226 FORMAT (6X23HKNOWN TEMPERATURE NODES//2X29HNODE     ORBIT       TEMPE     0008840
   1RATURE//)                                                                 0008850
227 FORMAT (I5,I9,F16.5)                                                      0008860
228 FORMAT (44X22HCOATING SPECIFICATIONS/2X14HCOATING NUMBER,7X,13HLIM        0008870
   1IT POINT 1,8X,13HLIMIT POINT 2,7X,13HLIMIT POINT 3,8X,13HLIMIT POI       0008880
   2NT 4/21X79HALPHA     EPSILON     ALPHA     EPSILON    ALPHA     EPSI     0008890
   3LON     ALPHA     EPSILON)                                               0008900
229 FORMAT (I10,F18.6,F10.6,F11.6,3F10.6,F11.6,F10.6)                         0008910
230 FORMAT(9X,2HK(,I2,1H,I2,20H) IS NOT EQUAL TO K(I2,1H,I2,13H),     K(      0008920
   1I,J)=1PE13.7,4X,7HK(J,I)=E13.7)                                           0008930
231 FORMAT(9X,2HR(I2,1H,I2,20H) IS NOT EQUAL TO R(I2,1H,I2,13H),     R(      0008940
   1I,J)=1PE13.7,4X,7HR(J,I)=E13.7)                                           0008950
232 FORMAT(9X30HALL TEMPERATURES ARE WITHIN THEIR ALLOWABLE LIMITS//)         0008960
233 FORMAT(9X28HK(I,J) DOES NOT EQUAL K(J,I)//)                               0008970
234 FORMAT(9X28HR(I,J) DOES NOT EQUAL R(J,I)//)                               0008980
235 FORMAT(9X55HANY TEMPERATURE IS  LESS THAN 0 OR GREATER THAN 100000        0008990
   1.,////)                                                                   0009000
236 FORMAT(9X47HSET  K(I,J) = K(J,I)   AND   SET  R(I,J)=R(J,I)//)           0009010
237 FORMAT(9X56HMAKE FIRST ESTIMATE  OF  ABSORPTIVITIES AND EMISSIVITI       0009020
   1ES//)                                                                     0009030
238 FORMAT(9X35HPRINT ALL TEMPERATURES AT EACH STEP///)                       0009040
239 FORMAT(///50X,21HSTEP CHANGE PROCEDURE///27X6HIN MRD,53X,8HIN TREN       0009050
   1D///20X,19HINCREASE    DECREASE,41X,19HINCREASE    DECREASE//21X,F6.     0009060
   23,5X,F6.3,43X,F6.3,5X,F6.3)                                               0009070
300 FORMAT(1H1)                                                               0009080
    END                                                                       0009090
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$IBFTC LIM      EULIST,REF,DD                                                   0009100
       SUBROUTINE LIM                                                           0009110
C                       COMMON ASSOCIATED WITH INPUT                            0009120
       COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                 0009130
       COMMON BOLTZ                                                             0009140
       COMMON CONDUC(34,44),CONVER(6)                                           0009150
       COMMON DELMIN,DELTA                                                      0009160
       COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                      0009170
       COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                       0009180
       COMMON KOAT(34)                                                          0009190
       COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                     0009200
       COMMON QFX(34,20)                                                        0009210
       COMMON RADTN(34,44)                                                      0009220
       COMMON SOLFX(34,20)                                                      0009230
       COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)             0009240
C                       SINGLE CELL COMMON                                      0009250
       COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,         0009260
      1        BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,       0009270
      2        NOS,USMRD,DSMRD,USTRN,DSTRN                                     0009280
C                       COMPUTED ARRAY COMMON                                   0009290
       COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                   0009300
       COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),             0009310
      1        DESTH(34)                                                       0009320
       COMMON EMLOW(34,6),EPS(34,40)                                            0009330
       COMMON IS(40)                                                            0009340
       COMMON KS(40)                                                            0009350
       COMMON LS(40)                                                            0009360
       COMMON NN(34)                                                            0009370
       COMMON PBA(34),PBE(34)                                                   0009380
       COMMON R(34)                                                             0009390
       COMMON SCRAT(34),SUMK1(34,20)                                            0009400
       COMMON TM(34,34)                                                         0009410
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0009420
       COMMON INT,IC1                                                           0009430
       DO 35 I = 1,NNODE                                                        0009440
       DO 20 N = 1,5                                                            0009450
       N1 = N+1                                                                 0009460
       ARG1=(EMLOW(I,N1)-EMLOW(I,N))*(DALS(I,2)  -ALOW(I,N))                    0009470
       ARG2=(DES(I,2)  -EMLOW(I,N))*(ALOW(I,N1)-ALOW(I,N))                      0009480
       IF(ARG1.LT.ARG2) GO TO 20                                                0009490
       X=DES(I,2)                                                               0009500
       Y=DALS(I,2)                                                              0009510
       X1=(EMLOW(I,N1)-EMLOW(I,N))/(ALOW(I,N1)-ALOW(I,N))                       0009520
       Y1 = 1./X1                                                               0009530
       DUMMY=(DALS(I,2)-ALOW(I,N)*Y1*(EMLOW(I,N)-X))/(X1*Y1)                    0009540
       DES(I,2)=X+DUMMY                                                         0009550
       DALS(I,2)=Y-X1*DUMMY                                                     0009560
       IF (N.EQ.1) GO TO 20                                                     0009570
       N2 = N-1                                                                 0009580
       ARG1=(EMLOW(I,N)-EMLOW(I,N2))*(DALS(I,2)  -ALOW(I,N2))                   0009590
       ARG2=(DES(I,2)  -EMLOW(I,N2))*(ALOW(I,N)-ALOW(I,N2))                     0009600
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      IF(ARG1.LE.ARG2) GO TO 20                                          0009610
      DES(I,2)=EMLOW(I,N)                                                0009620
      DALS(I,2)=ALOW(I,N)                                                0009630
      GO TO 30                                                           0009640
   20 CONTINUE                                                           0009650
   30 ALPA(I)=DALS(I,2)                                                  0009660
      EMIS(I)=DES(I,2)                                                   0009670
   35 CONTINUE                                                           0009680
   40 RETURN                                                             0009690
      END                                                                0009700
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$IBFTC MRD1     DD,REF,EV,IST                                                   0009710
      SUBROUTINE MRD1(KTM)                                                     0009720
C                       COMMON ASSOCIATED WITH INPUT                           0009730
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                 0009740
      COMMON BOLTZ                                                             0009750
      COMMON CONDUC(34,44),CONVER(6)                                           0009760
      COMMON DELMIN,DELTA                                                      0009770
      COMMON EAPFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                      0009780
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                       0009790
      COMMON KOAT(34)                                                          0009800
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                     0009810
      COMMON QFX(34,20)                                                        0009820
      COMMON RADTN(34,44)                                                      0009830
      COMMON SOLFX(34,20)                                                      0009840
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)             0009850
C                       SINGLE CELL COMMON                                     0009860
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,         0009870
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,        0009880
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                       0009890
C                       COMPUTED ARRAY COMMON                                  0009900
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                   0009910
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),             0009920
     1       DESTH(34)                                                         0009930
      COMMON EMLOW(34,6),EPS(34,40)                                            0009940
      COMMON IS(40)                                                            0009950
      COMMON KS(40)                                                            0009960
      COMMON LS(40)                                                            0009970
      COMMON NN(34)                                                            0009980
      COMMON PBA(34),PBE(34)                                                   0009990
      COMMON R(34)                                                             0010000
      COMMON SCRAT(34),SUMKT(34,20)                                            0010010
      COMMON TM(34,34)                                                         0010020
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES       0010030
      COMMON INT,IOT                                                           0010040
      DIMENSION TD(34,3),C(34),RR(34),SUM1(34),MAXL(34,20),THS(34,20)          0010050
      DIMENSION AMAXV(34,20)                                                   0010060
      KFIRST=KTM                                                               0010070
      IF(KFIRST .EQ. 1) GO TO 5                                                0010080
      LSC1=0                                                                   0010090
      LSC2=0                                                                   0010100
      IF(NSTOP(1) .EQ. 1) LSC1=1                                               0010110
      IF(NSTOP(4) .EQ. 1) LSC2=1                                               0010120
      IF(LSC1 .EQ. 0 .AND. LSC2 .EQ. 0 ) GO TO 4                               0010130
      IF(LSC1 .EQ. 0  .OR. LSC2 .EQ. 0 ) GO TO 1                               0010140
      LSCN=3                                                                   0010150
      GO TO 5                                                                  0010160
    1 IF(LSC1 .EQ. 0) GO TO 3                                                  0010170
      LSCN=1                                                                   0010180
      GO TO 5                                                                  0010190
    3 LSCN=2                                                                   0010200
      GO TO 5                                                                  0010210
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  4 LSCN=4                                                                    0010220
  5 IF(NSTEP.EQ.1) GO TO 30                                                   0010230
    KK1=1                                                                     0010240
    KK2=NORB                                                                  0010250
    GO TO 35                                                                  0010260
 30 KK1=KMAX                                                                  0010270
    KK2=KMAX                                                                  0010280
 35 DO 40 K=KK1,KK2                                                           0010290
    DO 40 I=1,NNODE                                                           0010300
 40 TRHS(I,K)=SUMT(I,K)+ ALPA(I)*SOLFX(I,K)+EMIS(I)*EARFX(I,K)                0010310
    DO 125 K=KK1,KK2                                                          0010320
    NITER=1                                                                   0010330
 45 DO 50 I=1,NNODE                                                           0010340
    IF(KFIRST.EQ.1) GO TO 48                                                  0010350
    TD(I,1)=TINTL(I)                                                          0010360
    GO TO 50                                                                  0010370
 48 TD(I,1)=T(I,K)                                                            0010380
 50 C(I)=TRHS(I,K)                                                            0010390
 55 DO 70 I=1,NNODE                                                           0010400
    SUM1(I)=0.                                                                0010410
    DO 60 J=1,NNODE                                                           0010420
    IF(CONDUC(I,J).EQ.0.0) GOTO 57                                            0010430
    SUM1(I)=SUM1(I)+CONDUC(I,J)*TD(J,1)                                       0010440
 57 IF(RADTN(I,J).EQ.0.0)  GOTO 60                                            0010450
    SUM1(I)=SUM1(I)+RADTN(I,J)*TD(J,1)**4                                     0010460
 60 CONTINUE                                                                  0010470
    SUM1(I)=SUM1(I)+EXAREA(I)*EMIS(I)*TD(I,1)**4                              0010480
 70 R(I)=C(I)-SUM1(I)                                                         0010490
    DO 80 I=1,NNODE                                                           0010500
    SUM2=0.                                                                   0010510
    DO 75 J=1,NNODE                                                           0010520
 75 SUM2=SUM2+AT(I,J)*R(J)                                                    0010530
    TD(I,2)=TD(I,1)+SUM2                                                      0010540
    IF(TD(I,2).GT.0.) GO TO 80                                                0010550
    GO TO (79,99,99,79),LSCN                                                  0010560
 79 TD(I,2)=0.                                                                0010570
 80 CONTINUE                                                                  0010580
    RMAX1=ABS(R(1))                                                           0010590
    TMAX1=ABS(TD(1,2)-TD(1,1))                                                0010600
    DO 90 I=2,NNODE                                                           0010610
    ARG1=ABS(R(I))                                                            0010620
    IF(ARG1.GT.RMAX1) RMAX1=ARG1                                              0010630
    ARG1=ABS(TD(I,2)-TD(I,1))                                                 0010640
    IF(ARG1.GT.TMAX1) TMAX1=ARG1                                              0010650
 90 CONTINUE                                                                  0010660
    IF(NCONV.EQ.2) GO TO 92                                                   0010670
    IF(TMAX1.GT.DTEMP) GO TO 94                                               0010680
    IF(NCONV.EQ.1) GO TO 120                                                  0010690
 92 IF(RMAX1.LE.DR) GO TO 120                                                 0010700
 94 NITER=NITER+1                                                             0010710
    IF((LG.EQ.1.AND.NITER.GT.5*ITERMX ).OR.(LG.GT.1.AND.NITER.GT.ITERM        0010720
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```
     1X)) GOTO 1                                                          00100730
      DO 95 I=1,NNODE                                                     00100740
      TD(I,3)=TD(I,1)                                                     00100750
   95 TD(I,1)=TD(I,2)                                                     00100760
      IF((LSCN.EQ.1) .OR. (LSCN.EQ.4)) GO TO 55                           00100770
C                     TEST FOR TEMPERATURE GREATER THAN 10000.          00100780
      DO 98 I=1,NNODE                                                     00100790
      IF(TD(I,1).GT.10000.) GO TO 99                                      00100800
   98 CONTINUE                                                            00100810
      GO TO 55                                                            00100820
   99 WRITE(IOT,200) I,K,TD(I,2)                                          00100830
      KTM=2                                                               00100840
      GO TO 500                                                           00100850
C                     A MAXIMUM NUMBER OF ITERATIONS REACHED            00100860
  100 WRITE(IOT, 203)   K                                                 00100870
      WRITE(IOT,201)                                                      00100880
      DO 105 I=1,NNODE                                                    00100890
      SUMT=0.                                                             00100900
      DO 103 J=1,NNODE                                                    00100910
  103 SUMT=SUMT+CONDUC(I,J)*TD(J,2)+RADTN(I,J)*TD(J,2)**4                 00100920
      SUMT=SUMT+EMIS(I)*EXAREA(I)*(TD(I,2)**4                             00100930
  105 RR(I)=ABS(C(I)-SUMT)                                                00100940
      DO 110 I=1,NNODE                                                    00100950
      DELTA1=ABS(TD(I,1)-TD(I,3))                                         00100960
      DELTA2=ABS(TD(I,2)-TD(I,1))                                         00100970
      DELRR=ABS(R(I)/RR(I))                                               00100980
      IF((DELRR.LT.1.00001) .AND. (DELRR.GT..99999)) GO TO 107            00100990
      ANUM=ABS(RR(I)/DR)                                                  00101000
      DELNR=(ALOG(ANUM))/(ALOG(DELRR))                                    00101010
      GO TO 108                                                           00101020
  107 DELNR=1.E20                                                         00101030
  108 DT12=DELTA1/DELTA2                                                  00101040
      IF((DT12.LT.1.00001) .AND. (DT12.GT..99999)) GO TO 109              00101050
      DELNT=ALOG(DELTA2/DTEMP)/ALOG(DT12)                                 00101060
      GO TO 110                                                           00101070
  109 DELNT=1.E20                                                         00101080
  110 WRITE(IOT,202) NN(I),DELTA1,DELTA2,DELNT,R(I),RR(I),DELNR           00101090
      KTM=2                                                               00101100
      GO TO 500                                                           00101110
C                     TEMPERATURE CONVERGED                             00101120
  120 DO 123 I=1,NNODE                                                    00101130
  123 T(I,K)=TD(I,2)                                                      00101140
      IF(NSTEP.EQ.0) GO TO 125                                            00101150
      NSTEP=0                                                             00101160
      GO TO 500                                                           00101170
  125 CONTINUE                                                            00101180
      IF(NSTEP.EQ.1) GO TO 165                                            00101190
C                     FIND MAXIMUM TEMPERATURE DIFFERENCE               00101200
C                     BETWEEN TEMP COMPUTED AND TEMP LIMIT              00101210
      IF(LSCN.EQ.4) GO TO 158                                             00101220
C                     TEST LIMITS                                       00101230
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      IOMIT=0                                                          0011240
      DO 153 I=1,NNODE                                                 0011250
      DO 153 K=1,NORB                                                  0011260
      IA=I                                                             0011270
      KA=K                                                             0011280
      GO TO(151,152,151),LSCN                                          0011290
  151 IF((T(I,K) .GE. TL(I)) .AND.(T(I,K) .LE. TU(I))) GO TO 153       0011300
      IOMIT=1                                                          0011310
      GO TO (153,152,152),LSCN                                         0011320
  152 IF((T(I,K) .LT. 0.) .OR. (T(I,K) .GT. 1.E+5)) GO TO 155          0011330
  153 CONTINUE                                                         0011340
      IF(IOMIT.EQ.1) GOTO 158                                          0011350
      GO TO (154,158,154),LSCN                                         0011360
  154 WRITE(IOT,303)                                                   0011370
      WRITE(IOT,300)                                                   0011380
      GOTO 158                                                         0011390
  155 WRITE(IOT,303)                                                   0011400
      WRITE(IOT,301) IA,KA,T(IA,KA)                                    0011410
  157 CALL OUTPUT(6)                                                   0011420
      KTM =2                                                           0011430
      GO TO 500                                                        0011440
  158 DO 162 I=1,NNODE                                                 0011450
      DENOM = TU(I)-TL(I)                                              0011460
      DO 162 K=1,NORB                                                  0011470
      DIFFU =     (T(I,K)-TU(I))                                       0011480
      DIFFL =     (TL(I)-T(I,K))                                       0011490
      IF(DIFFU.GT.DIFFL) GO TO 159                                     0011500
      MAXL(I,K)=1                                                      0011510
      AMAXV(I,K) = DIFFL/DENOM                                         0011520
      GO TO 160                                                        0011530
  159 MAXL(I,K)=2                                                      0011540
      AMAXV(I,K) = DIFFU/DENOM                                         0011550
  160 IF ((I.EQ.1).AND.(K.EQ.1)) GO TO 161                             0011560
C                       I AND J ARE BOTH NOT EQUAL TO 1                0011570
      IF (AMAXB.GT.AMAXV(I,K)) GO TO 162                               0011580
      AMAXB = AMAXV(I,K)                                               0011590
      IMAX = I                                                         0011600
      KMAX = K                                                         0011610
      GO TO 162                                                        0011620
C                       I AND J ARE EQUAL TO 1                         0011630
  161 IMAX=1                                                           0011640
      KMAX = 1                                                         0011650
      AMAXB = AMAXV(1,1)                                               0011660
  162 CONTINUE                                                         0011670
      LMAX=MAXL(IMAX,KMAX)                                             0011680
      BETA=AMAXB                                                       0011690
      GOTO (163,500,163,500),LSCN                                      0011700
  163 IF(IOMIT.EQ.1) GOTO 500                                          0011710
      CALL OUTPUT(6)                                                   0011720
      KTM=2                                                            0011730
      RETURN                                                           0011740
```

```
165 NSTEP=0                                                                    0011750
500 RETURN                                                                     0011760
200 FORMAT(9X24HTEMPERATURE OUT OF RANGE,6X,3HI =I3,3X,3HK =I3,7X,3HT          0011770
   1=F13.3)                                                                    0011780
201 FORMAT(10X22HCHANGE IN  TEMPERATURE,52X,8HRESIDUAL//9X34HPREVIOUS          0011790
   1ITERATION  THIS ITERATION,26X34HPREVIOUS ITERATION  THIS ITERATION         0011800
   2///2X,4HNODE,4X,8HDELTA T1,12X,8HDELTA T2,17X,5HDELNT,15X,2HR1,18X         0011810
   3,2HR2,15X,5HDELNR//)                                                       0011820
202 FORMAT(I5,1PE19.8,5E20.8)                                                  0011830
203 FORMAT(1H1,40X38HTEMPERATURE DID NOT CONVERGE FOR ORBIT I3///)              0011840
300 FORMAT(9X,35HALL TEMPERATURES FELL WITHIN LIMITS)                          0011850
301 FORMAT(73HTEMPERATURE FELL OUTSIDE THE RANGE OF GREATER THAN 0 AND         0011860
   1 LESS THAN 100000,2X,2HT(I2,1H,I2,2H)=F11.2)                               0011870
303 FORMAT(1H1)                                                                0011880
    END                                                                        0011890
```

```
$IBFTC MRD2     EULIST,REF,DD                                                   0011900
       SUBROUTINE MRD2(ITNT)                                                    0011910
C                       COMMON ASSOCIATED WITH INPUT                            0011920
       COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                 0011930
       COMMON BOLTZ                                                             0011940
       COMMON CONDUC(34,44),CONVER(6)                                           0011950
       COMMON DELMIN,DELTA                                                      0011960
       COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                      0011970
       COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                       0011980
       COMMON KOAT(34)                                                          0011990
       COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                     0012000
       COMMON QFX(34,20)                                                        0012010
       COMMON RADTN(34,44)                                                      0012020
       COMMON SOLFX(34,20)                                                      0012030
       COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(18),TL(34),TU(34)             0012040
C                       SINGLE CELL COMMON                                      0012050
       COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,         0012060
      1        BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,      0012070
      2        NOS,USMRD,DSMRD,USTRN,DSTRN                                     0012080
C                       COMPUTED ARRAY COMMON                                   0012090
       COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                   0012100
       COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),             0012110
      1        DESTH(34)                                                       0012120
       COMMON EMLOW(34,6),EPS(34,40)                                            0012130
       COMMON IS(40)                                                            0012140
       COMMON KS(40)                                                            0012150
       COMMON LS(40)                                                            0012160
       COMMON NN(34)                                                            0012170
       COMMON PBA(34),PBE(34)                                                   0012180
       COMMON R(34)                                                             0012190
       COMMON SCRAT(34),SUMKT(34,20)                                            0012200
       COMMON TM(34,34)                                                         0012210
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0012220
       COMMON INT,IOT                                                           0012230
       DIMENSION DA(34),DE(34)                                                  0012240
       SUMA = 0.                                                                0012250
       SUME = 0.                                                                0012260
       CALL ONEPT1                                                              0012270
       CALL OUTPUT(ITNT)                                                        0012280
       DO 1 I = 1,NEXND                                                         0012290
       SUMA = SUMA+PBA(I)**2                                                    0012300
     1 SUME = SUME+PBE(I)**2                                                    0012310
       AL = DELT/(SQRT(SUMA+SUME))                                              0012320
       IF(ITNT.EQ.7) GO TO 10                                                   0012330
       DO 5 I = 1,NEXND                                                         0012340
       DALPHS(I)=AL*PBA(I)                                                      0012350
     5 DEMISS(I)=AL*PBE(I)                                                      0012360
       LR=LR+1                                                                  0012370
       GO TO 30                                                                 0012380
    10 SUM1=0.                                                                  0012390
       DO 15 I=1,NEXND                                                          0012400
```

```
      DA(I)=AL*PBA(I)                                                   0012410
      DE(I)=AL*PBE(I)                                                   0012420
   15 SUM1=SUM1+DALPHS(I)*DA(I)+DEMISS(I)*DE(I)                         0012430
      IF(SUM1.GT. 0.) GO TO 25                                          0012440
      ITNT=0                                                            0012450
      LR=LR+1                                                           0012460
      DO 20 I=1,NEXND                                                   0012470
      DALPHS(I)=DA(I)                                                   0012480
   20 DEMISS(I)=DE(I)                                                   0012490
      GO TO 30                                                          0012500
   25 ITNT=1                                                            0012510
   30 RETURN                                                            0012520
      END                                                               0012530
```

```
$IBFTC MTINV                                                                    0012540
C                                  MATRIX INVERSION SUBROUTINE                  0012550
      SUBROUTINE MTINV(A,NRARG,NCARG,IDIM,LABEL)                                0012560
      DIMENSION A(IDIM,1),LABEL(IDIM)                                           0012570
    1 NR=NRARG                                                                  0012580
      NC=NCARG                                                                  0012590
      DO 21 J1=1,NR                                                             0012600
   21 LABEL(J1)=J1                                                              0012610
      DO 291 J1=1,NR                                                            0012620
C     FIND REMAINING ROW CONTAINING LARGEST ABSOLUTE VALUE IN PIVOTAL           0012630
C     COLUMN                                                                    0012640
  101 TEMP=0.0                                                                  0012650
      DO 121 J2=J1,NR                                                           0012660
      IF(ABS(A(J2,J1)).LT.TEMP) GO TO 121                                       0012670
      TEMP=ABS(A(J2,J1))                                                        0012680
      IBIG=J2                                                                   0012690
  121 CONTINUE                                                                  0012700
      IF(IBIG.EQ.J1) GO TO 201                                                  0012710
C     REARRANGE ROWS TO PLACE LARGEST ABSOLUTE VALUE IN PIVOT POSITION          0012720
      DO 141 J2=1,NC                                                            0012730
      TEMP=A(J1,J2)                                                             0012740
      A(J1,J2)=A(IBIG,J2)                                                       0012750
  141 A(IBIG,J2)=TEMP                                                           0012760
      I=LABEL(J1)                                                               0012770
      LABEL(J1)=LABEL(IBIG)                                                     0012780
      LABEL(IBIG)=I                                                             0012790
C     COMPUTE COEFFICIENTS IN PIVOTAL ROW                                       0012800
  201 TEMP=A(J1,J1)                                                             0012810
      A(J1,J1)=1.                                                               0012820
      DO 221 J2=1,NC                                                            0012830
  221 A(J1,J2)=A(J1,J2)/TEMP                                                    0012840
C     COMPUTE COEFFICIENTS IN OTHER ROWS                                        0012850
      DO 281 J2=1,NR                                                            0012860
      IF(J2.EQ.J1) GO TO 281                                                    0012870
      TEMP=A(J2,J1)                                                             0012880
      A(J2,J1)=0.                                                               0012890
      DO 241 J3=1,NC                                                            0012900
  241 A(J2,J3)=A(J2,J3)-TEMP*A(J1,J3)                                           0012910
  281 CONTINUE                                                                  0012920
  291 CONTINUE                                                                  0012930
C     INTERCHANGE COLUMNS ACCORDING TO INTERCHANGES OF ROWS OF                  0012940
C     ORIGINAL MATRIX                                                           0012950
  301 N1=NR-1                                                                   0012960
      DO 391 J1=1,N1                                                            0012970
      DO 321 J2=J1,NR                                                           0012980
      IF(LABEL(J2).NE.J1) GO TO 321                                             0012990
      IF(J2.EQ.J1) GO TO 391                                                    0013000
      GO TO 341                                                                 0013010
  321 CONTINUE                                                                  0013020
  341 DO 361 J3=1,NR                                                            0013030
      TEMP=A(J3,J1)                                                             0013040
```

```
      A(J3,J1)=A(J3,J2)                                          C013050
  341 A(J3,J2)=TEMP                                              C013060
      LABEL(J2)=LABEL(J1)                                        C013070
  391 CONTINUE                                                   C013080
 5001 RETURN                                                     C013090
      END                                                        C013100
```

```
$IBFTC ONEPT1  EUL IST,REF,DD                                                   0013110
      SUBROUTINE ONEPT1                                                         0013120
C                       COMMON ASSOCIATED WITH INPUT                            0013130
      COMMON ALPA(34),ALPFX(34,20),/SPEC(4,10)                                  0013140
      COMMON BOLTZ                                                              0013150
      COMMON CONDUC(34,44),CONVER(6)                                            0013160
      COMMON DELMIN,DELTA                                                       0013170
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0013180
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0013190
      COMMON KOAT(34)                                                           0013200
      COMMON NCOAT,NCTN,NEXND,NNODE,NUPTN(5),NORB,NSTOP(5)                      0013210
      COMMON QFX(34,20)                                                         0013220
      COMMON RADTN(34,44)                                                       0013230
      COMMON SOLFX(34,20)                                                       0013240
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0013250
C                       SINGLE CELL COMMON                                      0013260
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0013270
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,         0013280
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0013290
C                       COMPUTED ARRAY COMMON                                   0013300
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0013310
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0013320
     1       DESTH(34)                                                          0013330
      COMMON EMLOW(34,6),EPS(34,40)                                             0013340
      COMMON IS(40)                                                             0013350
      COMMON KS(40)                                                             0013360
      COMMON LS(40)                                                             0013370
      COMMON NN(34)                                                             0013380
      COMMON PBA(34),PBE(34)                                                    0013390
      COMMON R(34)                                                              0013400
      COMMON SCRAT(34),SUMKT(34,20)                                             0013410
      COMMON TM(34,34)                                                          0013420
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0013430
      COMMON INT,IOT                                                            0013440
      DIMENSION PTE(34),PTA(34),TFT(34,20),DUM11(34)                            0013450
      IF(( IMAX.EQ.IMAX2) .AND. (KMAX.EQ.KMAX2) .AND. (LMAX.EQ.LMAX2))          0013460
     1 GO TO 4                                                                  0013470
    2 IMAX2=IMAX                                                                0013480
      KMAX2=KMAX                                                                0013490
      LMAX2=LMAX                                                                0013500
      DO 3 I=1,NNODE                                                            0013510
      DO 3 K=1,NORB                                                             0013520
    3 TFT(I,K)=T(I,K)                                                           0013530
      GO TO 10                                                                  0013540
    4 DO 5 I=1,NNODE                                                            0013550
      DO 5 K=1,NORB                                                             0013560
      IF(ABS(T(I,K)-TFT(I,K)) .GT. (.01*TFT(I,K))) GO TO 2                      0013570
    5 CONTINUE                                                                  0013580
      GO TO 75                                                                  0013590
   10 JJ2=NNODE+NCTN                                                            0013600
      DO 12 J=1,JJ2                                                             0013610
```

```
   12 DUM11(J)=T(J,KMAX)**3                                                    0013620
      DO 25 I=1,NNODE                                                          0013630
      DO 25 J=1,NNODE                                                          0013640
      IF(I.EQ.J) GO TO 20                                                      0013650
      TM(I,J)=+CONDUC(I,J)+4.*RADTN(I,J)*DUM11(J)                              0013660
      GO TO 25                                                                 0013670
   20 TM(I,J)=CONDUC(I,I)+4.*(DUM11(I)*RADTN(I,I)+EMIS(I)*EXAREA(I)*DUM1       0013680
     1 1(I))                                                                   0013690
   25 CONTINUE                                                                 0013700
      CALL MTINV(TM,NNODE,NNODE,34,SCRAT)                                      0013710
C                          MPUTE P VALUES                                     0013720
      IF(LMAX .EQ. 1) GO TO 35                                                 0013730
      AMUL=1.                                                                  0013740
      GO TO 40                                                                 0013750
   35 AMUL=-1.                                                                 0013760
   40 DO 70 I = 1,NEXND                                                        0013770
      DEN=TU(I)-TL(I)                                                          0013780
      PTE(I) =TM(IMAX,I)*(-EXAREA(I)*(T(I,KMAX))**4+EARFX(I,KMAX))            0013790
      PTA(I)  = TM(IMAX,I)*(SOLFX(I,KMAX))                                    0013800
      PBE(I)=AMUL*PTE(I)/DEN                                                   0013810
      PBA(I)=AMUL*PTA(I)/DEN                                                   0013820
   70 CONTINUE                                                                 0013830
   75 RETURN                                                                   0013840
      END                                                                      0013850
```

```
$IBFTC OUTPUT  DD,REF,FULIST                                                    0013860
      SUBROUTINE OUTPUT(LOPT)                                                   0013870
C                       COMMON ASSOCIATED WITH INPUT                          0013880
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0013890
      COMMON BOLTZ                                                              0013900
      COMMON CONDUC(34,44),CONVER(6)                                            0013910
      COMMON DELMIN,DELTA                                                       0013920
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0013930
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0013940
      COMMON KOAT(34)                                                           0013950
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                      0013960
      COMMON QFX(34,20)                                                         0013970
      COMMON RADTN(34,44)                                                       0013980
      COMMON SOLFX(34,20)                                                       0013990
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0014000
C                       SINGLE CELL COMMON                                    0014010
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0014020
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,         0014030
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                       0014040
C                       COMPUTED ARRAY COMMON                                 0014050
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0014060
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0014070
     1       DESTH(34)                                                          0014080
      COMMON EMLOW(34,6),EPS(34,40)                                             0014090
      COMMON IS(40)                                                             0014100
      COMMON KS(40)                                                             0014110
      COMMON LS(40)                                                             0014120
      COMMON NN(34)                                                             0014130
      COMMON PBA(34),PBE(34)                                                    0014140
      COMMON R(34)                                                              0014150
      COMMON SCRAT(34),SUMKT(34,20)                                             0014160
      COMMON TM(3),34)                                                          0014170
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES      0014180
      COMMON INT,IOT                                                            0014190
      DIMENSION MORB(10)                                                        0014200
      WRITE(IOT,300)                                                            0014210
      WRITE(IOT,301) (TITLE(I),I=1,12)                                          0014220
      NPRNT =  OPT                                                              0014230
      IF(NPRNT.EQ.6) GO TO 3                                                    0014240
      IF(NPRNT.LT.5) GO TO 2                                                    0014250
C                       PRINTOUT 2 ONLY                                       0014260
      WRITE(IOT,111)                                                            0014270
      DO 1 I=1,NEXND                                                            0014280
    1 WRITE(IOT,112) NN(I),PBA(I),PBE(I)                                        0014290
      GO TO 86                                                                  0014300
    2 IF(NPRNT.EQ.1) GO TO 4                                                    0014310
    3 IF(LG.EQ.1.AND.LR.EQ.1)   GOTO 4                                          0014320
      IF(BETA.GE.BBEST) GO TO 5                                                 0014330
    4 BBEST=BETA                                                                0014340
      IBEST=IMAX                                                                0014350
      KBEST=KMAX                                                                0014360
```

```
      LBEST=LMAX                                                        0014370
      LGBEST=LG                                                         0014380
    5 KOUNT=11                                                          0014390
      WRITE(IOT,101) LG,LR,DELT                                         0014400
      GO TO (6,7,8,9,10,6,11),NPRNT                                     0014410
    6 WRITE(IOT,102)                                                    0014420
      GO TO 12                                                          0014430
    7 WRITE(IOT,103)                                                    0014440
      GO TO 12                                                          0014450
    8 WRITE(IOT,104)                                                    0014460
      GO TO 12                                                          0014470
    9 WRITE(IOT,105)                                                    0014480
      GO TO 12                                                          0014490
   10 WRITE(IOT,118)                                                    0014500
      GO TO 12                                                          0014510
   11 WRITE(IOT,119)                                                    0014520
C                       WRITE HEADING FOR FIRST SET                     0014530
   12 WRITE(IOT, 06)                                                    0014540
      WRITE(IOT, 07) BETA,NN(IMAX),KMAX,BBEST,LGBEST,NN(IBEST),KBEST    0014550
      IF (LMAX.E .1) GO TO 15                                           0014560
C                       UPPER LIMIT                                     0014570
      WRITE(IOT,108)                                                    0014580
      GO TO 20                                                          0014590
C                       LOWER LIMIT                                     0014600
   15 WRITE(IOT,109)                                                    0014610
   20 IF(LBEST.EQ.1) GO TO 25                                           0014620
      WRITE(IOT,120)                                                    0014630
      GO TO 26                                                          0014640
   25 WRITE(IOT,121)                                                    0014650
   26 WRITE(IOT,110)                                                    0014660
      DO 30 I = 1,NEXND                                                 0014670
   30 WRITE(IOT,113)NN(I),ALPA(I),EMIS(I)                               0014680
C                       PREPARE TO PRINT TEMPERATURES                   0014690
   45 WRITE( OT,300)                                                    0014700
      WRITE(IOT,125)                                                    0014710
      NN1 = 1                                                           0014720
      KOUNT = 10                                                        0014730
      MORB(1) = 1                                                       0014740
      IF (NORB.GT.10) GO TO 50                                          0014750
C                       NUMBER OF ORBITS WILL BE ON ONE LINE OF PRINT   0014760
      LOB = 0                                                           0014770
      NN2 = NORB                                                        0014780
      NN3=NORB                                                          0014790
      IF (NORB.EQ.1) GO TO 65                                           0014800
      GO TO 55                                                          0014810
   50 LOB = 1                                                           0014820
      NN2 = 10                                                          0014830
      NN3=10                                                            0014840
   55 DO 60 NA=2,NN3                                                    0014850
   60 MORB(NA) = MORB(NA-1)+1                                           0014860
   65 IA1 = 1                                                           0014870
```

```
   70 WRITE(IOT,114) MORB(1)                                                0014880
      IF(NORB .EQ. 1) GO TO 72                                              0014890
      WRITE(IOT,117) (MORB(K),K=2,NN3)                                      0014900
   72 WRITE(IOT,115)                                                        0014910
      DO 75 KA = IA1,NNODE                                                  0014920
      WRITE(IOT,116)NN(KA),(T(KA,K),K = NN1,NN2)                            0014930
      NB = KA+1                                                             0014940
      KOUNT = KOUNT+1                                                       0014950
      IF (KOUNT.GE.46) GO TO 85                                             0014960
   75 CONTINUE                                                              0014970
   78 IF(LOB.EQ.0) GO TO 86                                                 0014980
      MORB(1) = NN2+1                                                       0014990
      NN1 = MORB(10)+1                                                      0015000
      IF ((MORB(10)+10).LT.NORB) GO TO 80                                   0015010
      NN3=NORB-NN2                                                          0015020
      LOB = 0                                                               0015030
      NN2 = NORB                                                            0015040
      GO TO 55                                                              0015050
   80 NN2 = MORB(10)+10                                                     0015060
      GO TO 55                                                              0015070
   85 IF (NB.GT.NNODE) GO TO 78                                             0015080
      KOUNT = 6                                                             0015090
      IA1 = NB                                                              0015100
      WRITE(IOT,300)                                                        0015110
      GO TO 70                                                              0015120
   86 IF(LR.LT.40) GO TO 95                                                 0015130
   87 LR=30                                                                 0015140
      DO 88 M=1,3                                                           0015150
  871 IA=M+10                                                               0015160
      IS(M)=IS(IA)                                                          0015170
      KS(M)=KS(IA)                                                          0015180
      LS(M)=LS(IA)                                                          0015190
      DO 88 I=1,NEXND                                                       0015200
      EPS(I,M)=EPS(I,IA)                                                    0015210
   88 ALS(I,M)=ALS(I,IA)                                                    0015220
   89 DO 90 M=31,40                                                         0015230
      IS(M)=0                                                               0015240
      KS(M)=0                                                               0015250
      LS(M)=0                                                               0015260
      DO 90 I=1,NEXND                                                       0015270
      EPS(I,M)=0.                                                           0015280
   90 ALS(I,M)=0.                                                           0015290
   95 RETURN                                                                0015300
C                    FORMAT STATEMENTS FOR OUTPUT                          0015310
  300 FORMAT (1H1,                                                          0015320
  301 FORMAT(12A6//)                                                        0015330
  101 FORMAT(2X4HMODE,21X,9HITERATIONI6,4X,49HNO. OF SURFACES ENCOUNTERE    0015340
     1D SINCE LAST TREND STEPI6,2X,9HDELTA S =F8.5)                         0015350
  102 FORMAT(1H+,9X,4HMRD1//)                                               0015360
  103 FORMAT(1H+,9X,4HCNTR//)                                               0015370
  104 FORMAT(1H+,9X,6HTREND2//)                                             0015380
```

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105 FORMAT(1H+,9X,4HBACK//)                                                    0015390
106 FORMAT(14X4HBETA,11X,4HNODE,5X,5HORBIT,4X,5HLIMIT,5X,54HMINIMUM BE        0015400
   1TA OCCURRED AT ITERATION   NODE  ORBIT LIMIT//)                           0015410
107 FORMAT(1PE24.8,I8,I10,E27.5,I18,I10,I6)                                    0015420
108 FORMAT(1H+,46X,5HUPPER)                                                    0015430
109 FORMAT(1H+,46X,5HLOWER)                                                    0015440
110 FORMAT (9X4HNODE,6X,12HABSORPTIVITY,4X,10HEMISSIVITY)                      0015450
111 FORMAT(9X4HNODE,4X,57HPARTIAL BETA  W/R TO ALPHA    PARTIAL BETA W        0015460
   1/R TO EPSILON)                                                             0015470
112 FORMAT(I12,1PE25.8,E31.8)                                                  0015480
113 FORMAT (I12,F17.8,F15.8)                                                   0015490
114 FORMAT (16X5HORBIT16)                                                      0015500
115 FORMAT (9X4HNODE//)                                                        0015510
116 FORMAT (I12,F18.2,9F10.2)                                                  0015520
117 FORMAT(1H+,26X,9I10)                                                       0015530
  8 FORMAT(1H+,16X,4HMRD2//)                                                   0015540
  9 FORMAT(1H+,9X,14HTEST 2 IN MRD2//)                                         0015550
 20 FORMAT(1H+,105X,5HUPPER////)                                               0015560
 21 FORMAT(1H+,105X,5HLOWER////)                                               0015570
 25 FORMAT(51X18HTEMPERATURE VALUES///)                                        0015580
    END                                                                        0015590
```

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$IBFTC START   FULIST,REF,DD                                                    0015600
      SUBROUTINE START                                                          0015610
C                       COMMON ASSOCIATED WITH INPUT                          0015620
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0015630
      COMMON BOLTZ                                                              0015640
      COMMON CONDUC(34,34),CONVER(6)                                            0015650
      COMMON DELMIN,DELTA                                                       0015660
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0015670
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0015680
      COMMON KOAT(34)                                                           0015690
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                      0015700
      COMMON QFX(34,20)                                                         0015710
      COMMON RADTN(34,44)                                                       0015720
      COMMON SOLFX(34,20)                                                       0015730
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0015740
C                       SINGLE CELL COMMON                                    0015750
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0015760
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERM,NCONV,DTEMP,DR,          0015770
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0015780
C                       COMPUTED ARRAY COMMON                                 0015790
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0015800
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0015810
     1       DESTH(34)                                                          0015820
      COMMON EMLOW(34,6),EPS(34,40)                                             0015830
      COMMON IS(40)                                                             0015840
      COMMON KS(40)                                                             0015850
      COMMON LS(40)                                                             0015860
      COMMON NN(34)                                                             0015870
      COMMON PBA(34),PBE(34)                                                    0015880
      COMMON R(34)                                                              0015890
      COMMON SCRAT(34),SUMKT(34,20)                                             0015900
      COMMON TM(34,34)                                                          0015910
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES      0015920
      COMMON INT,IOT                                                            0015930
      DIMENSION BETAMX(34,4)                                                    0015940
      JJ2 = NNODE+NCTN                                                          0015950
      DO 20 I = 1,NNODE                                                         0015960
      EXAREA(I) = BOLTZ*EXAREA(I)                                               0015970
      DO 10 J = 1,JJ2                                                           0015980
   10 RADTN(I,J) = BOLTZ*RADTN(I,J)                                             0015990
      DO 20 K = 1,NORB                                                          0016000
      SOLFX(I,K) = HEATKS(I)*SOLFX(I,K)+HEATKA(I)*ALPFX(I,K)                    0016010
      EARFX(I,K) = HEATKE(I)*EARFX(I,K)                                         0016020
   20 QFX(I,K) = HEATKA(I)*QFX(I,K)                                             0016030
      DO 65 I = 1,NNODE                                                         0016040
      IF(EXAREA(I) .LE. 1.E-15) GO TO 65                                        0016050
   25 LSUB = KOAT(I)                                                            0016060
      DO 30 NA = 1,4                                                            0016070
      IF (NA.GT.2) GO TO 28                                                     0016080
      NA2 = NA+4                                                                0016090
      ALOW(I,NA2) = ASPEC(NA,LSUB)                                              0016100
```

```
      EMLOW(I,NA2) = ESPEC(NA,LSUB)                                          0016110
   28 ALOW(I,NA) = ASPEC(NA,LSUB)                                            0016120
   30 EMLOW(I,NA) = ESPEC(NA,LSUB)                                           0016130
      DO 46 NA = 1,5                                                         0016140
      NA2 = NA+1                                                             0016150
      IF (ALOW(I,NA).NE.ALOW(I,NA2)) GO TO 43                                0016160
      IF (EMLOW(I,NA2).GT.EMLOW(I,NA)) GO TO 41                              0016170
      DEL = -.00001                                                          0016180
      GO TO 42                                                               0016190
   41 DEL = .00001                                                           0016200
   42 ALOW(I,NA2) = ALOW(I,NA2)*(1.+DEL)                                     0016210
      GO TO 46                                                               0016220
   43 IF (EMLOW(I,NA).NE.EMLOW(I,NA2)) GO TO 46                              0016230
      IF (ALOW(I,NA2).GT.ALOW(I,NA)) GO TO 44                                0016240
      DEL = .00001                                                           0016250
      GO TO 45                                                               0016260
   44 DEL = -.00001                                                          0016270
   45 EMLOW(I,NA2) = EMLOW(I,NA2)*(1.+DEL)                                   0016280
   46 CONTINUE                                                               0016290
C                        TEST OPTION FOR PROGRAM GUESS AT ALPHA AND EMISS    0016300
      IF (NOPTN(2)) 65,65,47                                                 0016310
C                        PROGRAM COMPUTES FIRST ALPHAS AND EMISS            0016320
   47 DO 60 N = 1,4                                                          0016330
      DEMIS = EMLOW(I,N)                                                     0016340
      DALPH = ALOW(I,N)                                                      0016350
      BMAXM1 = 0.                                                            0016360
      DO 48 K = 1,NORB                                                       0016370
      T(I,K) = ((DALPH*SOLFX(I,K)+DEMIS*EARFX(I,K)+QFX(I,K))/(DEMIS*EXAR     0016380
     1EA(I)))**(.25)                                                         0016390
      ATEMP =      (T(I,K)-TU(I))                                            0016400
      BTEMP =      (TL(I)-T(I,K))                                            0016410
      BMAXM = AMAX1(ATEMP,BTEMP)                                             0016420
      IF (BMAXM.GT.BMAXM1) BMAXM1 = BMAXM                                    0016430
   48 CONTINUE                                                               0016440
   50 BETAMX(I,N) = BMAXM1                                                   0016450
      IF (N.GT.1) GO TO 58                                                   0016460
   55 BMIN = BETAMX(I,1)                                                     0016470
      MR = 1                                                                 0016480
      GO TO 60                                                               0016490
   58 IF (BMIN.LT.BETAMX(I,N)) GO TO 60                                      0016500
      MR = N                                                                 0016510
      BMIN = BETAMX(I,N)                                                     0016520
   60 CONTINUE                                                               0016530
      ALPA(I) = ALOW(I,MR)                                                   0016540
      EMIS(I) = EMLOW(I,MR)                                                  0016550
   65 CONTINUE                                                               0016560
   70 RETURN                                                                 0016570
      END                                                                    0016580
```

```
$IBFTC STEP    FULIST,REF,DD                                                  0016590
      SUBROUTINE STEP(ITNT)                                                   0016600
C                       COMMON ASSOCIATED WITH INPUT                          0016610
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                0016620
      COMMON BOLTZ                                                            0016630
      COMMON CONDUC(34,44),CONVER(6)                                          0016640
      COMMON DELMIN,DELTA                                                     0016650
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                     0016660
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                      0016670
      COMMON KOAT(34)                                                         0016680
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                    0016690
      COMMON QFX(34,20)                                                       0016700
      COMMON RADTN(34,44)                                                     0016710
      COMMON SOLFX(34,20)                                                     0016720
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)            0016730
C                       SINGLE CELL COMMON                                    0016740
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,        0016750
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,       0016760
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                      0016770
C                       COMPUTED ARRAY COMMON                                 0016780
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                  0016790
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),            0016800
     1       DESTH(34)                                                        0016810
      COMMON EMLOW(34,6),EPS(34,40)                                           0016820
      COMMON IS(40)                                                           0016830
      COMMON KS(40)                                                           0016840
      COMMON LS(40)                                                           0016850
      COMMON NN(34)                                                           0016860
      COMMON PBA(34),PBE(34)                                                  0016870
      COMMON R(34)                                                            0016880
      COMMON SCRAT(34),SUMKT(34,20)                                           0016890
      COMMON TM(34,34)                                                        0016900
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES      0016910
      COMMON INT,IOT                                                          0016920
      LR1 = LR                                                                0016930
      DELT=DSMRD*DELT                                                         0016940
      IF (DELT .GE.DELMIN) GO TO 10                                           0016950
      WRITE(IOT,100)                                                          0016960
      WRITE(IOT,101)                                                          0016970
      ITNT=2                                                                  0016980
      GO TO 30                                                                0016990
   10 DO 20 J = 2,LR1                                                         0017000
      IS(J) = 0                                                               0017010
      KS(J) = 0                                                               0017020
      LS(J) = 0                                                               0017030
      DO 20 I = 1,NEXND                                                       0017040
      ALS(I,J) = 0.                                                           0017050
   20 EPS(I,J) = 0.                                                           0017060
      DO 25 I = 1,NEXND                                                       0017070
      DALPHS(I)=.4*DALPHS(I)                                                  0017080
   25 DEMISS(I)=.4*DEMISS(I)                                                  0017090
```

```
      LR = 1                                                            0017100
   30 RETURN                                                            0017110
  100 FORMAT(1H1)                                                       0017120
  101 FORMAT(//37HSTEP SIZE LESS THAN MINIMUM STEP SIZE)                0017130
      END                                                               0017140
```

```
$IBFTC TEST     EUL,LIST,REF,DD                                                 0017150
       SUBROUTINE TEST(IMRD2)                                                  0017160
C                       COMMON ASSOCIATED WITH INPUT                           0017170
       COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                0017180
       COMMON BOLTZ                                                            0017190
       COMMON CONDUC(34,44),CONVER(6)                                          0017200
       COMMON DELMIN,DELTA                                                     0017210
       COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                     0017220
       COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                      0017230
       COMMON KOAT(34)                                                         0017240
       COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                    0017250
       COMMON QFX(34,20)                                                       0017260
       COMMON RADTN(34,44)                                                     0017270
       COMMON SOLFX(34,20)                                                     0017280
       COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)            0017290
C                       SINGLE CELL COMMON                                     0017300
       COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,        0017310
      1        BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,      0017320
      2        NOS,USMRD,DSMRD,USTRN,DSTRN                                     0017330
C                       COMPUTED ARRAY COMMON                                  0017340
       COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                  0017350
       COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),            0017360
      1        DESTH(34)                                                       0017370
       COMMON EMLOW(34,6),EPS(34,40)                                           0017380
       COMMON IS(40)                                                           0017390
       COMMON KS(40)                                                           0017400
       COMMON LS(40)                                                           0017410
       COMMON NN(34)                                                           0017420
       COMMON PBA(34),PBE(34)                                                  0017430
       COMMON R(34)                                                            0017440
       COMMON SCRAT(34),SUMKT(34,20)                                           0017450
       COMMON TM(34,34)                                                        0017460
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES       0017470
       COMMON INT,IOT                                                          0017480
       LR1 = LR                                                                0017490
       IS(LR1) = IMAX                                                          0017500
       KS(LR1) = KMAX                                                          0017510
       LS(LR1) = LMAX                                                          0017520
       J = LR1-1                                                               0017530
     1 IF (J.LT.1) GO TO 5                                                     0017540
       IMRD2 = J                                                               0017550
       IF ((IS(LR1).EQ.IS(J)).AND.(KS(LR1).EQ.KS(J))  .AND.(LS(LR1).EQ.LS      0017560
      1(J))) GO TO 10                                                          0017570
       J = J-1                                                                 0017580
       GO TO 1                                                                 0017590
     5 IMRD2=0                                                                 0017600
    10 RETURN                                                                  0017610
       END                                                                     0017620
```

```
$IBFTC TRANSM  EUL IST,REF,DD                                                   0017630
      SUBROUTINE TRANSM                                                         0017640
C                       COMMON ASSOCIATED WITH INPUT                            0017650
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0017660
      COMMON BOLTZ                                                              0017670
      COMMON CONDUC(34,44),CONVER(6)                                            0017680
      COMMON DELMIN,DELTA                                                       0017690
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0017700
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0017710
      COMMON KOAT(34)                                                           0017720
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                      0017730
      COMMON QFX(34,20)                                                         0017740
      COMMON RADTN(34,44)                                                       0017750
      COMMON SOLFX(34,20)                                                       0017760
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0017770
C                       SINGLE CELL COMMON                                      0017780
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0017790
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,         0017800
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0017810
C                       COMPUTED ARRAY COMMON                                   0017820
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0017830
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0017840
     1       DESTH(34)                                                          0017850
      COMMON EMLOW(34,6),EPS(34,40)                                             0017860
      COMMON IS(40)                                                             0017870
      COMMON KS(40)                                                             0017880
      COMMON LS(40)                                                             0017890
      COMMON NN(34)                                                             0017900
      COMMON PBA(34),PBE(34)                                                    0017910
      COMMON R(34)                                                              0017920
      COMMON SCRAT(34),SUMKT(34,20)                                             0017930
      COMMON TM(34,34)                                                          0017940
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0017950
      COMMON INT,IOT                                                            0017960
      DIMENSION AP(34)                                                          0017970
      DO 10 I = 1,NNODE                                                         0017980
      AP(I) = EXAREA(I)                                                         0017990
      DO 10 K = 1,NNODE                                                         0018000
      IF (I.EQ.K) GO TO 5                                                       0018010
      TM(I,K) = 0.                                                              0018020
      GO TO 10                                                                  0018030
    5 TM(I,K) = 1.                                                              0018040
   10 CONTINUE                                                                  0018050
      J = 0                                                                     0018060
      DO 22 I = 1,NEXND                                                         0018070
   15 J = J-1                                                                   0018080
      IF(AP(J) .LE. 1.E-15) GO TO 15                                            0018090
      IF (I.EQ.J) GO TO 22                                                      0018100
      AP(I) = AP(J)                                                             0018110
      AP(J) = 0.                                                                0018120
      DO 20 K = 1,NNODE                                                         0018130
```

```
      TEM = TM(I,K)                                                    0018140
      TM(I,K) = TM(J,K)                                                0018150
      TM(J,K) = TEM                                                    0018160
   20 CONTINUE                                                         0018170
   22 CONTINUE                                                         0018180
      DO 25 I = 1,NNODE                                                0018190
      DO 25 J = 1,NNODE                                                0018200
      PROD = 0.                                                        0018210
      DO 23 NR = 1,NNODE                                               0018220
   23 PROD = PROD+TM(I,NR)*RADTN(NR,J)                                 0018230
   25 AT (I,J) = PROD                                                  0018240
      DO 30 I = 1,NNODE                                                0018250
      DO 30 J = 1,NNODE                                                0018260
      PROD = 0.                                                        0018270
      DO 28 NR = 1,NNODE                                               0018280
   28 PROD = PROD+AT(I,NR)*TM(J,NR)                                    0018290
   30 RADTN(I,J) = PROD                                                0018300
      IA=1                                                             0018310
   32 DO 40 I=1,NNODE                                                  0018320
      DO 40 J=1,NORB                                                   0018330
      SUM1=0.                                                          0018340
      DO 35 NR=1,NNODE                                                 0018350
      GO TO (33,34),IA                                                 0018360
   33 SUM1=SUM1+TM(I,NR)*SOLFX(NR,J)                                   0018370
      GO TO 35                                                         0018380
   34 SUM1=SUM1+TM(I,NR)*EARFX(NR,J)                                   0018390
   35 CONTINUE                                                         0018400
   40 AT(I,J)=SUM1                                                     0018410
      DO 45 I=1,NNODE                                                  0018420
      DO 45 J=1,NORB                                                   0018430
      GO TO (43,44),IA                                                 0018440
   43 SOLFX(I,J)=AT(I,J)                                               0018450
      GO TO 45                                                         0018460
   44 EARFX(I,J)=AT(I,J)                                               0018470
   45 CONTINUE                                                         0018480
      IF(IA.EQ. 2) GO TO 46                                            0018490
      IA=2                                                             0018500
      GO TO 32                                                         0018510
   46 IA=1                                                             0018520
   47 DO 55 I=1,NNODE                                                  0018530
      DO 55 NA=1,6                                                     0018540
      SUM1=0.                                                          0018550
      DO 50 JA=1,NNODE                                                 0018560
      GO TO (48,49),IA                                                 0018570
   48 SUM1=SUM1+TM(I,JA)*ENLOW(JA,NA)                                  0018580
      GO TO 50                                                         0018590
   49 SUM1=SUM1+TM(I,JA)*ALOW(JA,NA)                                   0018600
   50 CONTINUE                                                         0018610
   55 AT(I,NA)=SUM1                                                    0018620
      DO 60 I=1,NNODE                                                  0018630
      DO 60 NA=1,6                                                     0018640
```

```
      GO TO (57,58),IA                                                  0018650
   57 EMLOW(I,NA)=AT(I,NA)                                              0018660
      GO TO 60                                                          0018670
   58 ALOW(I,NA)=AT(I,NA)                                               0018680
   60 CONTINUE                                                          0018690
      IF(IA.EQ.2) GO TO 62                                              0018700
      IA=2                                                              0018710
      GO TO 47                                                          0018720
   62 IA=1                                                              0018730
   64 DO 80 I=1,NNODE                                                   0018740
      SUM1=0.                                                           0018750
      DO 75 NR=1,NNODE                                                  0018760
      TEM=TM(I,NR)                                                      0018770
      GO TO (65,66,67,68,69,70,71),IA                                   0018780
   65 SUM1=SUM1+TEM*EMIS(NR)                                            0018790
      GO TO 75                                                          0018800
   66 SUM1=SUM1+TEM*ALPA(NR)                                            0018810
      GO TO 75                                                          0018820
   67 SUM1=SUM1+TEM*EXAREA(NR)                                          0018830
      GO TO 75                                                          0018840
   68 SUM1=SUM1+TEM*TINTL(NR)                                           0018850
      GO TO 75                                                          0018860
   69 SUM1=SUM1+TEM*TEMMAX(NR)                                          0018870
      GO TO 75                                                          0018880
   70 SUM1=SUM1+TEM*TU(NR)                                              0018890
      GO TO 75                                                          0018900
   71 SUM1=SUM1+TEM*TL(NR)                                              0018910
   75 CONTINUE                                                          0018920
   80 AT(I,1)=SUM1                                                      0018930
      DO 90 I=1,NNODE                                                   0018940
      GO TO (81,82,83,84,85,86,87),IA                                   0018950
   81 EMIS(I)=AT(I,1)                                                   0018960
      GO TO 90                                                          0018970
   82 ALPA(I)=AT(I,1)                                                   0018980
      GO TO 90                                                          0018990
   83 EXAREA(I)=AT(I,1)                                                 0019000
      GO TO 90                                                          0019010
   84 TINTL(I)=AT(I,1)                                                  0019020
      GO TO 90                                                          0019030
   85 TEMMAX(I)=AT(I,1)                                                 0019040
      GO TO 90                                                          0019050
   86 TU(I)=AT(I,1)                                                     0019060
      GO TO 90                                                          0019070
   87 TL(I)=AT(I,1)                                                     0019080
   90 CONTINUE                                                          0019090
      IF(IA.EQ.7) GO TO 92                                              0019100
      IA=IA+1                                                           0019110
      GO TO 64                                                          0019120
   92 DO 95 I=1,NNODE                                                   0019130
      DO 95 JB=1,NORB                                                   0019140
      SUM1=0.                                                           0019150
```

```
      DO 94 NR=1,NNODE                                                  0019160
   94 SUM1=SUM1+TM(I,NR)*SUMKT(NR,JB)                                   0019170
   95 AT(I,JB)=SUM1                                                     0019180
      DO 96 I=1,NNODE                                                   0019190
      DO 96 JB2=1,NORB                                                  0019200
   96 SUMKT(I,JB2)=AT(I,JB2)                                            0019210
      DO 99 I=1,NNODE                                                   0019220
      DO 97 JB2 = 1,NNODE                                               0019230
      JJ = JB2                                                          0019240
      IF(TM(I,JB2) .GT. 1.E-6) GO TO 98                                 0019250
   97 CONTINUE                                                          0019260
      GO TO 99                                                          0019270
   98 NN(I) = JJ                                                        0019280
   99 CONTINUE                                                          0019290
      DO 105 I=1,NNODE                                                  0019300
      DO 105 J=1,NNODE                                                  0019310
      SUM1=0.                                                           0019320
      DO 102 NR=1,NNODE                                                 0019330
  102 SUM1=SUM1+TM(I,NR)*CONDUC(NR,J)                                   0019340
  105 AT(I,J)=SUM1                                                      0019350
      DO 110 I=1,NNODE                                                  0019360
      DO 110 J=1,NNODE                                                  0019370
      SUM1=0.                                                           0019380
      DO 108 NR=1,NNODE                                                 0019390
  108 SUM1=SUM1+AT(I,NR)*TM(J,NR)                                       0019400
  110 CONDUC(I,J)=SUM1                                                  0019410
      IF(NCTN.EQ.0) GO TO 135                                           0019420
      JJ1=NNODE+1                                                       0019430
      JJ2=NNODE+NCTN                                                    0019440
      DO 115 I=1,NNODE                                                  0019450
      JJ=NN(I)                                                          0019460
      DO 115 J=1,NCTN                                                   0019470
      NSCRT=NNODE+J                                                     0019480
  115 TM(I,J)=CONDUC(JJ,NSCRT)                                          0019490
      DO 120 I=1,NNODE                                                  0019500
      DO 120 J=1,NCTN                                                   0019510
      NSCRT=NNODE+J                                                     0019520
  120 CONDUC(I,NSCRT)=TM(I,J)                                           0019530
      DO 125 I=1,NNODE                                                  0019540
      JJ=NN(I)                                                          0019550
      DO 125 J=1,NCTN                                                   0019560
      NSCRT=NNODE+J                                                     0019570
  125 TM(I,J)=RADTN(JJ,NSCRT)                                           0019580
      DO 130 I=1,NNODE                                                  0019590
      DO 130 J=1,NCTN                                                   0019600
      NSCRT=NNODE+J                                                     0019610
  130 RADTN(I,NSCRT)=TM(I,J)                                            0019620
  135 RETURN                                                            0019630
      END                                                               0019640
```

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$IBFTC TREND   FULIST,REF,DD                                                    0019650
      SUBROUTINE TREND(IMJ)                                                     0019660
C                       COMMON ASSOCIATED WITH INPUT                            0019670
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                  0019680
      COMMON BOLTZ                                                              0019690
      COMMON CONDUC(34,44),CONVER(6)                                            0019700
      COMMON DELMIN,DELTA                                                       0019710
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                       0019720
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                        0019730
      COMMON KOAT(34)                                                           0019740
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                      0019750
      COMMON QFX(34,20)                                                         0019760
      COMMON RADTN(34,44)                                                       0019770
      COMMON SOLFX(34,20)                                                       0019780
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)              0019790
C                       SINGLE CELL COMMON                                      0019800
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,          0019810
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,JR,         0019820
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                        0019830
C                       COMPUTED ARRAY COMMON                                   0019840
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                    0019850
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),              0019860
     1       DESTH(34)                                                          0019870
      COMMON EMLOW(34,6),EPS(34,40)                                             0019880
      COMMON IS(40)                                                             0019890
      COMMON KS(40)                                                             0019900
      COMMON LS(40)                                                             0019910
      COMMON NN(34)                                                             0019920
      COMMON PBA(34),PBE(34)                                                    0019930
      COMMON R(34)                                                              0019940
      COMMON SCRAT(34),SUMKT(34,20)                                             0019950
      COMMON TM(34,34)                                                          0019960
C                       COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES        0019970
      COMMON INT,IOT                                                            0019980
      LR1=LR                                                                    0019990
      J=IMJ                                                                     0020000
      DO 1 I = 1,NEXND                                                          0020010
      DALPHS(I)=ALS(I,LR1)-ALS(I,J)                                             0020020
    1 DEMISS(I)=EPS(I,LR1)-EPS(I,J)                                             0020030
      SUM1 = 0.                                                                 0020040
      SUM2 = 0.                                                                 0020050
      DO 5  I = 1,NEXND                                                         0020060
      SUM1=SUM1+(DALPHS(I))**2                                                  0020070
    5 SUM2=SUM2+DEMISS(I)**2                                                    0020080
      BOT = DELT/(SQRT(SUM1+SUM2))                                              0020090
      DO 10 I = 1,NEXND                                                         0020100
      DALPHS(I)=BOT*DALPHS(I)                                                   0020110
      DEMISS(I)=BOT*DEMISS(I)                                                   0020120
      DASTH(I)=DALPHS(I)                                                        0020130
   10 DESTH(I)=DEMISS(I)                                                        0020140
      RETURN                                                                    0020150
```

0020160

END

```
$IBFTC  TREND2  EUL IST,REF,DD                                                  0020170
      SUBROUTINE TREND2(NRET)                                                  0020180
C                     COMMON ASSOCIATED WITH INPUT                             0020190
      COMMON ALPA(34),ALPFX(34,20),ASPEC(4,10)                                 0020200
      COMMON BOLTZ                                                             0020210
      COMMON CONDUC(34,44),CONVER(6)                                           0020220
      COMMON DELMIN,DELTA                                                      0020230
      COMMON EARFX(34,20),EMIS(34),ESPEC(4,10),EXAREA(34)                      0020240
      COMMON HEATKA(34),HEATKE(34),HEATKQ(34),HEATKS(34)                       0020250
      COMMON KOAT(34)                                                          0020260
      COMMON NCOAT,NCTN,NEXND,NNODE,NOPTN(5),NORB,NSTOP(5)                     0020270
      COMMON QFX(34,20)                                                        0020280
      COMMON RADTN(34,44)                                                      0020290
      COMMON SOLFX(34,20)                                                      0020300
      COMMON T(44,20),TEMMAX(44),TINTL(44),TITLE(12),TL(34),TU(34)             0020310
C                     SINGLE CELL COMMON                                       0020320
      COMMON IMAX,KMAX,LMAX,IMAX1,KMAX1,LMAX1,IMAX2,KMAX2,LMAX2,LR,LG,         0020330
     1       BETA,BETA1,NSTEP,DELT,IT,KT,LT,MAXG,ITERMX,NCONV,DTEMP,DR,        0020340
     2       NOS,USMRD,DSMRD,USTRN,DSTRN                                       0020350
C                     COMPUTED ARRAY COMMON                                    0020360
      COMMON ALOW(34,6),ALS(34,40),AT(34,34)                                   0020370
      COMMON DALPHS(34),DALS(34,2),DASTH(34),DEMISS(34),DES(34,2),             0020380
     1       DES H(34)                                                         0020390
      COMMON EMLOW(34,6),EPS(34,40)                                            0020400
      COMMON IS(40)                                                            0020410
      COMMON KS(40)                                                            0020420
      COMMON LS(40)                                                            0020430
      COMMON NN(34)                                                            00204
      COMMON PBA(34),PBE(34)                                                   0020450
      COMMON R(34)                                                             0020460
      COMMON SGRAT(34),SUMKT(34,20)                                            0020470
      COMMON TM(34,34)                                                         0020480
C                     COMMON  FOR ASSIGNMENT OF INPUT AND OUTPUT TAPES         0020490
      COMMON INT,IOT                                                           0020500
      KRET=1                                                                   0020510
      DO 5 I = 1,NEXND                                                         0020520
      DALS(I,2)=DALS(I,1)+DALPHS(I)                                            0020530
    5 DES(I,2)=DES(I,1)+DEMISS(I)                                              0020540
      CALL LIM                                                                 0020550
      CALL MRD1(KRET)                                                          0020560
      IF(KRET.EQ.2) GO TO 10                                                   0020570
      IF(LG.GT.MAXG) GO TO 10                                                  0020580
      CALL OUTPUT(3)                                                           0020590
      IT = IMAX                                                                0020600
      KT = KMAX                                                                0020610
      LT = LMAX                                                                0020620
      GO TO 15                                                                 0020630
   10 NRET=2                                                                   0020640
   15 RETURN                                                                   0020650
      END
```