The MicroSkyshine Method For Gamma-Ray Skyshine Analysis

by

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February 1987

APPENDIX C

The K-SHINE Single Scatter Codes

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C   KSHINE Programs for Gamma-Ray Skyshine Calculations
C
C   -----------------------------------------------------------
C                 SILO FORTRAN, v. 2.1, 10 Oct 86
C                 IBM PC Version, R.E. Faw, 19 Dec 86
C   -----------------------------------------------------------
C
C   The program SILO calculates the dose rate from a point isotropic
C   gamma ray source collimated into a cone about the vertical and
C   shielded by an overhead concrete slab.
C
C   The method is documented in the paper "Point Kernel Calculation of
C   Skyshine Exposure Rates," Nucl. Sci. Engg., 80, 334-338 (1982). by
C   M. L Roseberry and J. Kenneth Shultis.  The program was written by
C   M. L. Roseberry, (M.S. Thesis, Kansas State University, 1980) and
C   revised by R. E. Faw, 1985, and D. L. George, 1986.
C
C   SKY integrates the singly scattered gamma-ray fluxes over a spatial
C   region encompassing up to 20 mean free paths in air for the total
C   path length, and up to 15 mean free paths in concrete.  Integration
C   is performed by triple Gaussian eight-point quadrature.  Interaction
C   coefficients and Berger buildup coefficients are taken from tabula-
C   tions in "Principles of Radiation Shielding", by Chilton, Shultis,
C   and Faw, Prentice-Hall, 1984.  Log-log interpolations are used for
C   interaction coefficients, semilog for buildup coefficients.  Conver-
C   sion factors for prescribed dose equivalents are taken from Standard
C   ANSI/ANS-6.6.1-1977.
C
C   The upper limit on source energy is 10 MeV.  An error state arises
C   if energies of scattered photons fall below 0.02 MeV.
C
C   Data input is in part interactive and in part via an input file.
C   The input file consists of an unformatted list of source-detector
C   distances (m).  Other data such as source energy and angle of
C   collimation are entered in response to prompts.  Data output is via
C   the console and a named output file.
C
C   Results are given as the dose rate per unit source strength,
C   multiplied by the square of the source-detector distance (m)
C   and divided by the specified full-angle of collimation (sr).
C
C   The following subprograms must be linked for execution:
C
C         SKY          The main program
C         RESG         Gamma ray response functions
C         GMU          Gamma ray interaction coefficients
C         BUBERG       Buildup factors (Berger formula)
C
C   -----------------------------------------------------------
C
C   Variables are as follows:
C         E            Energy (MeV)
C         D            Source-to-detector distance (m)
C         R            Silo inside radius (m)
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C         Y               Source and detector depth below top of silo (m)
C         RC              Concrete density (g/cm^3)
C         RAA             Air density (mg/cm^3)
C         T               Concrete thickness (m)
C         NRESP           Type of response (rad, Roentgen or rem)
C         DEL             Fractional precision for Gaussian quadrature
C         XSUM            Response per photon
C
C --------------------------------------------------------------------
C
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION X(20)
      CHARACTER*64 FNAME
      CHARACTER*64 A(8)
      EXTERNAL TING3
      EXTERNAL TING2
      EXTERNAL TING1
      COMMON/S1/T,CMU,E/S2/THS,D,US,ES,U/S3/N1,N2/S4/THA,B,KLUNK,DEL
     &/S5/NAA,NBB,RA,PI,CON,III
      DATA A/'Exposure','Air Kerma','Water Kerma','Dose Equivalent',
     &' (R/photon)',2*'( rad/photon)',' (rem/photon)'/
      PI=DACOS(-1.0D0)
C --------------------------------------------------------------------
  109 FORMAT(' CALCULATION OF SKYSHINE GAMMA-RAY NORMALIZED RESPONSE',/)
  100 FORMAT(' INPUT FILE NAME - ')
  101 FORMAT(A)
  102 FORMAT(' OUTPUT FILE NAME - ')
  111 FORMAT(7(F8.2,1X),1PE11.3)
C --------------------------------------------------------------------
C     Read Input Data
C --------------------------------------------------------------------
      WRITE(*,100)
      READ(*,101) FNAME
      OPEN(8,FILE=FNAME)
      WRITE(*,102)
      READ(*,101) FNAME
      OPEN(9,FILE=FNAME,STATUS='UNKNOWN')
      WRITE(*,109)
   20 READ (8,*,END=11) E,Y,D,R,RAA,T,RC,NRESP,DEL
C --------------------------------------------------------------------
C     Initialize Parameters
C --------------------------------------------------------------------
      IF (NRESP.EQ.1) THEN
         NAA = 1
         NBB = 1
      ELSE IF (NRESP.EQ.2) THEN
         NAA = 2
         NBB = 1
      ELSE IF (NRESP.EQ.3) THEN
         NAA = 2
         NBB = 2
      ELSE
         NAA = 3
         NBB = 1
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         END IF
         SUM=0.0D0
         N1=20
         N2=20
         N3=20
         RC=RC*1.0D 06
         CMU=GMU(E,1,3)*RC*1.D-4
         THS=DATAN(Y/R)
         RA=RAA*1.0D 03
         CON=4.7848D+18/D*RA
         BMN=BMIN(RA)
         U=GMU(E,1,1)*RA*1.D-4
         BMAX=PI-THS
         EMAX=SCATEN(E,BMAX)
         KLUNK=0
C----------------------------------------------------------------
C     Integrate Over All Beta, Theta and Epsilon Angles
C----------------------------------------------------------------
         CALL GAUS8(TING3,BMN,BMAX,DEL,XSUM,IERR3)
         IF (IERR3.NE.1) KLUNK=3
C ---------------------------------------------------------------
C     Write Output
C ---------------------------------------------------------------
         WRITE(*,111) E,Y,D,R,RAA,T,RC*1.D-6,XSUM
         WRITE(9,111) E,Y,D,R,RAA,T,RC*1.D-6,XSUM
         GO TO 20
   11    STOP
         END
C ------------------------------------------------------------
C     Function TING3: Integrate Over Beta
C ------------------------------------------------------------
         REAL*8 FUNCTION TING3(AUG)
         IMPLICIT REAL*8 (A-H,O-Z)
         EXTERNAL TING2
         COMMON/S1/T,CMU,E/S2/THS,D,US,ES,U/S3/N1,N2/S4/THA,B,KLUNK,DEL
        &/S5/NAA,NBB,RA,PI,CON,III
C--------------------------------------------------------------
C     Calculate Energy, Cross Section and Angle Parameters
C--------------------------------------------------------------
         ES=SCATEN(E,AUG)
         UEN=RESG(NAA,NBB,ES,III)
         US=GMU(ES,1,1)*RA*1.D-4
         SIG=SIGMA(E,AUG)
         THL=PI-THS
         IF (THL.GT.(PI-AUG)) THL=PI-AUG
         B=AUG
C--------------------------------------------------------------
C     Integrate Over Theta and Epsilon Integrals for Current Beta
C--------------------------------------------------------------
         CALL GAUS9(TING2,THS,THL,DEL,TANS2,IERR2)
         IF (IERR2.NE.1) KLUNK=2
         PARTN=SIG*UEN*TANS2
         TING3=CON*PARTN
         RETURN
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      END
C ----------------------------------------------------------------------
C      Function TING2: Integrate Over Theta
C ----------------------------------------------------------------------
      REAL*8 FUNCTION TING2 (THETA)
      IMPLICIT REAL*8 (A-H,O-Z)
      EXTERNAL TING1
      COMMON/S1/T,CMU,E/S2/THAS,D,US,ES,U/S3/N1,N2/S4/THA,B,KLUNK,DEL
C----------------------------------------------------------------------
C      Calculate Cross Section and Angle Parameters
C----------------------------------------------------------------------
      AR=D*(DCOS(THETA)+DSIN(THETA)/DTAN(B))*U
      BR=D*DSIN(THETA)/DSIN(B)*US
      EP=EPF(THETA)
      THA=THETA
C----------------------------------------------------------------------
C      Integrate Over Epsilon Integrals for Current Beta and Theta
C----------------------------------------------------------------------
      CALL GAUS10(TING1,0.D+00,EP,DEL,TANS1,IERR1)
      IF (IERR1.NE.1) KLUNK=1
      TING2=BUBERG(1,ES,BR,IERR)*DEXP(-AR-BR)*TANS1
      RETURN
      END
C ----------------------------------------------------------------------
C      Function TING1: Integrate Over Epsilon
C ----------------------------------------------------------------------
      REAL*8 FUNCTION TING1 (EPSILN)
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/S1/T,CMU,E/S2/THAS,D,US,ES,U/S3/N1,N2/S4/THA,B,KLUNK,DEL
      AG=T*CMU/DSIN(THA)
      A=AG/DCOS(EPSILN)
      TING1=BUBERG(3,E,A,IERR)*DEXP(-A)
      RETURN
      END
C ----------------------------------------------------------------------
C  FUNCTION EPF(THA) CALCULATES THE UPPER LIMIT ON THE EPSILON INTEGRAL
C            THA  = THETA VALUE IN RADIANS
C      FUNCTION EPF LIMITS EFP SUCH THAT THE CONCRETE PATH LENGTH <OR= 15
C ----------------------------------------------------------------------
      REAL*8 FUNCTION EPF(THA)
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/S1/T,SMU,E/S2/THSM,D,US,ES,U
      A=DSIN(THSM)/DSIN(THA)
      IF (A.GE.1.0D0) GO TO 10
      EP=DACOS(A)
      TEST=T*SMU/DCOS(EP)/DSIN(THA)
      IF (TEST.LE.15.0D0) GO TO 15
      A=TEST*DCOS(EP)/15.0D0
      IF (A.GE.1.0D0) GO TO 10
      EP=DACOS(A)
      GO TO 15
   10 EP=0.0D0
   15 EPF=EP
      RETURN
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      END
C ........................................................................
C    FUNCTION SCATEN(E,B) CALCULATES THE SCATTERED GAMMA ENERGY
C       IN MEV AFTER A SINGLE SCATTER.
C          E = THE UNSCATTERED GAMMA ENERGY IN MEV
C          B = THE SCATTERING ANGLE WITH RESPECT TO THE INCIDENT
C               PHOTON DIRECTION IN RADIANS
C ........................................................................
      REAL*8 FUNCTION SCATEN (E,B)
      IMPLICIT REAL*8 (A-H,O-Z)
      SCATEN=E/(1.0D0+E/.5110034D0*(1.0D0+DCOS(B)))
      RETURN
      END
C ........................................................................
C    FUNCTION SIGMA(E,B) CALCULATES THE KLEIN-NISHINA CROSS-
C       SECTION IN M**2
C          E = THE UNSCATTERED GAMMA ENERGY IN MEV
C          B = THE SCATTERING ANGLE WITH RESPECT TO THE INCIDENT
C               PHOTON DIRECTION IN RADIANS
C ........................................................................
      REAL*8 FUNCTION SIGMA (E,B)
      IMPLICIT REAL*8 (A-H,O-Z)
      AL=.5110034D0/E
      P=1.0D0+AL+DCOS(B)
      SIGMA=3.970387D-30*AL**2/P**2*(AL/P+P/AL-DSIN(B)**2)
      RETURN
      END
C ........................................................................
C    FUNCTION BMIN(R) ESTIMATES THE VALUE OF THE SCATTERING ANGLE FOR
C       WHICH THE TOTAL AIR PATH LENGTH IS 20 MFP
C          R = AIR DENSITY IN G/M**3
C ........................................................................
      REAL*8 FUNCTION BMIN(R)
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/S1/T,CMU,E/S2/THAS,D,US,ES,U/S4/THA,B,KLUNK,DEL
      PI=DACOS (-1.0D0)
      DB=PI/180.0D0
      B=2.0D0*DB
      DO 10 I=1,89
      AG=SCATEN(E,B)
      TEST=D*(U/DTAN(B)+GMU(AG,1,1)*R*1.D-4/DSIN(B))
      IF (TEST.LE.20.D0) GO TO 20
      B=B+DB
   10 CONTINUE
      DO 15 I=1,75
      AG=SCATEN(E,B)
      TEST=D*GMU(AG,1,1)*R*1.D-4
      IF (TEST.LE.10.D0) GO TO 20
      B=B+DB
   15 CONTINUE
      WRITE (9,5) D,E
      WRITE (*,5) D,E
    5 FORMAT (5X,'THE FUNCTION TO FIND THE MINIMUM VALUE OF BETA',
     A ' FAILED.  DETECTOR - SOURCE DISTANCE IS',F7.2,' SOURCE',
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5

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     B ' GAMMA ENERGY IS',F6.3)
  20 BMIN=B-DB
     RETURN
     END
C ................................................................
     FUNCTION RESG(N,M,E,IERR)
* DOUBLE PRECISION VERSION
*
* This function subprogram returns the gamma-ray response function at
* energy E (MeV) for the following types of response (arg. N):
*
*     1. Exposure                          (R cm^2)
*     2. Absorbed dose or kerma            (cGy cm^2)
*     3. ANSI Prescribed dose equivalent   (cSv cm^2)
*
* Absorbed dose or kerma is evaluated for the following media (arg. M):
*     1. Air
*     2. Water
*     3. Concrete
*     4. Iron
*     5. Lead
*
* Note: M is a dummy argument if N = 1 or 3.
*
* The following function is required: GMU
*
C----------------------------------------------------------------
     IMPLICIT REAL*8(A-H,O-Z)
     IERR = 0
     IF (M.LT.1.OR.M.GT.5) THEN
       IERR = 1
       RESG = 1.D0
       RETURN
     END IF
     IF (N.LT.1.OR.N.GT.3) THEN
       IERR = 2
       RESG = 1.D0
       RETURN
     END IF
     IF (N.EQ.3.AND.E.LT.0.01) THEN
       IERR = 3
       RESG = 1.D0
       RETURN
     END IF
     IF (N.EQ.3.AND.E.GT.15.D0) THEN
       IERR = 3
       RESG = 1.D0
       RETURN
     END IF
     IF (N.NE.3.AND.E.LT..01D0) THEN
       IERR = 3
       RESG = 1.D0
       RETURN
     END IF
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           IF (N.NE.3.AND.E.GT.10.D0) THEN
             IERR = 3
             RESG = 1.D0
             RETURN
           END IF

*

           IF (N.EQ.1) THEN
               RESG = 1.835D-8*E*GMU(E,2,1)
               RETURN
           ELSE IF (N.EQ.2) THEN
               RESG = 1.602D-8*E*GMU(E,2,M)
               RETURN
           ELSE IF (N.EQ.3) THEN
               X = LOG(E)
               IF(E.LE..03D0) THEN
                   RESG=-20.477D0-1.7454D0*X
                   GO TO 10
               ELSE IF(E.LE..5D0) THEN
                   RESG=-13.626D0-.57117D0*X-1.0954D0*X*X-.24897D0*X*X*X
                   GO TO 10
               ELSE IF(E.LE.5.D0) THEN
                   RESG=-13.133D0+.72008D0*X-.033603D0*X*X
                   GO TO 10
               ELSE
                   RESG=-12.791D0+.28309D0*X+.10873D0*X*X
               END IF
  10           RESG=EXP(RESG)/3600.D0
               RETURN
           END IF
           RETURN
           END
C -----------------------------------------------------------------
       FUNCTION GMU(EE,MM,NN)
C   DOUBLE PRECISION VERSION
C
C
C   COMPUTES MASS ATTENUATION COEFFICIENTS AND MASS KERMA COEFFICIENTS
C   FOR AIR, WATER, CONCRETE, IRON, AND LEAD
C   OVER THE RANGE 0.01 TO 10 MEV
C
C   Reference:   Hubbell, J. H., "Photon Mass Attenuation and
C                Energy-Absorption Coefficients from 1 keV to 20 MeV,"
C                Int. J. Appl. Radiat. Isot., 33, 1269-1290, 1982.
C
C   INDEX NN DETERMINES MATERIAL:     1. AIR
C                                     2. WATER
C                                     3. CONCRETE
C                                     4. IRON
C                                     5. LEAD
C
C   INDEX MM DETERMINES TYPE GMU:     1. TOTAL MASS INTER. COEFFICIENT
C                                     2. MASS KERMA COEFFICIENT
C
C   VARIABLE EE IS THE ENERGY (MeV)
C
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C   FUNCTION RETURNS COEFFICIENT (CM^2/G)
C   -------------------------------------------------------------------
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION N(5),E(33,5),COEF1(33,5),COEF2(33,5)
C   NUMBER OF ELEMENTS IN ENERGY RANGE
      DATA N/4*25,33/
C   ENERGY GROUP STRUCTURE
      DATA E/.01,.015,.02,.03,.04,.05,.06,.08,.10,.15,.2,.3,.4
     &,.5,.6,.8,1.,1.5,2.,3.,4.,5.,6.,8.,10.,8*0.
     &,.01,.015,.02,.03,.04,.05,.06,.08,.10,.15,.2,.3,.4
     &,.5,.6,.8,1.,1.5,2.,3.,4.,5.,6.,8.,10.,8*0.
     &,.01,.015,.02,.03,.04,.05,.06,.08,.10,.15,.2,.3,.4
     &,.5,.6,.8,1.,1.5,2.,3.,4.,5.,6.,8.,10.,8*0.
     &,.01,.015,.02,.03,.04,.05,.06,.08,.10,.15,.2,.3,.4
     &,.5,.6,.8,1.,1.5,2.,3.,4.,5.,6.,8.,10.,8*0.
     &,.01,.01304,.01304,.015,.0152,.0152,.015861,.015861,.02,.03,.04
     &,.05,.06,.08,.088004,.088004,.10,.15,.2,.3,.4,.5
     &,.6,.8,1.,1.5,2.,3.,4.,5.,6.,8.,10./
      DATA ((COEF1(I,J),I=1,33),J=1,1)/
     & 5.016D+00,1.581D+00,7.643D-01,3.501D-01,2.471D-01
     &,2.073D-01,1.871D-01,1.661D-01,1.541D-01,1.356D-01,1.234D-01
     &,1.068D-01,9.548D-02,8.712D-02,8.056D-02,7.075D-02,6.359D-02
     &,5.176D-02,4.447D-02,3.581D-02,3.079D-02,2.751D-02,2.523D-02
     &,2.225D-02,2.045D-02,8*0.D0/
      DATA ((COEF1(I,J),I=1,33),J=2,2)/
     & 5.223D+00,1.639D+00,7.958D-01,3.718D-01,2.668D-01,2.262D-01
     &,2.055D-01,1.835D-01,1.707D-01,1.504D-01,1.370D-01,1.187D-01
     &,1.061D-01,9.687D-02,8.957D-02,7.866D-02,7.070D-02,5.755D-02
     &,4.940D-02,3.969D-02,3.403D-02,3.031D-02,2.771D-02,2.429D-02
     &,2.219D-02,8*0.D0/
      DATA ((COEF1(I,J),I=1,33),J=3,3)/
     & 2.619D+01,8.185D+00,3.605D+00,1.202D+00,6.070D-01,3.918D-01
     &,2.943D-01,2.119D-01,1.781D-01,1.433D-01,1.270D-01,1.082D-01
     &,9.629D-02,8.767D-02,8.098D-02,7.103D-02,6.381D-02,5.197D-02
     &,4.482D-02,3.654D-02,3.189D-02,2.895D-02,2.696D-02,2.450D-02
     &,2.311D-02,8*0.D0/
      DATA ((COEF1(I,J),I=1,33),J=4,4)/
     & 1.690D+02,5.656D+01,2.546D+01,8.109D+00,3.601D+00,1.944D+00
     &,1.197D+00,5.918D-01,3.701D-01,1.960D-01,1.458D-01,1.098D-01
     &,9.398D-02,8.413D-02,7.703D-02,6.698D-02,5.994D-02,4.883D-02
     &,4.265D-02,3.622D-02,3.311D-02,3.146D-02,3.057D-02,2.991D-02
     &,2.994D-02,8*0.D0/
      DATA ((COEF1(I,J),I=1,33),J=5,5)/
     & 1.306D+02,6.100D+01,1.580D+02,1.116D+02,1.070D+02,1.480D+02
     &,1.320D+02,1.530D+02,8.636D+01,3.032D+01,1.436D+01,8.041D+00
     &,5.020D+00,2.419D+00,1.610D+00,7.380D+00,5.550D+00,2.014D+00
     &,9.985D-01,4.026D-01,2.323D-01,1.613D-01,1.248D-01,8.869D-02
     &,7.103D-02,5.222D-02,4.607D-02,4.234D-02,4.197D-02,4.272D-02
     &,4.391D-02,4.675D-02,4.972D-02/
      DATA ((COEF2(I,J),I=1,33),J=1,1)/
     & 4.640D+00,1.300D+00,5.255D-01,1.501D-01,6.694D-02
     &,4.031D-02,3.004D-02,2.393D-02,2.318D-02,2.494D-02,2.672D-02
     &,2.872D-02,2.949D-02,2.966D-02,2.953D-02,2.882D-02,2.787D-02
     &,2.545D-02,2.342D-02,2.054D-02,1.866D-02,1.737D-02,1.644D-02
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     &,1.521D-02,1.446D-02,8*0.D0/
      DATA ((COEF2(I,J),I=1,33),J=2,2)/
     & 4.840D+00,1.340D+00,5.367D-01,1.520D-01,6.803D-02,4.155D-02
     &,3.152D-02,2.583D-02,2.539D-02,2.762D-02,2.966D-02,3.192D-02
     &,3.279D-02,3.299D-02,3.284D-02,3.205D-02,3.100D-02,2.831D-02
     &,2.604D-02,2.278D-02,2.063D-02,1.913D-02,1.804D-02,1.657D-02
     &,1.566D-02,8*0.D0/
      DATA ((COEF2(I,J),I=1,33),J=3,3)/
     & 2.467D+01,7.582D+00,3.217D+00,9.454D-01,3.959D-01,2.048D-01
     &,1.230D-01,6.154D-02,4.180D-02,3.014D-02,2.887D-02,2.937D-02
     &,2.980D-02,2.984D-02,2.964D-02,2.887D-02,2.790D-02,2.554D-02
     &,2.348D-02,2.086D-02,1.929D-02,1.828D-02,1.760D-02,1.680D-02
     &,1.639D-02,8*0.D0/
      DATA ((COEF2(I,J),I=1,33),J=4,4)/
     & 1.367D+02,4.895D+01,2.257D+01,7.237D+00,3.146D+00,1.630D+00
     &,9.538D-01,4.093D-01,2.181D-01,7.970D-02,4.840D-02,3.374D-02
     &,3.050D-02,2.922D-02,2.843D-02,2.718D-02,2.604D-02,2.358D-02
     &,2.195D-02,2.036D-02,1.984D-02,1.976D-02,1.991D-02,2.043D-02
     &,2.100D-02,8*0.D0/
      DATA ((COEF2(I,J),I=1,33),J=5,5)/
     & 1.256D+02,6.100D+01,1.130D+02,8.939D+01,8.080D+01,1.090D+02
     &,9.880D+01,1.140E+02,6.923D+01,2.550D+01,1.221D+01,6.796D+00
     &,4.177D+00,1.936D+00,1.450D+00,2.310D+00,2.229D+00,1.135D+00
     &,6.229D-01,2.581D-01,1.439D-01,9.564D-02,7.132D-02,4.838D-02
     &,3.787D-02,2.714D-02,2.407D-02,2.351D-02,2.463D-02,2.600D-02
     &,2.730D-02,2.948D-02,3.114D-02/
C
C
C     PERFORM INTERPOLATION
C
      DO 101 I = 1,N(NN)
      IF (EE.EQ.E(I,NN)) GO TO 102
      IF (EE.LT.E(I,NN)) GO TO 103
  101 CONTINUE
  102 IF(MM.EQ.1) GMU = COEF1(I,NN)
      IF(MM.EQ.2) GMU = COEF2(I,NN)
      GO TO 104
  103 II = I-1
      GOTO (201,202), MM
  201 YY1 = DLOG(COEF1(II,NN))
      YY2 = DLOG(COEF1(I,NN))
      GOTO 203
  202 YY1 = DLOG(COEF2(II,NN))
      YY2 = DLOG(COEF2(I,NN))
  203 XX1 = DLOG(E(II,NN))
      XX2 = DLOG(E(I,NN))
      GG  = DLOG(EE)
      ZZ  = YY1 + (GG-XX1)*(YY2-YY1)/(XX2-XX1)
      GMU = DEXP(ZZ)
  104 CONTINUE
      RETURN
      END
C ------------------------------------------------------------------
      FUNCTION BUBERG(N,E,X,IERR)
C
```

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```
C This function subprogram evaluates gamma ray exposure buildup factors
C using the Berger form of the buildup factor with data as reported in
C Chilton, et al., Principles of Radiation Shielding, Prentice Hall,
C 1984, p. 454.  Variation of coefficients with energy is determined
C by linear interpolation in log(E).
C
C Argument N is the material index:  1. air
C                                     2. water
C                                     3. concrete
C                                     4. iron
C                                     5. lead
C Argument E is the energy E (MeV)
C Argument X is the number of mean free paths
C --------------------------------------------------------------------
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION U(25),A(25,5),B(25,5)
      IERR = 0
      IF (X.LE.0.D0) THEN
        BUBERG = 1.D0
        RETURN
      END IF
      IF (E.LT..015D0.OR.E.GT.15.D0) THEN
        IERR = 1
        BUBERG = 1.D0
        RETURN
      END IF
      IF (N.LT.1.OR.N.GT.5) THEN
        IERR = 2
        BUBERG = 1.D0
        RETURN
      END IF
      IF (X.GT.40.D0) THEN
        IERR = 3
        BUBERG = 1.D0
        RETURN
      END IF
C
      DATA U/.015,.02,.03,.04,.05,.06,.08,.1,.15,.2,.3,.4,.5,.6
     &,.8,1.,1.5,2.,3.,4.,5.,6.,8.,10.,15./
C data for air
      DATA A/.08,.23,.93,2.4,4.05,5.27,6.11,5.93,4.7,3.94,3.1,2.61,2.29
     &,2.05,1.71,1.5,1.16,.97,.75,.61,.53,.47,.37,.31,.23
C data for water
     &,.09,.26,1.01,2.58,4.36,5.59,6.47,6.11,4.88,4.13,3.18,2.67,2.32
     &,2.07,1.74,1.5,1.16,.97,.74,.62,.52,.47,.38,.31,.23
C data for concrete
     &,.01,.03,.1,.26,.52,.78,1.42,1.83,2.19,2.2,2.03,1.87,1.73,1.6
     &,1.41,1.27,1.02,.89,.71,.59,.49,.45,.36,.3,.21
C data for iron
     &,0.,.02,.01,.02,.04,.07,.14,.24,.52,.77,1.06,1.15,1.16,1.14,1.09
     &,1.03,.88,.76,.66,.56,.49,.42,.33,.25,.15
C data for lead
     &,0.,0.,0.,.01,.01,.01,.02,.2,.21,.08,.08,.11,.15,.19,.25,.3
     &,.36,.38,.37,.31,.24,.19,.11,.07,0./
```

```
C data for air
      DATA B/-.034,-.032,-.009,.018,.05,.075,.102,.113,.121,.113,.094
     &,.079,.067,.058,.045,.035,.021,.013,.005,.001,-.002
     &,-.004,-.004,-.004,-.006
C data for water
     &,-.036,-.032,-.006,.024,.057,.082,.108,.12,.125,.118,.096,.08
     &,.068,.059,.045,.036,.021,.013,.005,0.,-.002,-.005,-.006
     &,-.005,-.008
C data for concrete
     &,-.029,-.041,-.036,-.035,-.026,-.008,.007,.028,.054,.065,.067
     &,.061,.055,.049,.04,.032,.021,.014,.007,.004,.004,.002,.001
     &,.003,.004
C data for iron
     &,0.,-.032,-.036,-.032,-.034,-.039,-.034,-.030,-.015,.004,.022
     &,.033,.036,.036,.032,.028,.020,.018,.014,.015,.017,.021
     &,.028,.039,.066
C data for lead
     &,3*0.,-.066,-.046,-.028,-.029,.479,-.075,-.054,-.04,-.033,-.028
     &,-.024,-.019,-.015,-.007,.004,.019,.038,.062,.082,.125,.161,0./
C
      I = 1
   10 IF (E.LE.U(I+1)) GO TO 20
      I = I + 1
      GO TO 10
   20 AA=(A(I+1,N)-A(I,N))
      AA = AA*(DLOG(E)-DLOG(U(I)))/(DLOG(U(I+1))-DLOG(U(I)))
      AA = AA+A(I,N)
      BB=(B(I+1,N)-B(I,N))
      BB = BB*(DLOG(E)-DLOG(U(I)))/(DLOG(U(I+1))-DLOG(U(I)))
      BB = BB + B(I,N)
      BUBERG = 1. + AA*X*DEXP(BB*X)
      RETURN
      END
C****
C**** ................................................................
C****
C**** SUBROUTINE GAUS8 -- DOUBLE PRECISION IBM 370 VERSION
C****
C**** PURPOSE
C****    GAUS8 INTEGRATES REAL FUNCTIONS OF ONE VARIABLE OVER FINITE
C****    INTERVALS, USING AN ADAPTIVE 8-POINT GAUSS-LEGENDRE ALGORITHM.
C****    GAUS8 IS INTENDED PRIMARILY FOR HIGH ACCURACY INTEGRATION OR
C****    INTEGRATION OF SMOOTH FUNCTIONS.  FOR LOWER ACCURACY
C****    INTEGRATION OF FUNCTIONS WHICH ARE NOT VERY SMOOTH, EITHER
C****    QNC3 OR QNC7 MAY BE MORE EFFICIENT.
C****
C**** USAGE
C****    CALL GAUS8(FUN,A,B,ERR,ANS,IERR)
C****
C****    FUN - NAME OF EXTERNAL FUNCTION TO BE INTEGRATED.  THIS NAME
C****          MUST BE IN AN EXTERNAL STATEMENT IN THE CALLING PROGRAM.
C****          FUN MUST BE A FUNCTION OF ONE REAL ARGUMENT (THE
C****          VARIABLE OF INTEGRATION).
C****    A   - LOWER LIMIT OF INTEGRAL.
```

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```
C****     B    - UPPER LIMIT OF INTEGRAL (MAY BE LESS THAN A).
C****     ERR  - USER-SUPPLIED ERROR PARAMETER.  ANS WILL NORMALLY HAVE
C****            NO MORE ERROR THAN ERR TIMES THE INTEGRAL OF THE
C****            ABSOLUTE VALUE OF FUN(X).
C****     ANS  - COMPUTED VALUE OF INTEGRAL.
C****     IERR - ERROR PARAMETER SET BY GAUS8:
C****            IERR = 1 IS NORMAL.
C****            IERR = 2 MEANS ANS IS PROBABLY INSUFFICIENTLY ACCURATE.
C****
C**** SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C****    THE EXTERNAL FUNCTION FUN(X) MUST BE SUPPLIED BY THE USER.
C****
C**** METHOD
C****    AN ADAPTIVE 8-POINT GAUSS-LEGENDRE ALGORITHM WITH INTERVAL
C****    BISECTION, COMBINED RELATIVE/ABSOLUTE ERROR CONTROL, AND
C****    COMPUTED MAXIMUM REFINEMENT LEVEL WHEN A IS CLOSE TO B.
C****
C**** ..................................................................
C****

      SUBROUTINE GAUS8(FUN,A,B,ERR,ANS,IERR)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION AA(30),HH(30),LR(30),VL(30),GR(30)
C**** 8-POINT GAUSS-LEGEGNDRE QUADRATURE DATA.
      DATA X1,X2,X3,X4/0.18343464249565000,0.52553240991632900,
     1                 0.7966664774136270D0,0.96028985649753600/
      DATA W1,W2,W3,W4/0.362683783378362D0,0.313706645877887D0,
     1                 0.222381034453374D0,0.101228536290376D0/
C**** MISCELLANEOUS PARAMETERS.
      DATA SQ2/1.414213562373095D0/
      DATA LMN,NLMX,KMX,KML,NBITS/1,30,5000,6,64/
C**** 8-POINT GAUSS-LEGENDRE INTEGRATION FUNCTION.
      G8(X,H)=H*((W1*(FUN(X-X1*H)+FUN(X+X1*H))+W2*(FUN(X-X2*H)+FUN(X+X2*
     1H)))+(W3*(FUN(X-X3*H)+FUN(X+X3*H))+W4*(FUN(X-X4*H)+FUN(X+X4*H))))
C**** INITIALIZE.
      ANS=0.D0
      IERR=1
      IF(A.EQ.B) RETURN
      LMX=NLMX
      IF(B.EQ.0.D0) GO TO 3
      IF(DSIGN(1.D0,B)*A.LE.0.D0) GO TO 3
      C=DABS(1.D0-A/B)
      IF(C.GT.0.1D0) GO TO 3
      NIB=-IDINT(DLOG(C)/DLOG(2.D0))
      LMX=MINO(NLMX,NBITS-NIB-6)
      LMX=MAX0(LMX,LMN)
    3 TOL=DMAX1(ERR,2.D0**(5-NBITS))/2.D0
      IF(ERR.LT.0.D0) TOL=0.5D-6
      EPS=TOL
      HH(1)=(B-A)/4.D0
      AA(1)=A
      LR(1)=1
      L=1
      EST=G8(AA(L)+2.D0*HH(L),2.D0*HH(L))
      K=8
```

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```
         AREA=DABS(EST)
         EF=0.5D0
         MXL=0
C**** COMPUTE REFINED ESTIMATES, ESTIMATE THE ERROR, ETC.
       4 GL=G8(AA(L)+HH(L),HH(L))
         GR(L)=G8(AA(L)+3.D0*HH(L),HH(L))
         K=K+16
         AREA=AREA+(DABS(GL)+DABS(GR(L))-DABS(EST))
C        IF(L.LT.LMN) GO TO 11
         GLR=GL+GR(L)
         EE=EF*DABS(EST-GLR)
         AE=DMAX1(EPS*AREA,TOL*DABS(GLR))
         IF(EE-AE) 6,6,7
       5 MXL=1
       6 IF(LR(L)) 8,8,10
C**** CONSIDER THE LEFT HALF OF THIS LEVEL.
       7 IF(K.GT.KMX) LMX=KML
         IF(L.GE.LMX) GO TO 5
         L=L+1
         EPS=EPS/2.D0
         EF=EF/SQ2
         HH(L)=HH(L-1)/2.D0
         LR(L)=-1
         AA(L)=AA(L-1)
         EST=GL
         GO TO 4
C**** PROCEED TO RIGHT HALF AT THIS LEVEL.
       8 VL(L)=GLR
       9 EST=GR(L-1)
         LR(L)=1
         AA(L)=AA(L)+4.D0*HH(L)
         GO TO 4
C**** RETURN ONE LEVEL.
      10 VR=GLR
      11 IF(L.LE.1) GO TO 14
         L=L-1
         EPS=EPS*2.D0
         EF=EF*SQ2
         IF(LR(L).GT.0) GO TO 13
         VL(L)=VL(L+1)+VR
         GO TO 9
      13 VR=VL(L+1)+VR
         GO TO 11
C**** EXIT.
      14 ANS=VR
         IF(MXL.GT.0) IERR=2
         RETURN
         END
         SUBROUTINE GAUS9(FUN,A,B,ERR,ANS,IERR)
         IMPLICIT REAL*8 (A-H,O-Z)
         DIMENSION AA(30),HH(30),LR(30),VL(30),GR(30)
C**** 8-POINT GAUSS-LEGEGNDRE QUADRATURE DATA.
         DATA X1,X2,X3,X4/0.18343464249565000,0.52553240991632900,
      1                   0.796666477413627D0,0.960289856497536D0/
```

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```
          DATA W1,W2,W3,W4/0.362683783378362D0,0.313706645877887D0,
         1              0.222381034453374D0,0.101228536290376D0/
C**** MISCELLANEOUS PARAMETERS.
          DATA SQ2/1.41421356237309SD0/
          DATA LMN,NLMX,KMX,KML,NBITS/1,30,5000,6,64/
C**** 8-POINT GAUSS-LEGENDRE INTEGRATION FUNCTION.
          G8(X,H)=H*((W1*(FUN(X-X1*H)+FUN(X+X1*H))+W2*(FUN(X-X2*H)+FUN(X+X2*
         1H)))+(W3*(FUN(X-X3*H)+FUN(X+X3*H))+W4*(FUN(X-X4*H)+FUN(X+X4*H))))
C**** INITIALIZE.
          ANS=0.D0
          IERR=1
          IF(A.EQ.B) RETURN
          LMX=NLMX
          IF(B.EQ.0.D0) GO TO 3
          IF(DSIGN(1.D0,B)*A.LE.0.D0) GO TO 3
          C=DABS(1.D0-A/B)
          IF(C.GT.0.1D0) GO TO 3
          NIB=-IDINT(DLOG(C)/DLOG(2.D0))
          LMX=MINO(NLMX,NBITS-NIB-6)
          LMX=MAXO(LMX,LMN)
      3 TOL=DMAX1(ERR,2.D0**(5-NBITS))/2.D0
          IF(ERR.LT.0.D0) TOL=0.5D-6
          EPS=TOL
          HH(1)=(B-A)/4.D0
          AA(1)=A
          LR(1)=1
          L=1
          EST=G8(AA(L)+2.D0*HH(L),2.D0*HH(L))
          K=8
          AREA=DABS(EST)
          EF=0.5D0
          MXL=0
C**** COMPUTE REFINED ESTIMATES, ESTIMATE THE ERROR, ETC.
      4 GL=G8(AA(L)+HH(L),HH(L))
          GR(L)=G8(AA(L)+3.D0*HH(L),HH(L))
          K=K+16
          AREA=AREA+(DABS(GL)+DABS(GR(L))-DABS(EST))
C       IF(L.LT.LMN) GO TO 11
          GLR=GL+GR(L)
          EE=EF*DABS(EST-GLR)
          AE=DMAX1(EPS*AREA,TOL*DABS(GLR))
          IF(EE-AE) 6,6,7
      5 MXL=1
      6 IF(LR(L)) 8,8,10
C**** CONSIDER THE LEFT HALF OF THIS LEVEL.
      7 IF(K.GT.KMX) LMX=KML
          IF(L.GE.LMX) GO TO 5
          L=L+1
          EPS=EPS/2.D0
          EF=EF/SQ2
          HH(L)=HH(L-1)/2.D0
          LR(L)=-1
          AA(L)=AA(L-1)
          EST=GL
```

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```
         GO TO 4
C**** PROCEED TO RIGHT HALF AT THIS LEVEL.
      8 VL(L)=GLR
      9 EST=GR(L-1)
         LR(L)=1
         AA(L)=AA(L)+4.D0*HH(L)
         GO TO 4
C**** RETURN ONE LEVEL.
     10 VR=GLR
     11 IF(L.LE.1) GO TO 14
         L=L-1
         EPS=EPS*2.D0
         EF=EF*SQ2
         IF(LR(L).GT.0) GO TO 13
         VL(L)=VL(L+1)+VR
         GO TO 9
     13 VR=VL(L+1)+VR
         GO TO 11
C**** EXIT.
     14 ANS=VR
         IF(MXL.GT.0) IERR=2
         RETURN
         END
         SUBROUTINE GAUS10(FUN,A,B,ERR,ANS,IERR)
         IMPLICIT REAL*8 (A-H,O-Z)
         DIMENSION AA(30),HH(30),LR(30),VL(30),GR(30)
C**** 8-POINT GAUSS-LEGEGNDRE QUADRATURE DATA.
         DATA X1,X2,X3,X4/0.18343464249565000,0.52553240991632900,
        1                 0.79666647741362700,0.96028985649753600/
         DATA W1,W2,W3,W4/0.36268378333783620,0.31370664587788700,
        1                 0.22238103445337400,0.10122853629037600/
C**** MISCELLANEOUS PARAMETERS.
         DATA SQ2/1.414213562373095D0/
         DATA LMN,NLMX,KMX,KML,NBITS/1,30,5000,6,64/
C**** 8-POINT GAUSS-LEGENDRE INTEGRATION FUNCTION.
         G8(X,H)=H*((W1*(FUN(X-X1*H)+FUN(X+X1*H))+W2*(FUN(X-X2*H)+FUN(X+X2*
        1H)))+(W3*(FUN(X-X3*H)+FUN(X+X3*H))+W4*(FUN(X-X4*H)+FUN(X+X4*H))))
C**** INITIALIZE.
         ANS=0.D0
         IERR=1
         IF(A.EQ.B) RETURN
         LMX=NLMX
         IF(B.EQ.0.D0) GO TO 3
         IF(DSIGN(1.D0,B)*A.LE.0.D0) GO TO 3
         C=DABS(1.D0-A/B)
         IF(C.GT.0.1D0) GO TO 3
         NIB=-IDINT(DLOG(C)/DLOG(2.D0))
         LMX=MIN0(NLMX,NBITS-NIB-6)
         LMX=MAX0(LMX,LMN)
      3 TOL=DMAX1(ERR,2.D0**(5-NBITS))/2.D0
         IF(ERR.LT.0.D0) TOL=0.5D-6
         EPS=TOL
         HH(1)=(B-A)/4.D0
         AA(1)=A
```

```
        LR(1)=1
        L=1
        EST=G8(AA(L)+2.D0*HH(L),2.D0*HH(L))
        K=8
        AREA=DABS(EST)
        EF=0.5D0
        MXL=0
C**** COMPUTE REFINED ESTIMATES, ESTIMATE THE ERROR, ETC.
      4 GL=G8(AA(L)+HH(L),HH(L))
        GR(L)=G8(AA(L)+3.D0*HH(L),HH(L))
        K=K+16
        AREA=AREA+(DABS(GL)+DABS(GR(L))-DABS(EST))
C       IF(L.LT.LMN) GO TO 11
        GLR=GL+GR(L)
        EE=EF*DABS(EST-GLR)
        AE=DMAX1(EPS*AREA,TOL*DABS(GLR))
        IF(EE-AE) 6,6,7
      5 MXL=1
      6 IF(LR(L)) 8,8,10
C**** CONSIDER THE LEFT HALF OF THIS LEVEL.
      7 IF(K.GT.KMX) LMX=KHL
        IF(L.GE.LMX) GO TO 5
        L=L+1
        EPS=EPS/2.D0
        EF=EF/SQ2
        HH(L)=HH(L-1)/2.D0
        LR(L)=-1
        AA(L)=AA(L-1)
        EST=GL
        GO TO 4
C**** PROCEED TO RIGHT HALF AT THIS LEVEL.
      8 VL(L)=GLR
      9 EST=GR(L-1)
        LR(L)=1
        AA(L)=AA(L)+4.D0*HH(L)
        GO TO 4
C**** RETURN ONE LEVEL.
     10 VR=GLR
     11 IF(L.LE.1) GO TO 14
        L=L-1
        EPS=EPS*2.D0
        EF=EF*SQ2
        IF(LR(L).GT.0) GO TO 13
        VL(L)=VL(L+1)+VR
        GO TO 9
     13 VR=VL(L+1)+VR
        GO TO 11
C**** EXIT.
     14 ANS=VR
        IF(MXL.GT.0) IERR=2
        RETURN
        END
```

APPENDIX D

Tabulation of Results from K-SHINE Calculations

Table D6.2.   Normalized gamma-ray skyshine exposure as a function of areal density separating source and detector. The source is Cobalt-60 and is collimated by a cone of 150.5-degree full angle. In one case, there is no overhead shielding, in another there is a 21-cm thick concrete shield, and in a third there is a 42.8-cm thick concrete shield. Concrete density is 2.32 g/cm^3. The normalized exposure is Roentgens per photon, multiplied by the square of the source-to-detector distance (m) and divided by the two-pi steradian of collimation. Air density is 1.25 mg/cm^3 and the areal density is the product of the density and the source-to-detector distance. Calculations were performed using the K-Shine program.

Normalized Exposure (m^2 R/sr) [1.17-1.33 MeV Avg.]

Areal Density (g/cm^3)	Source-Detector Distance (m)	Open Silo	21-cm Concrete	43-cm Concrete
5	40	4.599E-17	3.026E-18	1.630E-19
10	80	7.693E-17	4.837E-18	2.552E-19
20	160	9.381E-17	5.265E-18	2.640E-19
30	240	8.064E-17	4.021E-18	1.907E-19
40	320	6.022E-17	2.672E-18	1.195E-19
60	480	2.765E-17	9.823E-19	3.877E-20
80	640	1.117E-17	3.235E-19	1.120E-20

APPENDIX E

Tabulation of Results from G^3 Calculations

Table E6.1. SAMPLE PROBLEM 001, AIR SCATTERING INTO COLLIMATED DETECTOR

```
     3  16    4   2    2   1   2  13   1   1   1   1
307.2    335.28  365.76   396.24   441.96   487.68   533.40   579.12
640.08   701.04  762.00   822.96   883.92   975.36   1200.0   1500.0
2000.0
0.0      0.78539 1.5708   2.3562   3.14159
0.0      0.087266 0.17453
  -1   1   -1
   1   4                                                          -1000.
95625-04 29375-04
7.0      8.0
14.0067  15.9994
1.17     1.33
3.70E+16 3.70E+16
0.05     0.06     0.08     0.10     0.15     0.20     0.30     0.40
0.50     0.60     0.80     1.00     1.50
12950-07 11880-07 13000-07 15960-07 25920-07 37080-07 59580-07 81480-07
10220-06 12220-06 15930-06 19230-06 26520-06
0.01     1.0      2.0
304.8    0.0      914.4
0.0      0.0      0.0
                            -1
STOP
```

```
       CONTROL    3   16   -4    2    2    1    2   13    1    1    1    1    0    0    0    0
X OR     R  3.0720E+02  3.3528E+02  3.6576E+02  3.9624E+02  4.4196E+02  4.8768E+02  5.3340E+02  5.7912E+02
            6.4008E+02  7.0104E+02  7.6200E+02  8.2296E+02  8.8392E+02  9.7536E+02  1.2000E+03  1.5000E+03
            2.0000E+03
Y OR    PHI  0.0000E+00  7.8539E-01  1.5708E+00  2.3562E+00  3.1416E+00
Z OR THETA  0.0000E+00  8.7266E-02  1.7453E-01
X OR     R  3.2124E+02  3.5052E+02  3.8100E+02  4.1910E+02  4.6482E+02  5.1054E+02  5.5626E+02  6.0960E+02
            6.7056E+02  7.3152E+02  7.9248E+02  8.5344E+02  9.2964E+02  1.0877E+03  1.3500E+03  1.7500E+03
Y OR    PHI  3.9270E-01  1.1781E+00  1.9635E+00  2.7489E+00
Z OR THETA  4.3633E-02  1.3090E-01
        F(L)  2.8996E+06  3.7473E+06  4.4269E+06  8.0384E+06  9.8861E+06  1.1925E+07  1.4155E+07  2.2672E+07
              2.7430E+07  3.2640E+07  3.8303E+07  4.4420E+07  7.9089E+07  2.6670E+08  5.4900E+08  1.5417E+09
        F(M)  7.8539E-01  7.8541E-01  7.8540E-01  7.8539E-01
        F(N)  3.8052E-03  1.1386E-02
```

SAMPLE PROBLEM 001, AIR SCATTERING INTO COLLIMATED DETECTOR

ZONE	BNDS	COMP	BND1	PK1	BND2	PK2	BND3	PK3	BND4	PK4	BND5	PK5	BND6	PK6
1	-1	1	-1	0										

BND	EQ	A	B	C	XO	YO	ZO	K
1	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	-1.0000E+03

```
COMP   MAT,   1         2
              N         O
   A       1.4007E+01  1.5999E+01
   1       9.5625E-04  2.9375E-04
```

```
     1       X= 0.0000E+00     Y= 0.0000E+00     Z= 0.0000E+00
  SOURCE     X= 3.0480E+02     Y= 0.0000E+00     Z= 9.1440E+02
  GROUP    ENERGY     SOURCE     MIN DIRECT  MAX DIRECT  MIN SCATTR  MAX SCATTR  MIND+MAXSC  GROUP
     1    1.1700E+00  3.7000E+16  6.4036E+03  6.4563E+03  1.2614E+01  1.2852E+01  6.4165E+03    1
     2    1.3300E+00  3.7000E+16  7.1243E+03  7.1739E+03  1.2671E+01  1.2887E+01  7.1372E+03    2
  TOTALS                         1.3528E+04  1.3630E+04  2.5285E+01  2.5739E+01  1.3554E+04
  BIN    LOWER EDGE   FACTOR     MIN SCATTR  MAX SCATTR  BIN
     1   0.0000E+00  1.2950E-07  0.0000E+00  0.0000E+00    1
     2   5.0000E-02  1.2950E-07  0.0000E+00  0.0000E+00    2
     3   6.0000E-02  1.1880E-07  0.0000E+00  0.0000E+00    3
     4   8.0000E-02  1.3000E-07  0.0000E+00  0.0000E+00    4
     5   1.0000E-01  1.5960E-07  0.0000E+00  0.0000E+00    5
     6   1.5000E-01  2.5920E-07  0.0000E+00  0.0000E+00    6
     7   2.0000E-01  3.7080E-07  2.1911E+00  2.4547E+00    7
     8   3.0000E-01  5.9580E-07  1.6182E+00  1.6783E+00    8
     9   4.0000E-01  8.1480E-07  1.4955E+00  1.5262E+00    9
    10   5.0000E-01  1.0220E-06  1.9349E+00  1.9601E+00   10
    11   6.0000E-01  1.2220E-06  6.5798E+00  6.6235E+00   11
    12   8.0000E-01  1.5930E-06  7.9667E+00  7.9914E+00   12
    13   1.0000E+00  1.9230E-06  3.4990E+00  3.5051E+00   13
    14   1.5000E+00  2.6520E-06  0.0000E+00  0.0000E+00   14
```

Table E6.3. SAMPLE PROBLEM 002, AIR SCATTERING FROM COLLIMATED SOURCE - Data

```
    3  19    1  1    2   1    1  14    1    1    1    1
 0.0       50.0      100.0    200.0    300.0    450.0    600.0    900.0
 1200.0    1500.0    1800.0   2100.0   2500.0   3000.0   3500.0   4000.0
 5000.0    6000.0    7000.0   8000.0
 0.0       6.28318
 0.0       .017453
   -1    1   -1
    1  4                                                          -1000.0
 95625-04 29406-04
 7.0       8.0
 14.0067   15.9994
 2.0
 13132+04
 .05       .06       .08      .1       .15      .2       .3       .4
 .5        .6        .8       1.0      1.5      2.0
 12950-07 11880-07 13000-07 15960-07 25920-07 37080-07 59580-07 81480-07
 10215-06 12222-06 15928-06 19230-06 26520-06 32720-06
 .01       1.0       1.0
 0.0       0.0       0.0         1  60
 76.20     0.0       131.98
 152.40    0.0       263.96
 304. 0    0.0       527.93
 609.60    0.0       1055.86
 990.60    0.0       1715.77
 1524.00   0.0       2639.65
                                 -1
```

Table E6.3. SAMPLE PROBLEM 002A, AIR SCATTERING FROM COLLIMATED SOURCE, RANGE CHECK - Data

```
   3  12    1  1    2  1    1  14    1   1   1   1
8000.0   9000.0   10000.0  11000.0  12000.0  13000.0  14000.0  15000.0
16000.0  17000.0  18000.0  19000.0  20000.0
0.0      6.28318
0.0      .017453
  -1  1  -1
   1  4                                                    -1000.0
95625-04 29406-04
7.0      8.0
14.0067  15.9994
2.0
13132+04
.05      .06      .08      .1       .15      .2       .3       .4
.5       .6       .8       1.0      1.5      2.0
12950-07 11880-07 13000-07 15960-07 25920-07 37080-07 59580-07 81480-07
10215-06 12222-06 15928-06 19230-06 26520-06 32720-06
.01      1.0      1.0
0.0      0.0      0.0
76.20    0.0      131.98
152.40   0.0      263.96
304. 0   0.0      527.93
609.60   0.0      1055.86
990.60   0.0      1715.77
1524.00  0.0      2639.65
                           -1
STOP
```

```
        CONTROL    3    19   -1    1    2    1    1   14    1    1    1    1    0    0    0    0
X OR     R  0.0000E+00  5.0000E+01  1.0000E+02  2.0000E+02  3.0000E+02  4.5000E+02  6.0000E+02  9.0000E+02
            1.2000E+03  1.5000E+03  1.8000E+03  2.1000E+03  2.5000E+03  3.0000E+03  3.5000E+03  4.0000E+03
            5.0000E+03  6.0000E+03  7.0000E+03  8.0000E+03
Y OR   PHI  0.0000E+00  6.2832E+00
Z OR THETA  0.0000E+00  1.7453E-02
X OR     R  2.5000E+01  7.5000E+01  1.5000E+02  2.5000E+02  3.7500E+02  5.2500E+02  7.5000E+02  1.0500E+03
            1.3500E+03  1.6500E+03  1.9500E+03  2.3000E+03  2.7500E+03  3.2500E+03  3.7500E+03  4.5000E+03
            5.5000E+03  6.5000E+03  7.5000E+03
Y OR   PHI  3.1416E+00
Z OR THETA  8.7265E-03
     F(L)   4.1667E+04  2.9167E+05  2.3333E+06  6.3333E+06  2.1375E+07  4.1625E+07  1.7100E+08  3.3300E+08
            5.4900E+08  8.1900E+08  1.1430E+09  2.1213E+09  3.7917E+09  5.2917E+09  7.0417E+09  2.0333E+10
            3.0333E+10  4.2333E+10  5.6333E+10
     F(M)   6.2832E+00
     F(N)   1.5229E-04
```

```
ZONE  BNDS  COMP  BND1  PK1  BND2  PK2  BND3  PK3  BND4  PK4  BND5  PK5  BND6  PK6

  1   -1     1    -1    0
```

```
BND   EQ     A         B         C         XO        YO        ZO         K

  1    4  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  -1.0000E+03
```

```
COMP   MAT,   1         2
              N         O
   A       1.4007E+01  1.5999E+01
   1       9.5625E-04  2.9406E-04
```

```
1        X= 7.6200E+01    Y= 0.0000E+00    Z= 1.3198E+02
SOURCE   X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	1.4598E-07	1.4599E-07	1.5451E-13	1.5475E-13	1.4598E-07	1
TOTALS			1.4598E-07	1.4599E-07	1.5451E-13	1.5475E-13	1.4598E-07	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	7.5073E-15	7.7179E-15	7
8	3.0000E-01	5.9580E-07	2.4643E-14	2.4651E-14	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	4.3916E-14	4.3922E-14	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	7.8446E-14	7.8458E-14	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
2        X= 1.5240E+02    Y= 0.0000E+00    Z= 2.6396E+02
SOURCE   X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	3.6187E-08	3.6200E-08	7.2715E-14	7.2967E-14	3.6187E-08	1
TOTALS			3.6187E-08	3.6200E-08	7.2715E-14	7.2967E-14	3.6187E-08	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	6.9233E-15	7.1340E-15	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	9.7750E-15	9.7830E-15	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	2.1678E-14	2.1689E-14	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	3.4339E-14	3.4361E-14	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
  3      X=  3.0400E+02    Y=  0.0000E+00    Z=  5.2793E+02
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	8.9062E-09	8.9189E-09	3.4140E-14	3.4421E-14	8.9062E-09	1
TOTALS			8.9062E-09	8.9189E-09	3.4140E-14	3.4421E-14	8.9062E-09	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	3.2096E-15	3.4131E-15	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	3.1419E-15	3.1532E-15	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	6.1127E-15	6.1262E-15	11
12	8.0000E-01	1.5928E-06	5.8834E-15	5.8957E-15	12
13	1.0000E+00	1.9230E-06	1.5793E-14	1.5833E-14	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
  4      X=  6.0960E+02    Y=  0.0000E+00    Z=  1.0559E+03
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	2.1494E-09	2.1616E-09	1.5719E-14	1.6048E-14	2.1494E-09	1
TOTALS			2.1494E-09	2.1616E-09	1.5719E-14	1.6048E-14	2.1494E-09	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	7.9522E-16	9.6472E-16	7
8	3.0000E-01	5.9580E-07	6.5903E-16	6.7703E-16	8
9	4.0000E-01	8.1480E-07	1.4630E-15	1.4839E-15	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	2.8736E-15	2.8989E-15	11
12	8.0000E-01	1.5928E-06	4.3653E-15	4.4025E-15	12
13	1.0000E+00	1.9230E-06	5.5632E-15	5.6213E-15	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
  5      X=  9.9060E+02    Y=  0.0000E+00    Z=  1.7158E+03
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	7.8020E-10	7.9162E-10	8.9195E-15	9.2958E-15	7.8021E-10	1
TOTALS			7.8020E-10	7.9162E-10	8.9195E-15	9.2958E-15	7.8021E-10	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	6.1097E-16	7.6920E-16	7
8	3.0000E-01	5.9580E-07	3.3871E-16	3.5606E-16	8
9	4.0000E-01	8.1480E-07	5.5474E-16	5.7392E-16	9
10	5.0000E-01	1.0215E-06	8.5586E-16	8.7730E-16	10
11	6.0000E-01	1.2222E-06	1.2078E-15	1.2337E-15	11
12	8.0000E-01	1.5928E-06	1.5482E-15	1.5820E-15	12
13	1.0000E+00	1.9230E-06	3.8032E-15	3.9037E-15	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
  6      X=  1.5240E+03    Y=  0.0000E+00    Z=  2.6396E+03
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	3.1064E-10	3.2113E-10	5.2169E-15	5.6390E-15	3.1064E-10	1
TOTALS			3.1064E-10	3.2113E-10	5.2169E-15	5.6390E-15	3.1064E-10	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	2.3353E-16	3.4688E-16	7
8	3.0000E-01	5.9580E-07	4.3570E-16	4.8518E-16	8
9	4.0000E-01	8.1480E-07	3.5479E-16	3.7841E-16	9
10	5.0000E-01	1.0215E-06	3.6382E-16	3.8355E-16	10
11	6.0000E-01	1.2222E-06	4.5309E-16	4.7568E-16	11
12	8.0000E-01	1.5928E-06	1.1663E-15	1.2249E-15	12
13	1.0000E+00	1.9230E-06	2.2097E-15	2.3443E-15	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
        CONTROL     3    12    1    1    2    1    1   14    1    1    1    1    0    0    0    0
X OR     R  8.0000E+03  9.0000E+03  1.0000E+04  1.1000E+04  1.2000E+04  1.3000E+04  1.4000E+04  1.5000E+04
            1.6000E+04  1.7000E+04  1.8000E+04  1.9000E+04  2.0000E+04
Y OR   PHI  0.0000E+00  6.2832E+00
Z OR THETA  0.0000E+00  1.7453E-02
X OR     R  8.5000E+03  9.5000E+03  1.0500E+04  1.1500E+04  1.2500E+04  1.3500E+04  1.4500E+04  1.5500E+04
            1.6500E+04  1.7500E+04  1.8500E+04  1.9500E+04
Y OR   PHI  3.1416E+00
Z OR THETA  8.7265E-03
       F(L)  7.2333E+10  9.0333E+10  1.1033E+11  1.3233E+11  1.5633E+11  1.8233E+11  2.1033E+11  2.4033E+11
             2.7233E+11  3.0633E+11  3.4233E+11  3.8033E+11
       F(M)  6.2832E+00
       F(N)  1.5229E-04
```

```
ZONE  BNDS  COMP  BND1  PK1  BND2  PK2  BND3  PK3  BND4  PK4  BND5  PK5  BND6  PK6

 1    -1     1    -1    0
```

```
BND   EQ     A          B          C          XO         YO         ZO          K

 1     4  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  -1.0000E+03
```

```
COMP    MAT,   1          2
               N          O
    A       1.4007E+01  1.5999E+01
    1       9.5625E-04  2.9406E-04
```

```
   1      X=  7.6200E+01   Y=  0.0000E+00    Z=  1.3198E+02
SOURCE    X=  0.0000E+00   Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	1.4598E-07	1.4599E-07	5.7583E-18	3.0690E-17	1.4598E-07	1
TOTALS			1.4598E-07	1.4599E-07	5.7583E-18	3.0690E-17	1.4598E-07	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	5.7583E-18	3.0690E-17	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
   2      X=  1.5240E+02   Y=  0.0000E+00    Z=  2.6396E+02
SOURCE    X=  0.0000E+00   Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	3.6187E-08	3.6200E-08	6.0275E-18	3.1714E-17	3.6187E-08	1
TOTALS			3.6187E-08	3.6200E-08	6.0275E-18	3.1714E-17	3.6187E-08	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	6.0275E-18	3.1714E-17	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
   3      X= 3.0400E+02    Y= 0.0000E+00    Z= 5.2793E+02
SOURCE    X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	8.9062E-09	8.9189E-09	6.6087E-18	3.3871E-17	8.9062E-09	1
TOTALS			8.9062E-09	8.9189E-09	6.6087E-18	3.3871E-17	8.9062E-09	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	6.6087E-18	3.3871E-17	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
   4      X= 6.0960E+02    Y= 0.0000E+00    Z= 1.0559E+03
SOURCE    X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	2.1494E-09	2.1616E-09	7.9657E-18	3.8659E-17	2.1494E-09	1
TOTALS			2.1494E-09	2.1616E-09	7.9657E-18	3.8659E-17	2.1494E-09	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	7.9657E-18	3.8659E-17	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

5	X= 9.9060E+02	Y= 0.0000E+00		Z= 1.7158E+03				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00		Z= 0.0000E+00				
GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	7.8020E-10	7.9162E-10	1.0110E-17	4.5639E-17	7.8020E-10	1
TOTALS			7.8020E-10	7.9162E-10	1.0110E-17	4.5639E-17	7.8020E-10	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.0110E-17	4.5639E-17	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

6	X= 1.5240E+03	Y= 0.0000E+00		Z= 2.6396E+03				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00		Z= 0.0000E+00				
GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	2.0000E+00	1.3132E+04	3.1064E-10	3.2113E-10	1.4232E-17	5.7585E-17	3.1064E-10	1
TOTALS			3.1064E-10	3.2113E-10	1.4232E-17	5.7585E-17	3.1064E-10	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.4232E-17	5.7585E-17	7
8	3.0000E-01	5.9580E-07	0.0000E+00	0.0000E+00	8
9	4.0000E-01	8.1480E-07	0.0000E+00	0.0000E+00	9
10	5.0000E-01	1.0215E-06	0.0000E+00	0.0000E+00	10
11	6.0000E-01	1.2222E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5928E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

PROBLEM 003A, OPEN SILO (150 DEGREE COLLIMATION -NEAR)

```
   3  20   10  12    9   2    2  14    5    4    1    1
  75.       100.      150.      200.0     250.0     300.0     350.0     400.0
 500.       600.      700.      800.      900.      1000.     1200.     1400.
1600.      1800.     2000.     2500.     3000.
 0.0        .1        .2        .3        .5        .7        1.0       1.5
 2.0        2.5       3.1416
 0.         .25       .50       .6        .7        .8        .9        1.0
 1.1        1.2       1.25      1.3       1.3134
     2   1   1   2   3   3
     3   1  -1   1   2   4   3   3
     3   1   2   4  -3   1   4   5
    -1   1  -2
     2   1  -4   3   2   4
     1   3                         0.0       0.0                 13924+04
     2   3                         0.0       0.0                 44521+04
     3   6                                                       31.
     4   6                                                       52.
 0.0        95625-04  29375-04  0.0       0.0       0.0       0.0       0.0
 0.0
 0.01193   0.0        1.063     0.0364    0.0978    0.6731    0.0411    0.1798
 0.02663
 1.0        7.0       8.0       11.0      13.0      14.0      19.0      20.0
26.0
 1.00797   14.007    15.995    22.990    26.98     28.086    39.102    40.08
55.847
 1.17       1.33
 3.70E+10  3.70E+10
 0.05       0.06      0.08      0.10      0.15      0.20      0.30      0.40
 0.50       0.60      0.80      1.00      1.50      2.0
12950-07 11880-07 13000-07 15960-07 25920-07 37080-07 59580-07 81480-07
10220-06 12220-06 15930-06 19230-06 26520-06 32720-06
 1.00E-04 1.00E-02 2.0
 0.0        0.0       0.0            1
4000.       0.0       0.0            1
8000.       0.0       0.0            1
16000.      0.0       0.0            1
24000.      0.0       0.0            1
32000.      0.0       0.0            1
48000.      0.0       0.0            1
64000.      0.0       0.0            1
                                    -1
```

```
PROBLEM 003B, OPEN SILO (150 DEGREE COLLIMATION -FAR)
   3  20   10  12    9   2   -2  14    5   4    1   1
3000.     3500.     4000.     4500.     5000.     6000.     7000.     8000.
9000.     10000.    15000.    20000.    25000.    30000.    35000.    40000.
50000.    60000.    70000.    80000.    100000.
0.0       .1        .2        .3        .5        .7        1.0       1.5
2.0       2.5       3.1416
0.        .25       .50       .6        .7        .8        .9        1.0
1.1       1.2       1.25      1.3       1.3134
    2   1   1   2   3   3
    3   1  -1   1   2   4   3   3
    3   1   2   4  -3   1   4   5
   -1   1  -2
    2   1  -4   3   2   4
    1   3                         0.0       0.0                 13924+04
    2   3                         0.0       0.0                 44521+04
    3   6                                                       31.
    4   6                                                       52.
0.0       95625-04  29375-04  0.0       0.0       0.0       0.0       0.0
0.0
0.01193   0.0       1.063     0.0364    0.0978    0.6731    0.0411    0.1798
0.02663
1.0       7.0       8.0       11.0      13.0      14.0      19.0      20.0
26.0
1.00797   14.007    15.995    22.990    26.98     28.086    39.102    40.08
55.847
1.17      1.33
3.70E+10  3.70E+10
0.05      0.06      0.08      0.10      0.15      0.20      0.30      0.40
0.50      0.60      0.80      1.00      1.50      2.0
12950-07 11880-07 13000-07 15960-07 25920-07 37080-07 59580-07 81480-07
10220-06 12220-06 15930-06 19230-06 26520-06 32720-06
1.00E-04 1.00E-02 2.0
0.0       0.0       0.0           1
4000.     0.0       0.0           1
8000.     0.0       0.0           1
16000.    0.0       0.0           1
24000.    0.0       0.0           1
32000.    0.0       0.0           1
48000.    0.0       0.0           1
64000.    0.0       0.0           1
                                 -1
STOP
```

```
        CONTROL    3   20   10   12    9    2    2   14    5    4    1    1    0    0    0    0
X OR    R  7.5000E+01  1.0000E+02  1.5000E+02  2.0000E+02  2.5000E+02  3.0000E+02  3.5000E+02  4.0000E+02
           5.0000E+02  6.0000E+02  7.0000E+02  8.0000E+02  9.0000E+02  1.0000E+03  1.2000E+03  1.4000E+03
           1.6000E+03  1.8000E+03  2.0000E+03  2.5000E+03  3.0000E+03
Y OR   PHI  0.0000E+00  1.0000E-01  2.0000E-01  3.0000E-01  5.0000E-01  7.0000E-01  1.0000E+00  1.5000E+00
            2.0000E+00  2.5000E+00  3.1416E+00
Z OR THETA  0.0000E+00  2.5000E-01  5.0000E-01  6.0000E-01  7.0000E-01  8.0000E-01  9.0000E-01  1.0000E+00
            1.1000E+00  1.2000E+00  1.2500E+00  1.3000E+00  1.3134E+00
X OR    R  8.7500E+01  1.2500E+02  1.7500E+02  2.2500E+02  2.7500E+02  3.2500E+02  3.7500E+02  4.5000E+02
           5.5000E+02  6.5000E+02  7.5000E+02  8.5000E+02  9.5000E+02  1.1000E+03  1.3000E+03  1.5000E+03
           1.7000E+03  1.9000E+03  2.2500E+03  2.7500E+03
Y OR   PHI  5.0000E-02  1.5000E-01  2.5000E-01  4.0000E-01  6.0000E-01  8.5000E-01  1.2500E+00  1.7500E+00
            2.2500E+00  2.8208E+00
Z OR THETA  1.2500E-01  3.7500E-01  5.5000E-01  6.5000E-01  7.5000E-01  8.5000E-01  9.5000E-01  1.0500E+00
            1.1500E+00  1.2250E+00  1.2750E+00  1.3067E+00
       F(L)  1.9271E+05  7.9167E+05  1.5417E+06  2.5417E+06  3.7917E+06  5.2917E+06  7.0417E+06  2.0333E+07
             3.0333E+07  4.2333E+07  5.6333E+07  7.2333E+07  9.0333E+07  2.4267E+08  3.3867E+08  4.5067E+08
             5.7867E+08  7.2267E+08  2.5417E+09  3.7917E+09
       F(M)  1.0000E-01  1.0000E-01  1.0000E-01  2.0000E-01  2.0000E-01  3.0000E-01  5.0000E-01  5.0000E-01
             5.0000E-01  6.4160E-01
       F(N)  3.1088E-02  9.1330E-02  5.2247E-02  6.0493E-02  6.8136E-02  7.5097E-02  8.1308E-02  8.6707E-02
             9.1238E-02  4.7036E-02  4.7824E-02  1.2935E-02
```

ZONE	BNDS	COMP	BND1	PK1	BND2	PK2	BND3	PK3	BND4	PK4	BND5	PK5	BND6	PK6
1	2	1	1	2	3	3								
2	3	1	-1	1	2	4	3	3						
3	3	1	2	4	-3	1	4	5						
4	-1	1	-2	0										
5	2	1	-4	3	2	4								

BND	EQ	A	B	C	X0	Y0	Z0	K
1	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3924E+04
2	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.4521E+04
3	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.1000E+01
4	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.2000E+01

COMP	MAT,	1	2	3	4	5	6	7	8	9
		H	N	O	NA	AL	SI	K	CA	FE
A		1.0080E+00	1.4007E+01	1.5995E+01	2.2990E+01	2.6980E+01	2.8086E+01	3.9102E+01	4.0080E+01	5.5847E+01
1		0.0000E+00	9.5625E-04	2.9375E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2		1.1930E-02	0.0000E+00	1.0630E+00	3.6400E-02	9.7800E-02	6.7310E-01	4.1100E-02	1.7980E-01	2.6630E-02

```
    1      X= 4.0000E+03   Y= 0.0000E+00   Z= 0.0000E+00
SOURCE    X= 0.0000E+00   Y= 0.0000E+00   Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	2.9660E-04	3.3502E-04	6.9617E-06	9.1786E-06	3.0577E-04	1
2	1.3300E+00	3.7000E+10	3.3477E-04	3.7171E-04	6.9806E-06	9.0239E-06	3.4379E-04	2
TOTALS			6.3137E-04	7.0672E-04	1.3942E-05	1.8203E-05	6.4957E-04	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.2518E-06	2.7912E-06	7
8	3.0000E-01	5.9580E-07	1.7569E-06	2.7362E-06	8
9	4.0000E-01	8.1480E-07	1.7636E-06	2.2866E-06	9
10	5.0000E-01	1.0220E-06	1.8522E-06	2.2051E-06	10
11	6.0000E-01	1.2220E-06	3.6438E-06	4.1185E-06	11
12	8.0000E-01	1.5930E-06	2.7944E-06	3.0941E-06	12
13	1.0000E+00	1.9230E-06	8.8169E-07	9.7348E-07	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
    2      X= 8.0000E+03   Y= 0.0000E+00   Z= 0.0000E+00
SOURCE    X= 0.0000E+00   Y= 0.0000E+00   Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	5.5051E-05	8.0082E-05	1.3949E-06	2.6770E-06	5.7728E-05	1
2	1.3300E+00	3.7000E+10	6.3329E-05	8.8076E-05	1.4303E-06	2.6336E-06	6.5963E-05	2
TOTALS			1.1838E-04	1.6816E-04	2.8252E-06	5.3107E-06	1.2369E-04	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.6221E-07	6.7186E-07	7
8	3.0000E-01	5.9580E-07	2.4396E-07	7.2479E-07	8
9	4.0000E-01	8.1480E-07	2.6561E-07	6.0399E-07	9
10	5.0000E-01	1.0220E-06	3.1124E-07	5.7822E-07	10
11	6.0000E-01	1.2220E-06	7.2415E-07	1.1476E-06	11
12	8.0000E-01	1.5930E-06	8.0034E-07	1.1444E-06	12
13	1.0000E+00	1.9230E-06	3.1788E-07	4.4007E-07	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
  3      X=  1.6000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	7.5864E-06	1.7567E-05	1.7132E-07	5.5333E-07	8.1397E-06	1
2	1.3300E+00	3.7000E+10	9.0651E-06	1.9575E-05	1.8160E-07	5.5441E-07	9.6195E-06	2
TOTALS			1.6651E-05	3.7142E-05	3.5292E-07	1.1077E-06	1.7759E-05	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.1749E-08	9.1042E-08	7
8	3.0000E-01	5.9580E-07	2.1326E-08	1.2651E-07	8
9	4.0000E-01	8.1480E-07	2.7318E-08	1.2556E-07	9
10	5.0000E-01	1.0220E-06	3.4223E-08	1.1853E-07	10
11	6.0000E-01	1.2220E-06	8.7213E-08	2.4360E-07	11
12	8.0000E-01	1.5930E-06	1.1007E-07	2.6526E-07	12
13	1.0000E+00	1.9230E-06	6.1053E-08	1.3737E-07	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
  4      X=  2.4000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	1.8586E-06	5.8020E-06	3.6493E-08	1.6603E-07	2.0246E-06	1
2	1.3300E+00	3.7000E+10	2.3069E-06	6.6455E-06	3.9932E-08	1.6948E-07	2.4763E-06	2
TOTALS			4.1654E-06	1.2447E-05	7.6425E-08	3.3551E-07	4.5009E-06	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.5839E-09	1.9075E-08	7
8	3.0000E-01	5.9580E-07	3.2089E-09	3.0079E-08	8
9	4.0000E-01	8.1480E-07	5.3699E-09	3.9013E-08	9
10	5.0000E-01	1.0220E-06	6.0822E-09	3.2911E-08	10
11	6.0000E-01	1.2220E-06	1.8416E-08	7.7038E-08	11
12	8.0000E-01	1.5930E-06	2.5902E-08	8.8071E-08	12
13	1.0000E+00	1.9230E-06	1.5869E-08	4.9340E-08	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

5	X= 3.2000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	5.7627E-07	2.2389E-06	9.8903E-09	6.0411E-08	6.3668E-07	1
2	1.3300E+00	3.7000E+10	7.4298E-07	2.6202E-06	1.1172E-08	6.2372E-08	8.0535E-07	2
TOTALS			1.3192E-06	4.8591E-06	2.1062E-08	1.2278E-07	1.4420E-06	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	2.8706E-10	5.1658E-09	7
8	3.0000E-01	5.9580E-07	6.4595E-10	8.9444E-09	8
9	4.0000E-01	8.1480E-07	1.2439E-09	1.3235E-08	9
10	5.0000E-01	1.0220E-06	1.4371E-09	1.1476E-08	10
11	6.0000E-01	1.2220E-06	5.0294E-09	3.0281E-08	11
12	8.0000E-01	1.5930E-06	7.4714E-09	3.4065E-08	12
13	1.0000E+00	1.9230E-06	4.9489E-09	1.9625E-08	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

6	X= 4.8000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	7.7821E-08	4.2150E-07	1.0465E-09	9.9115E-09	8.7732E-08	1
2	1.3300E+00	3.7000E+10	1.0826E-07	5.1063E-07	1.2602E-09	1.0506E-08	1.1876E-07	2
TOTALS			1.8608E-07	9.3213E-07	2.3067E-09	2.0417E-08	2.0649E-07	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.3631E-11	4.7392E-10	7
8	3.0000E-01	5.9580E-07	3.6343E-11	9.9207E-10	8
9	4.0000E-01	8.1480E-07	9.3495E-11	1.8621E-09	9
10	5.0000E-01	1.0220E-06	1.1340E-10	1.6193E-09	10
11	6.0000E-01	1.2220E-06	5.1697E-10	5.3318E-09	11
12	8.0000E-01	1.5930E-06	8.5549E-10	6.2169E-09	12
13	1.0000E+00	1.9230E-06	6.7762E-10	3.9226E-09	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

SAMPLE PROBLEM 003A, OPEN SILO PROBLEM (150 DEGREE COLLIMATION -NEAR)

7	X= 6.4000E+04	Y= 0.0000E+00	Z= 0.0000E+00					
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00					

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	1.3301E-08	9.4444E-08	1.4439E-10	1.8232E-09	1.5124E-08	1
2	1.3300E+00	3.7000E+10	1.9964E-08	1.1997E-07	1.8542E-10	2.0117E-09	2.1975E-08	2
TOTALS			3.3264E-08	2.1441E-07	3.2982E-10	3.8349E-09	3.7099E-08	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	8.0993E-13	4.4751E-11	7
8	3.0000E-01	5.9580E-07	2.7363E-12	1.2123E-10	8
9	4.0000E-01	8.1480E-07	8.5397E-12	2.7648E-10	9
10	5.0000E-01	1.0220E-06	1.1616E-11	2.5853E-10	10
11	6.0000E-01	1.2220E-06	6.6069E-11	9.8595E-10	11
12	8.0000E-01	1.5930E-06	1.2582E-10	1.2636E-09	12
13	1.0000E+00	1.9230E-06	1.1426E-10	8.8475E-10	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
     CONTROL    3   20   10    12     9     2     2    14     5     4     1     1     0     0     0     0

X OR     R  3.0000E+03  3.5000E+03  4.0000E+03  4.5000E+03  5.0000E+03  6.0000E+03  7.0000E+03  8.0000E+03
            9.0000E+03  1.0000E+04  1.5000E+04  2.0000E+04  2.5000E+04  3.0000E+04  3.5000E+04  4.0000E+04
            5.0000E+04  6.0000E+04  7.0000E+04  8.0000E+04  1.0000E+05

Y OR   PHI  0.0000E+00  1.0000E-01  2.0000E-01  3.0000E-01  5.0000E-01  7.0000E-01  1.0000E+00  1.5000E+00
            2.0000E+00  2.5000E+00  3.1416E+00

Z OR THETA  0.0000E+00  2.5000E-01  5.0000E-01  6.0000E-01  7.0000E-01  8.0000E-01  9.0000E-01  1.0000E+00
            1.1000E+00  1.2000E+00  1.2500E+00  1.3000E+00  1.3134E+00

X OR     R  3.2500E+03  3.7500E+03  4.2500E+03  4.7500E+03  5.5000E+03  6.5000E+03  7.5000E+03  8.5000E+03
            9.5000E+03  1.2500E+04  1.7500E+04  2.2500E+04  2.7500E+04  3.2500E+04  3.7500E+04  4.5000E+04
            5.5000E+04  6.5000E+04  7.5000E+04  9.0000E+04

Y OR   PHI  5.0000E-02  1.5000E-01  2.5000E-01  4.0000E-01  6.0000E-01  8.5000E-01  1.2500E+00  1.7500E+00
            2.2500E+00  2.8208E+00

Z OR THETA  1.2500E-01  3.7500E-01  5.5000E-01  6.5000E-01  7.5000E-01  8.5000E-01  9.5000E-01  1.0500E+00
            1.1500E+00  1.2250E+00  1.2750E+00  1.3067E+00

       F(L)  5.2917E+09  7.0417E+09  9.0417E+09  1.1292E+10  3.0333E+10  4.2333E+10  5.6333E+10  7.2333E+10
             9.0333E+10  7.9167E+11  1.5417E+12  2.5417E+12  3.7917E+12  5.2917E+12  7.0417E+12  2.0333E+13
             3.0333E+13  4.2333E+13  5.6333E+13  1.6267E+14

       F(M)  1.0000E-01  1.0000E-01  1.0000E-01  2.0000E-01  2.0000E-01  3.0000E-01  5.0000E-01  5.0000E-01
             5.0000E-01  6.4160E-01

       F(N)  3.1088E-02  9.1330E-02  5.2247E-02  6.0493E-02  6.8136E-02  7.5097E-02  8.1308E-02  8.6707E-02
             9.1238E-02  4.7036E-02  4.7824E-02  1.2935E-02
```

```
ZONE  BNDS  COMP  BND1  PK1  BND2  PK2  BND3  PK3  BND4  PK4  BND5  PK5  BND6  PK6

 1     2     1     1     2     3     3
 2     3     1    -1     1     2     4     3     3
 3     3     1     2     4    -3     1     4     5
 4    -1     1    -2     0
 5     2     1    -4     3     2     4
```

```
BND   EQ       A            B            C            XO           YO           ZO           K

 1     3   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   1.3924E+04
 2     3   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   4.4521E+04
 3     6   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   3.1000E+01
 4     6   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   0.0000E+00   5.2000E+01
```

```
COMP  MAT.     1           2           3           4           5           6           7           8           9
               H           N           O          NA          AL          SI           K          CA          FE
   A      1.0080E+00  1.4007E+01  1.5995E+01  2.2990E+01  2.6980E+01  2.8086E+01  3.9102E+01  4.0080E+01  5.5847E+01
   1      0.0000E+00  9.5625E-04  2.9375E-04  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
   2      1.1930E-02  0.0000E+00  1.0630E+00  3.6400E-02  9.7800E-02  6.7310E-01  4.1100E-02  1.7980E-01  2.6630E-02
```

1	X= 4.0000E+03	Y= 0.0000E+00	Z= 0.0000E+00					
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00					
GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	2.9660E-04	3.3502E-04	1.7884E-06	3.5928E-06	3.0019E-04	1
2	1.3300E+00	3.7000E+10	3.3477E-04	3.7171E-04	1.7361E-06	3.4370E-06	3.3821E-04	2
TOTALS			6.3137E-04	7.0672E-04	3.5245E-06	7.0298E-06	6.3840E-04	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	2.2365E-06	5.5083E-06	7
8	3.0000E-01	5.9580E-07	8.5298E-07	1.0535E-06	8
9	4.0000E-01	8.1480E-07	3.0775E-07	3.3511E-07	9
10	5.0000E-01	1.0220E-06	1.2730E-07	1.3254E-07	10
11	6.0000E-01	1.2220E-06	0.0000E+00	0.0000E+00	11
12	8.0000E-01	1.5930E-06	0.0000E+00	0.0000E+00	12
13	1.0000E+00	1.9230E-06	0.0000E+00	0.0000E+00	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

2	X= 8.0000E+03	Y= 0.0000E+00	Z= 0.0000E+00					
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00					
GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	5.5051E-05	8.0082E-05	1.2855E-06	2.7382E-06	5.7790E-05	1
2	1.3300E+00	3.7000E+10	6.3329E-05	8.8076E-05	1.2976E-06	2.6847E-06	6.6014E-05	2
TOTALS			1.1838E-04	1.6816E-04	2.5831E-06	5.4229E-06	1.2380E-04	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	5.4278E-07	2.1692E-06	7
8	3.0000E-01	5.9580E-07	5.0247E-07	1.1006E-06	8
9	4.0000E-01	8.1480E-07	4.0329E-07	6.6716E-07	9
10	5.0000E-01	1.0220E-06	3.4549E-07	4.8866E-07	10
11	6.0000E-01	1.2220E-06	5.4394E-07	6.9843E-07	11
12	8.0000E-01	1.5930E-06	2.2684E-07	2.7843E-07	12
13	1.0000E+00	1.9230E-06	1.8308E-08	2.2226E-08	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

3	X= 1.6000E+04	Y=	0.0000E+00	Z=	0.0000E+00			
SOURCE	X= 0.0000E+00	Y=	0.0000E+00	Z=	0.0000E+00			

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	7.5864E-06	1.7567E-05	3.7921E-07	1.1417E-06	8.7281E-06	1
2	1.3300E+00	3.7000E+10	9.0651E-06	1.9575E-05	4.0022E-07	1.1514E-06	1.0217E-05	2
TOTALS			1.6651E-05	3.7142E-05	7.7944E-07	2.2932E-06	1.8945E-05	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	6.9465E-08	4.4394E-07	7
8	3.0000E-01	5.9580E-07	8.5641E-08	4.0894E-07	8
9	4.0000E-01	8.1480E-07	1.2075E-07	3.6106E-07	9
10	5.0000E-01	1.0220E-06	1.2376E-07	2.9072E-07	10
11	6.0000E-01	1.2220E-06	1.9004E-07	4.1618E-07	11
12	8.0000E-01	1.5930E-06	1.5692E-07	3.0892E-07	12
13	1.0000E+00	1.9230E-06	3.3032E-08	6.3506E-08	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

4	X= 2.4000E+04	Y=	0.0000E+00	Z=	0.0000E+00			
SOURCE	X= 0.0000E+00	Y=	0.0000E+00	Z=	0.0000E+00			

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	1.8586E-06	5.8020E-06	1.2498E-07	4.8913E-07	2.3477E-06	1
2	1.3300E+00	3.7000E+10	2.3069E-06	6.6455E-06	1.3693E-07	5.0741E-07	2.8143E-06	2
TOTALS			4.1654E-06	1.2447E-05	2.6191E-07	9.9654E-07	5.1620E-06	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	9.3746E-09	9.6437E-08	7
8	3.0000E-01	5.9580E-07	2.7792E-08	1.7213E-07	8
9	4.0000E-01	8.1480E-07	2.7178E-08	1.3123E-07	9
10	5.0000E-01	1.0220E-06	3.6357E-08	1.3525E-07	10
11	6.0000E-01	1.2220E-06	7.9526E-08	2.3905E-07	11
12	8.0000E-01	1.5930E-06	6.4137E-08	1.7508E-07	12
13	1.0000E+00	1.9230E-06	1.7558E-08	4.7549E-08	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
   5       X= 3.2000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE    X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	5.7627E-07	2.2389E-06	4.4992E-08	2.2215E-07	7.9843E-07	1
2	1.3300E+00	3.7000E+10	7.4298E-07	2.6202E-06	5.1104E-08	2.3598E-07	9.7896E-07	2
TOTALS			1.3192E-06	4.8591E-06	9.6096E-08	4.5814E-07	1.7774E-06	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	1.7469E-09	2.5629E-08	7
8	3.0000E-01	5.9580E-07	6.6022E-09	5.9305E-08	8
9	4.0000E-01	8.1480E-07	9.8017E-09	6.1704E-08	9
10	5.0000E-01	1.0220E-06	1.1707E-08	6.2054E-08	10
11	6.0000E-01	1.2220E-06	2.9415E-08	1.1989E-07	11
12	8.0000E-01	1.5930E-06	2.8053E-08	9.9514E-08	12
13	1.0000E+00	1.9230E-06	8.7813E-09	3.0171E-08	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

```
   6       X= 4.8000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE    X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	7.7821E-08	4.2150E-07	6.9213E-09	5.1082E-08	1.2890E-07	1
2	1.3300E+00	3.7000E+10	1.0826E-07	5.1063E-07	8.4294E-09	5.6446E-08	1.6470E-07	2
TOTALS			1.8608E-07	9.3213E-07	1.5351E-08	1.0753E-07	2.9360E-07	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	8.6603E-11	2.0987E-09	7
8	3.0000E-01	5.9580E-07	6.2260E-10	8.5907E-09	8
9	4.0000E-01	8.1480E-07	9.4687E-10	1.1098E-08	9
10	5.0000E-01	1.0220E-06	1.6305E-09	1.4221E-08	10
11	6.0000E-01	1.2220E-06	4.7832E-09	3.2260E-08	11
12	8.0000E-01	1.5930E-06	5.3895E-09	2.9823E-08	12
13	1.0000E+00	1.9230E-06	1.8922E-09	9.4479E-09	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

7	X= 6.4000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.1700E+00	3.7000E+10	1.3301E-08	9.4444E-08	1.2277E-09	1.2199E-08	2.5500E-08	1
2	1.3300E+00	3.7000E+10	1.9964E-08	1.1997E-07	1.6017E-09	1.4092E-08	3.4056E-08	2
TOTALS			3.3264E-08	2.1441E-07	2.8294E-09	2.6292E-08	5.9556E-08	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	1.2950E-07	0.0000E+00	0.0000E+00	1
2	5.0000E-02	1.2950E-07	0.0000E+00	0.0000E+00	2
3	6.0000E-02	1.1880E-07	0.0000E+00	0.0000E+00	3
4	8.0000E-02	1.3000E-07	0.0000E+00	0.0000E+00	4
5	1.0000E-01	1.5960E-07	0.0000E+00	0.0000E+00	5
6	1.5000E-01	2.5920E-07	0.0000E+00	0.0000E+00	6
7	2.0000E-01	3.7080E-07	4.8242E-12	1.8108E-10	7
8	3.0000E-01	5.9580E-07	5.1091E-11	1.1677E-09	8
9	4.0000E-01	8.1480E-07	1.4086E-10	2.1997E-09	9
10	5.0000E-01	1.0220E-06	2.3486E-10	3.1245E-09	10
11	6.0000E-01	1.2220E-06	8.1766E-10	7.9242E-09	11
12	8.0000E-01	1.5930E-06	1.1336E-09	8.7239E-09	12
13	1.0000E+00	1.9230E-06	4.4694E-10	2.9772E-09	13
14	1.5000E+00	2.6520E-06	0.0000E+00	0.0000E+00	14
15	2.0000E+00	3.2720E-06	0.0000E+00	0.0000E+00	15

Table E6.7. PROBLEM GGG006, OPEN SILO PROBLEM - Input Data

```
    3 20 . 20  20   -9   2   1  14    5   4    1   1
   55.        90.       125.      150.0    210.0    315.0    465.0    680.0
  1000.      1470.     2155.     3160.    4640.    6810.   10000.   14760.
 21550.     31660.    46410.    68130.   100000.
  0.0        .025      .05       .075     .1       .15      .2       .25
  .3         .4        .5        .6       .8       1.0      1.2      1.4
  1.6        1.8       2.0       2.4      3.1416
  0.         .1        .2        .3       .4       .5       .6       .70
  .75        .8        .85       .9       .95      1.0      1.05     1.10
  1.125      1.25      1.275     1.3      1.314
    2   1    1    2    3    3
    3   2   -1    1    2    4    3    3
    3   1    2    4   -3    1    4    5
   -1   1   -2
    2   1   -4    3    2    4
    1   3                        0.0      0.0              13924+04
    2   3                        0.0      0.0              44521+04
    3   6                                                  31.
    4   6                                                  52.0
  0.0      95625-04 29375-04 0.0      0.0      0.0      0.0      0.0
  0.0
  0.01193  0.0      1.063    0.0364   0.0978   0.6731   0.0411   0.1798
  0.02663
  1.0      7.0      8.0      11.0     13.0     14.0     19.0     20.0
  26.0
  1.00797  14.007   15.995   22.990   26.98    28.086   39.102   40.08
  55.847
  1.25
  2.
  0.05     0.06     0.08     0.10     0.15     0.20     0.30     0.40
  0.50     0.60     0.80     1.00     1.50     2.0
 34315-11 31158-11 33911-11 41655-11 67987-11 97255-11 15799-10 21580-10
 27342-10 32480-10 42132-10 51013-10 69914-10 85878-10
  1.00E-04 1.00E-02 2.0
  0.0      0.0      0.0         1
  4000.    0.0      0.0         1
  8000.    0.0      0.0         1
 16000.    0.0      0.0         1
 24000.    0.0      0.0         1
 32000.    0.0      0.0         1
 48000.    0.0      0.0         1
 64000.    0.0      0.0         1
                                -1
STOP
```

```
     CONTROL    3    20    20    20     9     2     1    14     5     4     1     1     0     0     0     0
X OR     R  5.5000E+01  9.0000E+01  1.2500E+02  1.5000E+02  2.1000E+02  3.1500E+02  4.6500E+02  6.8000E+02
            1.0000E+03  1.4700E+03  2.1550E+03  3.1600E+03  4.6400E+03  6.8100E+03  1.0000E+04  1.4760E+04
            2.1550E+04  3.1660E+04  4.6410E+04  6.8130E+04  1.0000E+05
Y OR   PHI  0.0000E+00  2.5000E-02  5.0000E-02  7.5000E-02  1.0000E-01  1.5000E-01  2.0000E-01  2.5000E-01
            3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  8.0000E-01  1.0000E+00  1.2000E+00  1.4000E+00
            1.6000E+00  1.8000E+00  2.0000E+00  2.4000E+00  3.1416E+00
Z OR THETA  0.0000E+00  1.0000E-01  2.0000E-01  3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  7.0000E-01
            7.5000E-01  8.0000E-01  8.5000E-01  9.0000E-01  9.5000E-01  1.0000E+00  1.0500E+00  1.1000E+00
            1.1250E+00  1.2500E+00  1.2750E+00  1.3000E+00  1.3140E+00
X OR     R  7.2500E+01  1.0750E+02  1.3750E+02  1.8000E+02  2.6250E+02  3.9000E+02  5.7250E+02  8.4000E+02
            1.2350E+03  1.8125E+03  2.6575E+03  3.9000E+03  5.7250E+03  8.4050E+03  1.2380E+04  1.8155E+04
            2.6605E+04  3.9035E+04  5.7270E+04  8.4065E+04
Y OR   PHI  1.2500E-02  3.7500E-02  6.2500E-02  8.7500E-02  1.2500E-01  1.7500E-01  2.2500E-01  2.7500E-01
            3.5000E-01  4.5000E-01  5.5000E-01  7.0000E-01  9.0000E-01  1.1000E+00  1.3000E+00  1.5000E+00
            1.7000E+00  1.9000E+00  2.2000E+00  2.7708E+00
Z OR THETA  5.0000E-02  1.5000E-01  2.5000E-01  3.5000E-01  4.5000E-01  5.5000E-01  6.5000E-01  7.2500E-01
            7.7500E-01  8.2500E-01  8.7500E-01  9.2500E-01  9.7500E-01  1.0250E+00  1.0750E+00  1.1125E+00
            1.1875E+00  1.2625E+00  1.2875E+00  1.3070E+00
     F(L)   1.8754E+05  4.0804E+05  4.7396E+05  1.9620E+06  7.3316E+06  2.3096E+07  7.1296E+07  2.2852E+08
            7.2551E+08  2.2771E+09  7.1822E+09  2.2781E+10  7.1975E+10  2.2806E+11  7.3853E+11  2.2641E+12
            7.2422E+12  2.2742E+13  7.2092E+13  2.2792E+14
     F(M)   2.5000E-02  2.5000E-02  2.5000E-02  2.5000E-02  5.0000E-02  5.0000E-02  5.0000E-02  5.0000E-02
            1.0000E-01  1.0000E-01  1.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01
            2.0000E-01  2.0000E-01  4.0000E-01  7.4160E-01
     F(N)   4.9958E-03  1.4938E-02  2.4730E-02  3.4275E-02  4.3478E-02  5.2247E-02  6.0493E-02  3.3153E-02
            3.4982E-02  3.6724E-02  3.8373E-02  3.9927E-02  4.1381E-02  4.2731E-02  4.3975E-02  2.2419E-02
            1.1585E-01  2.3820E-02  2.4003E-02  1.3516E-02
```

ZONE	BNDS	COMP	BND1	PK1	BND2	PK2	BND3	PK3	BND4	PK4	BND5	PK5	BND6	PK6
1	2	1	1	2	3	3								
2	3	2	-1	1	2	4	3	3						
3	3	1	2	4	-3	1	4	5						
4	-1	1	-2	0										
5	2	1	-4	3	2	4								

BND	EQ	A	B	C	X0	Y0	Z0	K
1	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3924E+04
2	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.4521E+04
3	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.1000E+01
4	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.2000E+01

COMP	MAT,	1	2	3	4	5	6	7	8	9
		H	N	O	NA	AL	SI	K	CA	FE
A		1.0080E+00	1.4007E+01	1.5995E+01	2.2990E+01	2.6980E+01	2.8086E+01	3.9102E+01	4.0080E+01	5.5847E+01
1		0.0000E+00	9.5625E-04	2.9375E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2		1.1930E-02	0.0000E+00	1.0630E+00	3.6400E-02	9.7800E-02	6.7310E-01	4.1100E-02	1.7980E-01	2.6630E-02

1   X= 4.0000E+03   Y= 0.0000E+00   Z= 0.0000E+00
SOURCE   X= 0.0000E+00   Y= 0.0000E+00   Z= 0.0000E+00

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	4.8726E-23	6.0086E-22	1.2621E-19	1.8185E-19	1.8190E-19	1
TOTALS			4.8726E-23	6.0086E-22	1.2621E-19	1.8185E-19	1.8190E-19	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.3175E-20	5.7328E-20	7
8	3.0000E-01	1.5799E-10	2.1352E-20	3.0098E-20	8
9	4.0000E-01	2.1580E-10	1.3693E-20	1.7667E-20	9
10	5.0000E-01	2.7342E-10	1.4464E-20	1.7080E-20	10
11	6.0000E-01	3.2480E-10	2.7178E-20	3.0618E-20	11
12	8.0000E-01	4.2132E-10	2.0329E-20	2.2540E-20	12
13	1.0000E+00	5.1013E-10	6.0217E-21	6.6745E-21	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

2   X= 8.0000E+03   Y= 0.0000E+00   Z= 0.0000E+00
SOURCE   X= 0.0000E+00   Y= 0.0000E+00   Z= 0.0000E+00

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	9.1305E-24	1.1125E-22	3.9241E-20	7.7686E-20	7.7696E-20	1
TOTALS			9.1305E-24	1.1125E-22	3.9241E-20	7.7686E-20	7.7696E-20	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	6.0758E-21	2.2003E-20	7
8	3.0000E-01	1.5799E-10	4.2680E-21	1.1417E-20	8
9	4.0000E-01	2.1580E-10	4.6481E-21	8.9144E-21	9
10	5.0000E-01	2.7342E-10	5.1841E-21	8.2872E-21	10
11	6.0000E-01	3.2480E-10	9.3245E-21	1.3526E-20	11
12	8.0000E-01	4.2132E-10	7.4359E-21	1.0330E-20	12
13	1.0000E+00	5.1013E-10	2.3181E-21	3.2185E-21	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

3   X= 1.6000E+04   Y= 0.0000E+00   Z= 0.0000E+00

SOURCE   X= 0.0000E+00   Y= 0.0000E+00   Z= 0.0000E+00

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	1.2824E-24	1.5336E-23	8.2451E-21	2.4656E-20	2.4657E-20	1
TOTALS			1.2824E-24	1.5336E-23	8.2451E-21	2.4656E-20	2.4657E-20	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	5.7467E-22	3.8230E-21	7
8	3.0000E-01	1.5799E-10	7.7056E-22	3.8303E-21	8
9	4.0000E-01	2.1580E-10	1.1129E-21	3.5691E-21	9
10	5.0000E-01	2.7342E-10	1.0597E-21	2.8610E-21	10
11	6.0000E-01	3.2480E-10	2.0928E-21	4.9229E-21	11
12	8.0000E-01	4.2132E-10	1.9962E-21	4.2755E-21	12
13	1.0000E+00	5.1013E-10	6.3898E-22	1.3857E-21	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

4   X= 2.4000E+04   Y= 0.0000E+00   Z= 0.0000E+00

SOURCE   X= 0.0000E+00   Y= 0.0000E+00   Z= 0.0000E+00

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	3.2019E-25	3.8119E-24	2.4485E-21	9.6326E-21	9.6330E-21	1
TOTALS			3.2019E-25	3.8119E-24	2.4485E-21	9.6326E-21	9.6330E-21	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.0263E-22	9.3376E-22	7
8	3.0000E-01	1.5799E-10	1.5953E-22	1.2215E-21	8
9	4.0000E-01	2.1580E-10	2.7473E-22	1.3624E-21	9
10	5.0000E-01	2.7342E-10	3.2345E-22	1.2494E-21	10
11	6.0000E-01	3.2480E-10	6.7342E-22	2.1926E-21	11
12	8.0000E-01	4.2132E-10	6.8574E-22	2.0014E-21	12
13	1.0000E+00	5.1013E-10	2.2978E-22	6.7670E-22	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

5	X= 3.2000E+04	Y=	0.0000E+00	Z=	0.0000E+00		
SOURCE	X= 0.0000E+00	Y=	0.0000E+00	Z=	0.0000E+00		

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	1.0118E-25	1.2266E-24	8.4600E-22	4.2008E-21	4.2009E-21	1
TOTALS			1.0118E-25	1.2266E-24	8.4600E-22	4.2008E-21	4.2009E-21	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.4483E-23	2.2147E-22	7
8	3.0000E-01	1.5799E-10	4.6350E-23	4.6040E-22	8
9	4.0000E-01	2.1580E-10	9.2309E-23	5.8734E-22	9
10	5.0000E-01	2.7342E-10	9.5311E-23	5.3635E-22	10
11	6.0000E-01	3.2480E-10	2.3009E-22	1.0258E-21	11
12	8.0000E-01	4.2132E-10	2.7607E-22	1.0292E-21	12
13	1.0000E+00	5.1013E-10	9.1809E-23	3.4106E-22	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

6	X= 4.8000E+04	Y=	0.0000E+00	Z=	0.0000E+00		
SOURCE	X= 0.0000E+00	Y=	0.0000E+00	Z=	0.0000E+00		

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	1.4193E-26	1.9539E-25	1.2742E-22	9.2514E-22	9.2516E-22	1
TOTALS			1.4193E-26	1.9539E-25	1.2742E-22	9.2514E-22	9.2516E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	7.4062E-25	1.9020E-23	7
8	3.0000E-01	1.5799E-10	3.5579E-24	6.2552E-23	8
9	4.0000E-01	2.1580E-10	9.6859E-24	1.0334E-22	9
10	5.0000E-01	2.7342E-10	1.2960E-23	1.1576E-22	10
11	6.0000E-01	3.2480E-10	3.4975E-23	2.5629E-22	11
12	8.0000E-01	4.2132E-10	4.7549E-23	2.7223E-22	12
13	1.0000E+00	5.1013E-10	1.7988E-23	9.6420E-23	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
  7      X=  6.4000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	2.5198E-27	4.4136E-26	2.2712E-23	2.1788E-22	2.1788E-22	1
TOTALS			2.5198E-27	4.4136E-26	2.2712E-23	2.1788E-22	2.1788E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.8367E-26	1.4666E-24	7
8	3.0000E-01	1.5799E-10	5.3041E-25	1.0327E-23	8
9	4.0000E-01	2.1580E-10	1.0420E-24	1.7749E-23	9
10	5.0000E-01	2.7342E-10	1.4857E-24	2.2537E-23	10
11	6.0000E-01	3.2480E-10	6.4429E-24	6.5009E-23	11
12	8.0000E-01	4.2132E-10	9.3745E-24	7.3675E-23	12
13	1.0000E+00	5.1013E-10	3.8111E-24	2.7161E-23	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

Table E6.9. PROBLEM GGG007, SHIELDED SILO (21 CM CONCRETE) - Data

```
   3  20   20  20    9   2    1  14    5   4    1   1
 55.        90.      125.     150.0    210.0   315.0    465.0     680.0
 1000.      1470.    2155.    3160.    4640.   6810.    10000.    14760.
 21550.     31660.   46410.   68130.   100000.
 0.0        .025     .05      .075     .1      .15      .2        .25
 .3         .4       .5       .6       .8      1.0      1.2       1.4
 1.6        1.8      2.0      2.4      3.1416
 0.         .1       .2       .3       .4      .5       .6        .70
 .75        .8       .85      .9       .95     1.0      1.05      1.10
 1.125      1.25     1.275    1.3      1.314
      2   1    1   2    3   3
      3   2   -1   1    2   4    3   3
      3   2    2   4   -3   1    4   5
     -1   1   -2
      2   1   -4   3    2   4
      1   3                        0.0      0.0               13924+04
      2   3                        0.0      0.0               44521+04
      3   6                                                   31.
      4   6                                                   52.0
 0.0        95625-04 29375-04 0.0      0.0     0.0      0.0       0.0
 0.0
 12992-02   0.0      1.15606  39672-02 11136-01 73544-01 44544-02 19163-01
 28304-02
 1.0        7.0      8.0      11.0     13.0    14.0     19.0      20.0
 26.0
 1.00797    14.007   15.995   22.990   26.98   28.086   39.102    40.08
 55.847
 1.25
 2.
 0.05       0.06     0.08     0.10     0.15    0.20     0.30      0.40
 0.50       0.60     0.80     1.00     1.50    2.0
 34315-11   31158-11 33911-11 41655-11 67987-11 97255-11 15799-10 21580-10
 27342-10   32480-10 42132-10 51013-10 69914-10 85878-10
 1.00E-04   1.00E-02 2.0
 0.0        0.0      0.0          1
 4000.      0.0      0.0          1
 8000.      0.0      0.0          1
 16000.     0.0      0.0          1
 24000.     0.0      0.0          1
 32000.     0.0      0.0          1
 48000.     0.0      0.0          1
 64000.     0.0      0.0          1
                              -1
STOP
```

```
        CONTROL    3    20    20    20     9     2     1    14     5     4     1     1     0     0     0     0
X OR      R  5.5000E+01  9.0000E+01  1.2500E+02  1.5000E+02  2.1000E+02  3.1500E+02  4.6500E+02  6.8000E+02
             1.0000E+03  1.4700E+03  2.1550E+03  3.1600E+03  4.6400E+03  6.8100E+03  1.0000E+04  1.4760E+04
             2.1550E+04  3.1660E+04  4.6410E+04  6.8130E+04  1.0000E+05
Y OR    PHI  0.0000E+00  2.5000E-02  5.0000E-02  7.5000E-02  1.0000E-01  1.5000E-01  2.0000E-01  2.5000E-01
             3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  8.0000E-01  1.0000E+00  1.2000E+00  1.4000E+00
             1.6000E+00  1.8000E+00  2.0000E+00  2.4000E+00  3.1416E+00
Z OR THETA   0.0000E+00  1.0000E-01  2.0000E-01  3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  7.0000E-01
             7.5000E-01  8.0000E-01  8.5000E-01  9.0000E-01  9.5000E-01  1.0000E+00  1.0500E+00  1.1000E+00
             1.1250E+00  1.2500E+00  1.2750E+00  1.3000E+00  1.3140E+00
X OR      R  7.2500E+01  1.0750E+02  1.3750E+02  1.8000E+02  2.6250E+02  3.9000E+02  5.7250E+02  8.4000E+02
             1.2350E+03  1.8125E+03  2.6575E+03  3.9000E+03  5.7250E+03  8.4050E+03  1.2380E+04  1.8155E+04
             2.6605E+04  3.9035E+04  5.7270E+04  8.4065E+04
Y OR    PHI  1.2500E-02  3.7500E-02  6.2500E-02  8.7500E-02  1.2500E-01  1.7500E-01  2.2500E-01  2.7500E-01
             3.5000E-01  4.5000E-01  5.5000E-01  7.0000E-01  9.0000E-01  1.1000E+00  1.3000E+00  1.5000E+00
             1.7000E+00  1.9000E+00  2.2000E+00  2.7708E+00
Z OR THETA   5.0000E-02  1.5000E-01  2.5000E-01  3.5000E-01  4.5000E-01  5.5000E-01  6.5000E-01  7.2500E-01
             7.7500E-01  8.2500E-01  8.7500E-01  9.2500E-01  9.7500E-01  1.0250E+00  1.0750E+00  1.1125E+00
             1.1875E+00  1.2625E+00  1.2875E+00  1.3070E+00
     F(L)    1.8754E+05  4.0804E+05  4.7396E+05  1.9620E+06  7.3316E+06  2.3096E+07  7.1296E+07  2.2852E+08
             7.2551E+08  2.2771E+09  7.1822E+09  2.2781E+10  7.1975E+10  2.2806E+11  7.3853E+11  2.2641E+12
             7.2422E+12  2.2742E+13  7.2092E+13  2.2792E+14
     F(M)    2.5000E-02  2.5000E-02  2.5000E-02  2.5000E-02  5.0000E-02  5.0000E-02  5.0000E-02  5.0000E-02
             1.0000E-01  1.0000E-01  1.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01
             2.0000E-01  2.0000E-01  4.0000E-01  7.4160E-01
     F(N)    4.9958E-03  1.4938E-02  2.4730E-02  3.4275E-02  4.3478E-02  5.2247E-02  6.0493E-02  3.3153E-02
             3.4982E-02  3.6724E-02  3.8373E-02  3.9927E-02  4.1381E-02  4.2731E-02  4.3975E-02  2.2419E-02
             1.1585E-01  2.3820E-02  2.4003E-02  1.3516E-02
```

ZONE	BNDS	COMP	BND1	PK1	BND2	PK2	BND3	PK3	BND4	PK4	BND5	PK5	BND6	PK6
1	2	1	1	2	3	3								
2	3	2	-1	1	2	4	3	3						
3	3	2	2	4	-3	1	4	5						
4	-1	1	-2	0										
5	2	1	-4	3	2	4								

BND	EQ	A	B	C	X0	Y0	Z0	K
1	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3924E+04
2	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.4521E+04
3	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.1000E+01
4	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.2000E+01

COMP	MAT,	1	2	3	4	5	6	7	8	9
		H	N	O	NA	AL	SI	K	CA	FE
A		1.0080E+00	1.4007E+01	1.5995E+01	2.2990E+01	2.6980E+01	2.8086E+01	3.9102E+01	4.0080E+01	5.5847E+01
1		0.0000E+00	9.5625E-04	2.9375E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2		1.2992E-02	0.0000E+00	1.1561E+00	3.9672E-02	1.1136E-01	7.3544E-01	4.4544E-02	1.9163E-01	2.8304E-02

```
  1      X=  4.0000E+03    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	1.7545E-23	2.0920E-22	1.0823E-21	1.9897E-21	2.0073E-21	1
TOTALS			1.7545E-23	2.0920E-22	1.0823E-21	1.9897E-21	2.0073E-21	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	4.0015E-22	1.0256E-21	7
8	3.0000E-01	1.5799E-10	2.9507E-22	4.6681E-22	8
9	4.0000E-01	2.1580E-10	1.7157E-22	2.3235E-22	9
10	5.0000E-01	2.7342E-10	1.0455E-22	1.3068E-22	10
11	6.0000E-01	3.2480E-10	9.1729E-23	1.0841E-22	11
12	8.0000E-01	4.2132E-10	1.8630E-23	2.1705E-23	12
13	1.0000E+00	5.1013E-10	1.3114E-24	4.5413E-24	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
  2      X=  8.0000E+03    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE   X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	3.2877E-24	3.9114E-23	2.9317E-22	8.4050E-22	8.4378E-22	1
TOTALS			3.2877E-24	3.9114E-23	2.9317E-22	8.4050E-22	8.4378E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	7.9878E-23	3.5408E-22	7
8	3.0000E-01	1.5799E-10	8.3452E-23	2.3864E-22	8
9	4.0000E-01	2.1580E-10	5.3941E-23	1.1766E-22	9
10	5.0000E-01	2.7342E-10	3.5550E-23	6.5660E-23	10
11	6.0000E-01	3.2480E-10	3.2898E-23	5.3293E-23	11
12	8.0000E-01	4.2132E-10	7.0013E-24	1.0468E-23	12
13	1.0000E+00	5.1013E-10	4.7759E-25	1.2596E-24	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
  3       X=  1.6000E+04     Y=  0.0000E+00     Z=  0.0000E+00
SOURCE    X=  0.0000E+00     Y=  0.0000E+00     Z=  0.0000E+00
GROUP    ENERGY      SOURCE     MIN DIRECT  MAX DIRECT  MIN SCATTR  MAX SCATTR  MIND+MAXSC  GROUP
  1     1.2500E+00  2.0000E+00  4.6175E-25  5.5613E-24  4.9115E-23  2.3066E-22  2.3113E-22    1
TOTALS                          4.6175E-25  5.5613E-24  4.9115E-23  2.3066E-22  2.3113E-22
 BIN   LOWER EDGE   FACTOR     MIN SCATTR  MAX SCATTR    BIN
  1    0.0000E+00  3.4315E-11  0.0000E+00  0.0000E+00     1
  2    5.0000E-02  3.4315E-11  0.0000E+00  0.0000E+00     2
  3    6.0000E-02  3.1158E-11  0.0000E+00  0.0000E+00     3
  4    8.0000E-02  3.3911E-11  0.0000E+00  0.0000E+00     4
  5    1.0000E-01  4.1655E-11  0.0000E+00  0.0000E+00     5
  6    1.5000E-01  6.7987E-11  0.0000E+00  0.0000E+00     6
  7    2.0000E-01  9.7255E-11  7.8349E-24  6.2814E-23     7
  8    3.0000E-01  1.5799E-10  1.3450E-23  7.4023E-23     8
  9    4.0000E-01  2.1580E-10  1.0572E-23  4.3348E-23     9
 10    5.0000E-01  2.7342E-10  7.5278E-24  2.4675E-23    10
 11    6.0000E-01  3.2480E-10  7.7451E-24  2.0967E-23    11
 12    8.0000E-01  4.2132E-10  1.8904E-24  4.4995E-24    12
 13    1.0000E+00  5.1013E-10  1.2495E-25  3.6674E-25    13
 14    1.5000E+00  6.9914E-10  0.0000E+00  0.0000E+00    14
 15    2.0000E+00  8.5878E-10  0.0000E+00  0.0000E+00    15


  4       X=  2.4000E+04     Y=  0.0000E+00     Z=  0.0000E+00
SOURCE    X=  0.0000E+00     Y=  0.0000E+00     Z=  0.0000E+00
GROUP    ENERGY      SOURCE     MIN DIRECT  MAX DIRECT  MIN SCATTR  MAX SCATTR  MIND+MAXSC  GROUP
  1     1.2500E+00  2.0000E+00  1.1529E-25  1.4456E-24  1.2044E-23  7.8179E-23  7.8294E-23    1
TOTALS                          1.1529E-25  1.4456E-24  1.2044E-23  7.8179E-23  7.8294E-23
 BIN   LOWER EDGE   FACTOR     MIN SCATTR  MAX SCATTR    BIN
  1    0.0000E+00  3.4315E-11  0.0000E+00  0.0000E+00     1
  2    5.0000E-02  3.4315E-11  0.0000E+00  0.0000E+00     2
  3    6.0000E-02  3.1158E-11  0.0000E+00  0.0000E+00     3
  4    8.0000E-02  3.3911E-11  0.0000E+00  0.0000E+00     4
  5    1.0000E-01  4.1655E-11  0.0000E+00  0.0000E+00     5
  6    1.5000E-01  6.7987E-11  0.0000E+00  0.0000E+00     6
  7    2.0000E-01  9.7255E-11  1.1651E-24  1.4229E-23     7
  8    3.0000E-01  1.5799E-10  2.9016E-24  2.4551E-23     8
  9    4.0000E-01  2.1580E-10  2.7410E-24  1.7203E-23     9
 10    5.0000E-01  2.7342E-10  2.1474E-24  1.0579E-23    10
 11    6.0000E-01  3.2480E-10  2.4031E-24  9.3843E-24    11
 12    8.0000E-01  4.2132E-10  6.4254E-25  2.1116E-24    12
 13    1.0000E+00  5.1013E-10  4.6109E-26  1.6319E-25    13
 14    1.5000E+00  6.9914E-10  0.0000E+00  0.0000E+00    14
 15    2.0000E+00  8.5878E-10  0.0000E+00  0.0000E+00    15
```

```
5      X= 3.2000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE  X= 0.0000E+00   Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	3.6434E-26	4.9108E-25	3.5070E-24	3.0250E-23	3.0287E-23	1
TOTALS			3.6434E-26	4.9108E-25	3.5070E-24	3.0250E-23	3.0287E-23	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.0631E-25	3.7826E-24	7
8	3.0000E-01	1.5799E-10	7.0717E-25	8.6081E-24	8
9	4.0000E-01	2.1580E-10	7.9128E-25	7.1679E-24	9
10	5.0000E-01	2.7342E-10	6.9096E-25	4.8942E-24	10
11	6.0000E-01	3.2480E-10	8.3782E-25	4.6082E-24	11
12	8.0000E-01	4.2132E-10	2.5715E-25	1.1128E-24	12
13	1.0000E+00	5.1013E-10	1.8274E-26	7.8412E-26	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
6      X= 4.8000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE  X= 0.0000E+00   Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	5.1107E-27	8.6798E-26	3.9225E-25	5.3126E-24	5.3177E-24	1
TOTALS			5.1107E-27	8.6798E-26	3.9225E-25	5.3126E-24	5.3177E-24	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	9.1896E-27	3.2143E-25	7
8	3.0000E-01	1.5799E-10	5.1377E-26	1.1952E-24	8
9	4.0000E-01	2.1580E-10	7.8248E-26	1.2844E-24	9
10	5.0000E-01	2.7342E-10	8.3758E-26	1.0477E-24	10
11	6.0000E-01	3.2480E-10	1.2284E-25	1.1461E-24	11
12	8.0000E-01	4.2132E-10	4.3427E-26	2.9882E-25	12
13	1.0000E+00	5.1013E-10	3.5709E-27	2.1581E-26	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

| 7 | X= 6.4000E+04 | Y= 0.0000E+00 | Z= 0.0000E+00 | | | | |

| SOURCE | X= 0.0000E+00 | Y= 0.0000E+00 | Z= 0.0000E+00 | | | | |

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	9.0734E-28	2.0325E-26	5.4352E-26	9.9929E-25	1.0002E-24	1
TOTALS			9.0734E-28	2.0325E-26	5.4352E-26	9.9929E-25	1.0002E-24	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	5.0379E-28	2.8017E-26	7
8	3.0000E-01	1.5799E-10	4.3511E-27	1.6340E-25	8
9	4.0000E-01	2.1580E-10	8.9290E-27	2.3568E-25	9
10	5.0000E-01	2.7342E-10	1.1343E-26	2.1570E-25	10
11	6.0000E-01	3.2480E-10	1.9993E-26	2.7002E-25	11
12	8.0000E-01	4.2132E-10	8.5091E-27	8.0793E-26	12
13	1.0000E+00	5.1013E-10	7.3546E-28	5.8600E-27	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

Table E6.11. PROBLEM GGG008, SHIELDED SILO (42.8 CM CONCRETE) - Data

```
    3   20    20    20     9    2     1    14     5     4     1     1
  75.          90.        125.         150.0       210.0      315.0      465.0      680.0
  1000.        1470.      2155.        3160.       4640.      6810.      10000.     14760.
  21550.       31660.     46410.       68130.      100000.
  0.0          .025       .05          .075        .1         .15        .2         .25
  .3           .4         .5           .6          .8         1.0        1.2        1.4
  1.6          1.8        2.0          2.4         3.1416
  0.           .1         .2           .3          .4         .5         .6         .70
  .75          .8         .85          .9          .95        1.0        1.05       1.10
  1.125        1.25       1.275        1.3         1.314
      2    1    1    2    3    3
      3    2   -1    1    2    4     3     3
      3    2    2    4   -3    1     4     5
     -1    1   -2
      2    1   -4    3    2    4
      1    3                              0.0        0.0                   13924+04
      2    3                              0.0        0.0                   44521+04
      3    6                                                               31.
      4    6                                                               73.8
  0.0          95625-04   29375-04  0.0            0.0        0.0        0.0        0.0
  0.0
  12992-02  0.0           1.15606   39672-02  11136-01  73544-01  44544-02  19163-01
  28304-02
  1.0          7.0        8.0          11.0        13.0       14.0       19.0       20.0
  26.0
  1.00797      14.007     15.995       22.990      26.98      28.086     39.102     40.08
  55.847
  1.25
  2.
  0.05         0.06       0.08         0.10        0.15       0.20       0.30       0.40
  0.50         0.60       0.80         1.00        1.50       2.0
  34315-11  31158-11  33911-11  41655-11  67987-11  97255-11  15799-10  21580-10
  27342-10  32480-10  42132-10  51013-10  69914-10  85878-10
  1.00E-04  1.00E-02  2.0
  0.0          0.0        0.0              1
  4000.        0.0        0.0              1
  8000.        0.0        0.0              1
  16000.       0.0        0.0              1
  24000.       0.0        0.0              1
  32000.       0.0        0.0              1
  48000.       0.0        0.0              1
  64000.       0.0        0.0              1
                                        -1
STOP
```

```
       CONTROL    3   20   20   20    9    2    1   14    5.   4    1    1    0    0    0    0
X OR      R 7.5000E+01  9.0000E+01  1.2500E+02  1.5000E+02  2.1000E+02  3.1500E+02  4.6500E+02  6.8000E+02
            1.0000E+03  1.4700E+03  2.1550E+03  3.1600E+03  4.6400E+03  6.8100E+03  1.0000E+04  1.4760E+04
            2.1550E+04  3.1660E+04  4.6410E+04  6.8130E+04  1.0000E+05
Y OR    PHI 0.0000E+00  2.5000E-02  5.0000E-02  7.5000E-02  1.0000E-01  1.5000E-01  2.0000E-01  2.5000E-01
            3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  8.0000E-01  1.0000E+00  1.2000E+00  1.4000E+00
            1.6000E+00  1.8000E+00  2.0000E+00  2.4000E+00  3.1416E+00
Z OR THETA  0.0000E+00  1.0000E-01  2.0000E-01  3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  7.0000E-01
            7.5000E-01  8.0000E-01  8.5000E-01  9.0000E-01  9.5000E-01  1.0000E+00  1.0500E+00  1.1000E+00
            1.1250E+00  1.2500E+00  1.2750E+00  1.3000E+00  1.3140E+00
X OR      R 8.2500E+01  1.0750E+02  1.3750E+02  1.8000E+02  2.6250E+02  3.9000E+02  5.7250E+02  8.4000E+02
            1.2350E+03  1.8125E+03  2.6575E+03  3.9000E+03  5.7250E+03  8.4050E+03  1.2380E+04  1.8155E+04
            2.6605E+04  3.9035E+04  5.7270E+04  8.4065E+04
Y OR    PHI 1.2500E-02  3.7500E-02  6.2500E-02  8.7500E-02  1.2500E-01  1.7500E-01  2.2500E-01  2.7500E-01
            3.5000E-01  4.5000E-01  5.5000E-01  7.0000E-01  9.0000E-01  1.1000E+00  1.3000E+00  1.5000E+00
            1.7000E+00  1.9000E+00  2.2000E+00  2.7708E+00
Z OR THETA  5.0000E-02  1.5000E-01  2.5000E-01  3.5000E-01  4.5000E-01  5.5000E-01  6.5000E-01  7.2500E-01
            7.7500E-01  8.2500E-01  8.7500E-01  9.2500E-01  9.7500E-01  1.0250E+00  1.0750E+00  1.1125E+00
            1.1875E+00  1.2625E+00  1.2875E+00  1.3070E+00
       F(L) 1.0238E+05  4.0804E+05  4.7396E+05  1.9620E+06  7.3316E+06  2.3096E+07  7.1296E+07  2.2852E+08
            7.2551E+08  2.2771E+09  7.1822E+09  2.2781E+10  7.1975E+10  2.2806E+11  7.3853E+11  2.2641E+12
            7.2422E+12  2.2742E+13  7.2092E+13  2.2792E+14
       F(M) 2.5000E-02  2.5000E-02  2.5000E-02  2.5000E-02  5.0000E-02  5.0000E-02  5.0000E-02  5.0000E-02
            1.0000E-01  1.0000E-01  1.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01
            2.0000E-01  2.0000E-01  4.0000E-01  7.4160E-01
       F(N) 4.9958E-03  1.4938E-02  2.4730E-02  3.4275E-02  4.3478E-02  5.2247E-02  6.0493E-02  3.3153E-02
            3.4982E-02  3.6724E-02  3.8373E-02  3.9927E-02  4.1381E-02  4.2731E-02  4.3975E-02  2.2419E-02
            1.1585E-01  2.3820E-02  2.4003E-02  1.3516E-02
```

```
ZONE  BNDS  COMP  BND1  PK1  BND2  PK2  BND3  PK3  BND4  PK4  BND5  PK5  BND6  PK6


  1    2     1     1    2     3    3
  2    3     2    -1    1     2    4     3     3
  3    3     2     2    4    -3    1     4     5
  4   -1     1    -2    0
  5    2     1    -4    3     2    4
```

```
BND   EQ      A           B           C           XD          YD          ZD          K

  1    3  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.3924E+04
  2    3  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  4.4521E+04
  3    6  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  3.1000E+01
  4    6  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  7.3800E+01
```

```
COMP   MAT,   1           2           3           4           5           6           7           8           9
               H           N           O           NA          AL          SI          K           CA          FE
    A      1.0080E+00  1.4007E+01  1.5995E+01  2.2990E+01  2.6980E+01  2.8086E+01  3.9102E+01  4.0080E+01  5.5847E+01
    1      0.0000E+00  9.5625E-04  2.9375E-04  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
    2      1.2992E-02  0.0000E+00  1.1561E+00  3.9672E-02  1.1136E-01  7.3544E-01  4.4544E-02  1.9163E-01  2.8304E-02
```

```
    1      X= 4.0000E+03    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE     X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	1.7545E-23	2.0920E-22	2.9028E-23	6.1185E-23	7.8730E-23	1
TOTALS			1.7545E-23	2.0920E-22	2.9028E-23	6.1185E-23	7.8730E-23	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.2652E-23	3.2886E-23	7
8	3.0000E-01	1.5799E-10	9.3447E-24	1.5130E-23	8
9	4.0000E-01	2.1580E-10	4.0991E-24	5.6790E-24	9
10	5.0000E-01	2.7342E-10	1.7207E-24	2.1903E-24	10
11	6.0000E-01	3.2480E-10	8.2553E-25	1.0716E-24	11
12	8.0000E-01	4.2132E-10	8.5923E-26	7.2583E-25	12
13	1.0000E+00	5.1013E-10	3.0188E-25	3.5435E-24	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
    2      X= 8.0000E+03    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE     X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	3.2877E-24	3.9114E-23	7.4949E-24	2.4775E-23	2.8063E-23	1
TOTALS			3.2877E-24	3.9114E-23	7.4949E-24	2.4775E-23	2.8063E-23	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.5000E-24	1.1333E-23	7
8	3.0000E-01	1.5799E-10	2.6910E-24	7.9301E-24	8
9	4.0000E-01	2.1580E-10	1.3153E-24	2.9942E-24	9
10	5.0000E-01	2.7342E-10	6.0897E-25	1.1683E-24	10
11	6.0000E-01	3.2480E-10	2.9918E-25	5.2108E-25	11
12	8.0000E-01	4.2132E-10	2.5913E-26	1.4958E-25	12
13	1.0000E+00	5.1013E-10	5.6382E-26	6.8139E-25	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
   3      X=  1.6000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE    X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	4.6175E-25	5.5613E-24	1.1538E-24	6.3839E-24	6.8457E-24	1
TOTALS			4.6175E-25	5.5613E-24	1.1538E-24	6.3839E-24	6.8457E-24	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.4889E-25	2.0277E-24	7
8	3.0000E-01	1.5799E-10	4.2713E-25	2.4434E-24	8
9	4.0000E-01	2.1580E-10	2.6191E-25	1.1305E-24	9
10	5.0000E-01	2.7342E-10	1.2982E-25	4.4572E-25	10
11	6.0000E-01	3.2480E-10	7.2072E-26	2.0884E-25	11
12	8.0000E-01	4.2132E-10	6.0388E-27	2.7937E-26	12
13	1.0000E+00	5.1013E-10	8.0451E-27	1.0263E-25	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

```
   4      X=  2.4000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE    X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	1.1529E-25	1.4456E-24	2.6049E-25	2.0540E-24	2.1693E-24	1
TOTALS			1.1529E-25	1.4456E-24	2.6049E-25	2.0540E-24	2.1693E-24	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	3.6634E-26	4.5785E-25	7
8	3.0000E-01	1.5799E-10	9.2919E-26	8.1984E-25	8
9	4.0000E-01	2.1580E-10	6.7523E-26	4.4993E-25	9
10	5.0000E-01	2.7342E-10	3.7354E-26	1.9563E-25	10
11	6.0000E-01	3.2480E-10	2.2237E-26	9.3907E-26	11
12	8.0000E-01	4.2132E-10	1.9871E-27	1.0048E-26	12
13	1.0000E+00	5.1013E-10	1.9800E-27	2.6903E-26	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

5	X= 3.2000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	3.6434E-26	4.9108E-25	7.0021E-26	7.5456E-25	7.9100E-25	1
TOTALS			3.6434E-26	4.9108E-25	7.0021E-26	7.5456E-25	7.9100E-25	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	6.6585E-27	1.2346E-25	7
8	3.0000E-01	1.5799E-10	2.2360E-26	2.8827E-25	8
9	4.0000E-01	2.1580E-10	1.9833E-26	1.9146E-25	9
10	5.0000E-01	2.7342E-10	1.1942E-26	9.0809E-26	10
11	6.0000E-01	3.2480E-10	7.8500E-27	4.7252E-26	11
12	8.0000E-01	4.2132E-10	7.7448E-28	4.5452E-27	12
13	1.0000E+00	5.1013E-10	6.1567E-28	8.9514E-27	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

6	X= 4.8000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	5.1107E-27	8.6798E-26	6.6734E-27	1.1968E-25	1.2479E-25	1
TOTALS			5.1107E-27	8.6798E-26	6.6734E-27	1.1968E-25	1.2479E-25	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.9538E-28	1.0466E-26	7
8	3.0000E-01	1.5799E-10	1.6369E-27	4.0890E-26	8
9	4.0000E-01	2.1580E-10	1.9460E-27	3.4614E-26	9
10	5.0000E-01	2.7342E-10	1.4584E-27	1.9661E-26	10
11	6.0000E-01	3.2480E-10	1.1247E-27	1.1590E-26	11
12	8.0000E-01	4.2132E-10	1.2880E-28	1.0767E-27	12
13	1.0000E+00	5.1013E-10	8.3923E-29	1.3926E-27	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

7	X= 6.4000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	1.2500E+00	2.0000E+00	9.0734E-28	2.0325E-26	7.9087E-28	2.0205E-26	2.1113E-26	1
TOTALS			9.0734E-28	2.0325E-26	7.9087E-28	2.0205E-26	2.1113E-26	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.6177E-29	9.0539E-28	7
8	3.0000E-01	1.5799E-10	1.3893E-28	5.6532E-27	8
9	4.0000E-01	2.1580E-10	2.2270E-28	6.3732E-27	9
10	5.0000E-01	2.7342E-10	1.9368E-28	4.0278E-27	10
11	6.0000E-01	3.2480E-10	1.8075E-28	2.7143E-27	11
12	8.0000E-01	4.2132E-10	2.4642E-29	2.7129E-28	12
13	1.0000E+00	5.1013E-10	1.4438E-29	2.7002E-28	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15

Table E6.13. SAMPLE PROBLEM GGG104 - UNSHIELDED WALL PROBLEM - Data

```
    2  20   20  20    9   3    1  19    5    5    1    1
   0.        50.      100.      150.      210.      315.      465.      680.
   1000.     1470.    2155.     3160.     4640.     6810.     10000.    14670.
   21550.    31660.   46410.    68130.    100000.
   0.0       .025     .05       .075      .1        .15       .2        .25
   0.3       0.4      0.5       0.6       0.8       1.0       1.2       1.4
   1.6       1.8      2.0       2.4       3.1416
   100.      140.     200.      280.      400.      560.      800.      1100.
   1600.     2200.    3200.     4500.     6300.     8900.     12500.    17800.
   25100.    35500.   50100.    70800.    100000.
      3   1    1   0    2   4    4   5
      2   1    1   0   -3   3
      3   1    1   0   -5   5    3   2
      4   3    1   0   -2   1    3   2    5   3
      4   1    1   0   -4   1    5   3    2   4
      1   1                                                        2.00E+10
      2   4                                                        100.
      3   4                                                        110.
      4   6                                                        70.
      5   6                                                        100.
   0.0       95625-04 29375-04 0.0       0.0       0.0       0.0       0.0
   0.0
   0.01193   0.0      1.063     0.0364    0.0978    0.6731    0.0411    0.1798
   0.02663
   0.0       1.00E+04 0.0       0.0       0.0       0.0       0.0       0.0
   0.0
   1.0       7.0      8.0       11.0      13.0      14.0      19.0      20.0
   26.0
   1.00797   14.007   15.995    22.990    26.98     28.086    39.102    40.08
   55.847
   6.12
   2.
   0.05      0.06     0.08      0.10      0.15      0.20      0.30      0.40
   0.50      0.60     0.80      1.00      1.50      2.0       3.0       4.0
   5.0       6.0      8.0
   34315-11 31158-11 33911-11 41655-11 67987-11 97255-11 15799-10 21580-10
   27342-10 32480-10 42132-10 51013-10 69914-10 85878-10 11285-09 13276-09
   15965-09 18167-09 22460-09
   .01       1.       2.0
   0.0       0.0      0.0          1
   10000.    0.0      0.0          1
   20000.    0.0      0.0          1
   30000.    0.0      0.0          1
   50000.    0.0      0.0          1
   80000.    0.0      0.0          1
                              -1
STOP
```

```
     CONTROL    2    20    20    20    9    3    1   19    5    5    1    1    0    0    0    0

X OR     R 0.0000E+00 5.0000E+01 1.0000E+02 1.5000E+02 2.1000E+02 3.1500E+02 4.6500E+02 6.8000E+02
           1.0000E+03 1.4700E+03 2.1550E+03 3.1600E+03 4.6400E+03 6.8100E+03 1.0000E+04 1.4670E+04
           2.1550E+04 3.1660E+04 4.6410E+04 6.8130E+04 1.0000E+05
Y OR   PHI 0.0000E+00 2.5000E-02 5.0000E-02 7.5000E-02 1.0000E-01 1.5000E-01 2.0000E-01 2.5000E-01
           3.0000E-01 4.0000E-01 5.0000E-01 6.0000E-01 8.0000E-01 1.0000E+00 1.2000E+00 1.4000E+00
           1.6000E+00 1.8000E+00 2.0000E+00 2.4000E+00 3.1416E+00
Z OR THETA 1.0000E+02 1.4000E+02 2.0000E+02 2.8000E+02 4.0000E+02 5.6000E+02 8.0000E+02 1.1000E+03
           1.6000E+03 2.2000E+03 3.2000E+03 4.5000E+03 6.3000E+03 8.9000E+03 1.2500E+04 1.7800E+04
           2.5100E+04 3.5500E+04 5.0100E+04 7.0800E+04 1.0000E+05
X OR     R 2.5000E+01 7.5000E+01 1.2500E+02 1.8000E+02 2.6250E+02 3.9000E+02 5.7250E+02 8.4000E+02
           1.2350E+03 1.8125E+03 2.6575E+03 3.9000E+03 5.7250E+03 8.4050E+03 1.2335E+04 1.8110E+04
           2.6605E+04 3.9035E+04 5.7270E+04 8.4065E+04
Y OR   PHI 1.2500E-02 3.7500E-02 6.2500E-02 8.7500E-02 1.2500E-01 1.7500E-01 2.2500E-01 2.7500E-01
           3.5000E-01 4.5000E-01 5.5000E-01 7.0000E-01 9.0000E-01 1.1000E+00 1.3000E+00 1.5000E+00
           1.7000E+00 1.9000E+00 2.2000E+00 2.7708E+00
Z OR THETA 1.2000E+02 1.7000E+02 2.4000E+02 3.4000E+02 4.8000E+02 6.8000E+02 9.5000E+02 1.3500E+03
           1.9000E+03 2.7000E+03 3.8500E+03 5.4000E+03 7.6000E+03 1.0700E+04 1.5150E+04 2.1450E+04
           3.0300E+04 4.2800E+04 6.0450E+04 8.5400E+04
      F(L) 1.2500E+03 3.7500E+03 6.2500E+03 1.0800E+04 2.7563E+04 5.8500E+04 1.2309E+05 2.6880E+05
           5.8045E+05 1.2416E+06 2.6708E+06 5.7720E+06 1.2423E+07 2.6812E+07 5.7604E+07 1.2460E+08
           2.6898E+08 5.7577E+08 1.2439E+09 2.6792E+09
      F(M) 2.5000E-02 2.5000E-02 2.5000E-02 2.5000E-02 5.0000E-02 5.0000E-02 5.0000E-02 5.0000E-02
           1.0000E-01 1.0000E-01 1.0000E-01 2.0000E-01 2.0000E-01 2.0000E-01 2.0000E-01 2.0000E-01
           2.0000E-01 2.0000E-01 4.0000E-01 7.4160E-01
      F(N) 4.0000E+01 6.0000E+01 8.0000E+01 1.2000E+02 1.6000E+02 2.4000E+02 3.0000E+02 5.0000E+02
           6.0000E+02 1.0000E+03 1.3000E+03 1.8000E+03 2.6000E+03 3.6000E+03 5.3000E+03 7.3000E+03
           1.0400E+04 1.4600E+04 2.0700E+04 2.9200E+04
```

ZONE	BNDS	COMP	BND1	PK1	BND2	PK2	BND3	PK3	BND4	PK4	BND5	PK5	BND6	PK6
1	3	1	1	0	2	4	4	5						
2	2	1	1	0	-3	3								
3	3	1	1	0	-5	5	3	2						
4	4	3	1	0	-2	1	3	2	5	3				
5	4	1	1	0	-4	1	5	3	2	4				

BND	EQ	A	B	C	X0	Y0	Z0	K
1	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.0000E+10
2	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000E+02
3	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1000E+02
4	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.0000E+01
5	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000E+02

COMP	MAT,	1	2	3	4	5	6	7	8	9
		H	N	O	NA	AL	SI	K	CA	FE
A		1.0080E+00	1.4007E+01	1.5995E+01	2.2990E+01	2.6980E+01	2.8086E+01	3.9102E+01	4.0080E+01	5.5847E+01
1		0.0000E+00	9.5625E-04	2.9375E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2		1.1930E-02	0.0000E+00	1.0630E+00	3.6400E-02	9.7800E-02	6.7310E-01	4.1100E-02	1.7980E-01	2.6630E-02
3		0.0000E+00	1.0000E+04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

```
   1       X=  1.0000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE     X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	3.0384E-21	9.4280E-21	9.4280E-21	1
TOTALS			0.0000E+00	0.0000E+00	3.0384E-21	9.4280E-21	9.4280E-21	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	3.6726E-22	2.3332E-21	7
8	3.0000E-01	1.5799E-10	7.1008E-22	2.7864E-21	8
9	4.0000E-01	2.1580E-10	5.3961E-22	1.5213E-21	9
10	5.0000E-01	2.7342E-10	4.6309E-22	1.0356E-21	10
11	6.0000E-01	3.2480E-10	5.6070E-22	1.0761E-21	11
12	8.0000E-01	4.2132E-10	3.1846E-22	5.4460E-22	12
13	1.0000E+00	5.1013E-10	7.9723E-23	1.3337E-22	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
   2       X=  2.0000E+04    Y=  0.0000E+00    Z=  0.0000E+00
SOURCE     X=  0.0000E+00    Y=  0.0000E+00    Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	4.8152E-22	2.3789E-21	2.3789E-21	1
TOTALS			0.0000E+00	0.0000E+00	4.8152E-22	2.3789E-21	2.3789E-21	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.5145E-23	3.0222E-22	7
8	3.0000E-01	1.5799E-10	8.0586E-23	6.2581E-22	8
9	4.0000E-01	2.1580E-10	8.6819E-23	4.7499E-22	9
10	5.0000E-01	2.7342E-10	7.7478E-23	3.2430E-22	10
11	6.0000E-01	3.2480E-10	1.0533E-22	3.5471E-22	11
12	8.0000E-01	4.2132E-10	6.6347E-23	1.8933E-22	12
13	1.0000E+00	5.1013E-10	3.9848E-23	1.0802E-22	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
3       X=  3.0000E+04     Y=  0.0000E+00     Z=  0.0000E+00
SOURCE  X=  0.0000E+00     Y=  0.0000E+00     Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	1.1032E-22	7.7085E-22	7.7085E-22	1
TOTALS			0.0000E+00	0.0000E+00	1.1032E-22	7.7085E-22	7.7085E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.6628E-24	5.3567E-23	7
8	3.0000E-01	1.5799E-10	1.2936E-23	1.6630E-22	8
9	4.0000E-01	2.1580E-10	1.7645E-23	1.5704E-22	9
10	5.0000E-01	2.7342E-10	1.9311E-23	1.3044E-22	10
11	6.0000E-01	3.2480E-10	2.6413E-23	1.3915E-22	11
12	8.0000E-01	4.2132E-10	1.7193E-23	7.2334E-23	12
13	1.0000E+00	5.1013E-10	1.4184E-23	5.2240E-23	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
4       X=  5.0000E+04     Y=  0.0000E+00     Z=  0.0000E+00
SOURCE  X=  0.0000E+00     Y=  0.0000E+00     Z=  0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	9.1257E-24	1.0544E-22	1.0544E-22	1
TOTALS			0.0000E+00	0.0000E+00	9.1257E-24	1.0544E-22	1.0544E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	5.2447E-26	2.2578E-24	7
8	3.0000E-01	1.5799E-10	5.3043E-25	1.4669E-23	8
9	4.0000E-01	2.1580E-10	9.9397E-25	1.9037E-23	9
10	5.0000E-01	2.7342E-10	1.2436E-24	1.7447E-23	10
11	6.0000E-01	3.2480E-10	2.6596E-24	2.7517E-23	11
12	8.0000E-01	4.2132E-10	1.8264E-24	1.4096E-23	12
13	1.0000E+00	5.1013E-10	1.8209E-24	1.0439E-23	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
5       X= 8.0000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE  X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	3.6676E-25	6.5413E-24	6.5413E-24	1
TOTALS			0.0000E+00	0.0000E+00	3.6676E-25	6.5413E-24	6.5413E-24	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.9891E-28	2.6928E-26	7
8	3.0000E-01	1.5799E-10	4.6343E-27	2.9410E-25	8
9	4.0000E-01	2.1580E-10	2.2219E-26	9.0524E-25	9
10	5.0000E-01	2.7342E-10	4.3439E-26	1.2048E-24	10
11	6.0000E-01	3.2480E-10	9.7575E-26	1.8793E-24	11
12	8.0000E-01	4.2132E-10	9.8364E-26	1.3231E-24	12
13	1.0000E+00	5.1013E-10	1.0031E-25	9.0911E-25	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

Table E6.15. SAMPLE PROBLEM GGG103, SHIELDED WALL (30 CM CONCRETE) - Data

```
    2  20   20   20     9    3     1   19     5    5     1    1
   0.        50.       100.      150.      210.     315.     465.     680.
  1000.     1470.     2155.     3160.     4640.    6810.   10000.   14670.
 21550.    31660.    46410.    68130.   100000.
   0.0       .025      .05       .075      .1       .15      .2       .25
   0.3       0.4       0.5       0.6       0.8      1.0      1.2      1.4
   1.6       1.8       2.0       2.4       3.1416
   100.      140.      200.      280.      400.     560.     800.    1100.
  1600.     2200.     3200.     4500.     6300.    8900.   12500.   17800.
 25100.    35500.    50100.    70800.   100000.
    3   1    1   0    2    4     4    5
    2   1    1   0   -3    3
    3   1    1   0   -5    5     3    2
    4   3    1   0   -2    1     3    2     5    3
    4   2    1   0   -4    1     5    3     2    4
    1   1                                                    2.00E+10
    2   4                                                    100.
    3   4                                                    110.
    4   6                                                    70.
    5   6                                                    100.
   0.0       95625-04  29375-04  0.0       0.0      0.0      0.0      0.0
   0.0
   0.01193   0.0       1.063     0.0364    0.0978   0.6731   0.0411   0.1798
   0.02663
   0.0       1.00E+04  0.0       0.0       0.0      0.0      0.0      0.0
   0.0
   1.0       7.0       8.0       11.0      13.0     14.0     19.0     20.0
  26.0
   1.00797   14.007    15.995    22.990    26.98    28.086   39.102   40.08
  55.847
   6.12
   2.
   0.05      0.06      0.08      0.10      0.15     0.20     0.30     0.40
   0.50      0.60      0.80      1.00      1.50     2.0      3.0      4.0
   5.0       6.0       8.0
 34315-11  31158-11  33911-11  41655-11  67987-11 97255-11 15799-10 21580-10
 27342-10  32480-10  42132-10  51013-10  69914-10 85878-10 11285-09 13276-09
 15965-09  18167-09  22460-09
   .01       1.        2.0
   0.0       0.0       0.0          1
 10000.      0.0       0.0          1
 20000.      0.0       0.0          1
 30000.      0.0       0.0          1
 50000.      0.0       0.0          1
 80000.      0.0       0.0          1
                                   -1
STOP
```

```
      CONTROL    2   20    20    20    9    3    1    19    5    5    1    1    0    0    0    0
X OR      R  0.0000E+00  5.0000E+01  1.0000E+02  1.5000E+02  2.1000E+02  3.1500E+02  4.6500E+02  6.8000E+02
             1.0000E+03  1.4700E+03  2.1550E+03  3.1600E+03  4.6400E+03  6.8100E+03  1.0000E+04  1.4670E+04
             2.1550E+04  3.1660E+04  4.6410E+04  6.8130E+04  1.0000E+05
Y OR    PHI  0.0000E+00  2.5000E-02  5.0000E-02  7.5000E-02  1.0000E-01  1.5000E-01  2.0000E-01  2.5000E-01
             3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  8.0000E-01  1.0000E+00  1.2000E+00  1.4000E+00
             1.6000E+00  1.8000E+00  2.0000E+00  2.4000E+00  3.1416E+00
Z OR THETA   1.0000E+02  1.4000E+02  2.0000E+02  2.8000E+02  4.0000E+02  5.6000E+02  8.0000E+02  1.1000E+03
             1.6000E+03  2.2000E+03  3.2000E+03  4.5000E+03  6.3000E+03  8.9000E+03  1.2500E+04  1.7800E+04
             2.5100E+04  3.5500E+04  5.0100E+04  7.0800E+04  1.0000E+05
X OR      R  2.5000E+01  7.5000E+01  1.2500E+02  1.8000E+02  2.6250E+02  3.9000E+02  5.7250E+02  8.4000E+02
             1.2350E+03  1.8125E+03  2.6575E+03  3.9000E+03  5.7250E+03  8.4050E+03  1.2335E+04  1.8110E+04
             2.6605E+04  3.9035E+04  5.7270E+04  8.4065E+04
Y OR    PHI  1.2500E-02  3.7500E-02  6.2500E-02  8.7500E-02  1.2500E-01  1.7500E-01  2.2500E-01  2.7500E-01
             3.5000E-01  4.5000E-01  5.5000E-01  7.0000E-01  9.0000E-01  1.1000E+00  1.3000E+00  1.5000E+00
             1.7000E+00  1.9000E+00  2.2000E+00  2.7708E+00
Z OR THETA   1.2000E+02  1.7000E+02  2.4000E+02  3.4000E+02  4.8000E+02  6.8000E+02  9.5000E+02  1.3500E+03
             1.9000E+03  2.7000E+03  3.8500E+03  5.4000E+03  7.6000E+03  1.0700E+04  1.5150E+04  2.1450E+04
             3.0300E+04  4.2800E+04  6.0450E+04  8.5400E+04
      F(L)   1.2500E+03  3.7500E+03  6.2500E+03  1.0800E+04  2.7563E+04  5.8500E+04  1.2309E+05  2.6880E+05
             5.8045E+05  1.2416E+06  2.6708E+06  5.7720E+06  1.2423E+07  2.6812E+07  5.7604E+07  1.2460E+08
             2.6898E+08  5.7577E+08  1.2439E+09  2.6792E+09
      F(M)   2.5000E-02  2.5000E-02  2.5000E-02  2.5000E-02  5.0000E-02  5.0000E-02  5.0000E-02  5.0000E-02
             1.0000E-01  1.0000E-01  1.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01  2.0000E-01
             2.0000E-01  2.0000E-01  4.0000E-01  7.4160E-01
      F(N)   4.0000E+01  6.0000E+01  8.0000E+01  1.2000E+02  1.6000E+02  2.4000E+02  3.0000E+02  5.0000E+02
             6.0000E+02  1.0000E+03  1.3000E+03  1.8000E+03  2.6000E+03  3.6000E+03  5.3000E+03  7.3000E+03
             1.0400E+04  1.4600E+04  2.0700E+04  2.9200E+04
```

ZONE	BNDS	COMP	BND1	PK1	BND2	PK2	BND3	PK3	BND4	PK4	BND5	PK5	BND6	PK6
1	3	1	1	0	2	4	4	5						
2	2	1	1	0	-3	3								
3	3	1	1	0	-5	5	3	2						
4	4	3	1	0	-2	1	3	2	5	3				
5	4	2	1	0	-4	1	5	3	2	4				

BND	EQ	A	B	C	X0	Y0	Z0	K
1	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.0000E+10
2	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000E+02
3	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1000E+02
4	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.0000E+01
5	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0000E+02

COMP	MAT,	1	2	3	4	5	6	7	8	9
		H	N	O	NA	AL	SI	K	CA	FE
A		1.0080E+00	1.4007E+01	1.5995E+01	2.2990E+01	2.6980E+01	2.8086E+01	3.9102E+01	4.0080E+01	5.5847E+01
1		0.0000E+00	9.5625E-04	2.9375E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2		1.1930E-02	0.0000E+00	1.0630E+00	3.6400E-02	9.7800E-02	6.7310E-01	4.1100E-02	1.7980E-01	2.6630E-02
3		0.0000E+00	1.0000E+04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

1	X= 1.0000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	2.8366E-22	8.3845E-22	8.3845E-22	1
TOTALS			0.0000E+00	0.0000E+00	2.8366E-22	8.3845E-22	8.3845E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.5079E-23	1.5926E-22	7
8	3.0000E-01	1.5799E-10	6.3459E-23	2.4884E-22	8
9	4.0000E-01	2.1580E-10	5.3262E-23	1.5090E-22	9
10	5.0000E-01	2.7342E-10	4.5963E-23	1.0341E-22	10
11	6.0000E-01	3.2480E-10	5.7923E-23	1.1160E-22	11
12	8.0000E-01	4.2132E-10	3.0042E-23	5.1344E-23	12
13	1.0000E+00	5.1013E-10	7.9621E-24	1.3339E-23	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

2	X= 2.0000E+04	Y= 0.0000E+00	Z= 0.0000E+00				
SOURCE	X= 0.0000E+00	Y= 0.0000E+00	Z= 0.0000E+00				

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	4.5572E-23	2.1773E-22	2.1773E-22	1
TOTALS			0.0000E+00	0.0000E+00	4.5572E-23	2.1773E-22	2.1773E-22	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.5476E-24	1.8799E-23	7
8	3.0000E-01	1.5799E-10	7.4205E-24	5.7306E-23	8
9	4.0000E-01	2.1580E-10	8.3452E-24	4.5707E-23	9
10	5.0000E-01	2.7342E-10	7.5320E-24	3.1687E-23	10
11	6.0000E-01	3.2480E-10	1.0521E-23	3.5556E-23	11
12	8.0000E-01	4.2132E-10	6.3075E-24	1.8087E-23	12
13	1.0000E+00	5.1013E-10	3.9108E-24	1.0618E-23	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
   3      X= 3.0000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE    X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	1.0556E-23	7.2046E-23	7.2046E-23	1
TOTALS			0.0000E+00	0.0000E+00	1.0556E-23	7.2046E-23	7.2046E-23	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.5051E-25	3.0770E-24	7
8	3.0000E-01	1.5799E-10	1.1667E-24	1.4908E-23	8
9	4.0000E-01	2.1580E-10	1.7443E-24	1.5498E-23	9
10	5.0000E-01	2.7342E-10	1.8601E-24	1.2652E-23	10
11	6.0000E-01	3.2480E-10	2.6303E-24	1.3928E-23	11
12	8.0000E-01	4.2132E-10	1.6491E-24	6.9962E-24	12
13	1.0000E+00	5.1013E-10	1.3564E-24	5.0039E-24	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
   4      X= 5.0000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE    X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
```

GROUP	ENERGY	SOURCE	MIN DIRECT	MAX DIRECT	MIN SCATTR	MAX SCATTR	MIND+MAXSC	GROUP
1	6.1200E+00	2.0000E+00	0.0000E+00	0.0000E+00	8.8288E-25	1.0115E-23	1.0115E-23	1
TOTALS			0.0000E+00	0.0000E+00	8.8288E-25	1.0115E-23	1.0115E-23	

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	2.4795E-27	1.0869E-25	7
8	3.0000E-01	1.5799E-10	4.9113E-26	1.3365E-24	8
9	4.0000E-01	2.1580E-10	9.5735E-26	1.8216E-24	9
10	5.0000E-01	2.7342E-10	1.2868E-25	1.8078E-24	10
11	6.0000E-01	3.2480E-10	2.5775E-25	2.6700E-24	11
12	8.0000E-01	4.2132E-10	1.8155E-25	1.4114E-24	12
13	1.0000E+00	5.1013E-10	1.6766E-25	9.6025E-25	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20

```
  5      X= 8.0000E+04    Y= 0.0000E+00    Z= 0.0000E+00
SOURCE   X= 0.0000E+00    Y= 0.0000E+00    Z= 0.0000E+00
GROUP   ENERGY     SOURCE    MIN DIRECT  MAX DIRECT  MIN SCATTR  MAX SCATTR  MIND+MAXSC  GROUP
  1    6.1200E+00  2.0000E+00  0.0000E+00  0.0000E+00  3.5560E-26  6.3748E-25  6.3748E-25    1
TOTALS                         0.0000E+00  0.0000E+00  3.5560E-26  6.3748E-25  6.3748E-25
```

BIN	LOWER EDGE	FACTOR	MIN SCATTR	MAX SCATTR	BIN
1	0.0000E+00	3.4315E-11	0.0000E+00	0.0000E+00	1
2	5.0000E-02	3.4315E-11	0.0000E+00	0.0000E+00	2
3	6.0000E-02	3.1158E-11	0.0000E+00	0.0000E+00	3
4	8.0000E-02	3.3911E-11	0.0000E+00	0.0000E+00	4
5	1.0000E-01	4.1655E-11	0.0000E+00	0.0000E+00	5
6	1.5000E-01	6.7987E-11	0.0000E+00	0.0000E+00	6
7	2.0000E-01	9.7255E-11	1.3218E-29	1.1842E-27	7
8	3.0000E-01	1.5799E-10	4.2364E-28	2.6510E-26	8
9	4.0000E-01	2.1580E-10	2.0756E-27	8.4462E-26	9
10	5.0000E-01	2.7342E-10	4.3398E-27	1.2129E-25	10
11	6.0000E-01	3.2480E-10	9.8642E-27	1.9062E-25	11
12	8.0000E-01	4.2132E-10	9.7886E-27	1.3157E-25	12
13	1.0000E+00	5.1013E-10	9.0602E-27	8.1923E-26	13
14	1.5000E+00	6.9914E-10	0.0000E+00	0.0000E+00	14
15	2.0000E+00	8.5878E-10	0.0000E+00	0.0000E+00	15
16	3.0000E+00	1.1285E-09	0.0000E+00	0.0000E+00	16
17	4.0000E+00	1.3276E-09	0.0000E+00	0.0000E+00	17
18	5.0000E+00	1.5965E-09	0.0000E+00	0.0000E+00	18
19	6.0000E+00	1.8167E-09	0.0000E+00	0.0000E+00	19
20	8.0000E+00	2.2460E-09	0.0000E+00	0.0000E+00	20