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M-1 Monte Carlo Radioisotope Shielding Code

MND-P-2726

May 1, 1962

Final Report

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Nuclear Division

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FOREWORD

This final report summarizes the results of a project to develop a machine calculation code program using the Monte Carlo technique to compute radiation flux or dose rates from radioisotope sources. The report covers the work performed by the Nuclear Division, Martin Company, under Subtask 7.4, from December 1960 through January 1962 under Contract AT(30-3)-217 with the U. S. Atomic Energy Commission.

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SUMMARY

The M-1 code described in this report is a Monte Carlo code that applies to cylindrical geometry when solving for the flux from a pre-specified radiation source. The source is a gamma and beta emitter and the solution is for the flux of each energy group and of each region of interest in regard to the emitter. A region is a volume of the system bounded by two planes perpendicular to the axis of symmetry and two cylinders (one cylinder if the region includes the axis of symmetry). The code will solve for a maximum of 30 energy groups and 280 regions. The M-1 is coded in Fortran for a 32,000-word 7090.

The M-1 code requires that the energy intervals be prespecified as well as a complete description of the geometry of the system. A specification of materials in the system must also be given. The number of particles to be followed must be specified by the user. Since the technique of splitting can be employed here and so that splitting can occur, a description of the manner in which the system is divided (geometrically) must also be given by the user. A detailed description of the input required by the code can be found in the body of the report.

The following answers are computed by the code:

- (1) The dose per unit volume due to bremsstrahlung gammas for each prespecified region.
- (2) The dose per unit volume due to nonbremsstrahlung gammas for each prespecified region.
- (3) The total dose per unit volume for each prespecified region.
- (4) The number of mean free paths traveled per second in each prespecified region for each energy group.
- (5) The gamma flux for each prespecified region and for each energy group.
- (6) The region volume associated with (1) to (5).

I. INTRODUCTION

This report is divided into five major sections and six appendices. The first section states the sequence of procedures for the calculations. The second section describes the input. The third section lists the subroutines and describes their function, and includes the flow diagram of each subroutine. The fourth section describes the test problems. The fifth section states the conclusions.

The first appendix, Appendix A, lists the symbols used in the report and in the flow diagrams. Appendix B is the analysis of the number of nonbremsstrahlung gammas born. Appendix C is the analysis of the number of bremsstrahlung gammas born. Appendix D is a description of what is considered in the pair production reaction. Appendix E describes the use of the Klein and Nishina elastic scattering. Appendix F contains a printout of the moments method and weather station results.

A great deal of this code was conceived through the guidance and assistance given by Mr. Sidney Auslander.

II. SEQUENCE OF PROCEDURES USED IN PERFORMING THE MONTE CARLO CALCULATIONS

The first operation performed by the code is the reading and the writing of the input. This is done by subroutine RWCMCG. RWCMCG lists the inputs and provides an explanation of the input. The code then calculates the volumes and the square of the radii in subroutine RSQVOL for later use by the code. The number of nonbremsstrahlung particles to be followed and the weight to be assigned to each particle is then determined by subroutine GNOB. (Note: A particle consists of N gammas, $0 < N < M$, where M is some arbitrarily large number.) Subroutine BREMG calculates the number of particles to be followed and the weight to be assigned to each particle due to bremsstrahlung reaction of the betas arising from radioactive decay. The histories of the particle of subroutine BREMG are traced first, then the particles of subroutine GNOB are traced. The code traces the particle histories in the following manner:

- (1) The code locates a source region.
- (2) The code locates the x, y, z coordinate of the particle to be followed by means of subroutine COORDX. COORDX selects the spatial coordinates of the particle from a uniform distribution of particles in the region of interest.
- (3) The source is assumed to be isotropic, and the direction cosines are picked in accordance with this assumption by means of subroutine COORDA (Ref. 1).
- (4) The number of mean free paths is then picked out of a negative exponential probability density function by means of function program RNEXP (Ref. 2).
- (5) The results (dose due to bremsstrahlung and nonbremsstrahlung gammas, the number of mean free paths and the gamma flux for each region of interest) are calculated by means of analytical estimation (Ref. 1) in subroutine ANAEST. The contribution to the flux in region X (assuming the particle will travel through region X) is obtained by adding the distances traveled through region X multiplied by the weight of the particles and the probability that the particles will reach region X . Dose in region X is obtained by multiplying the flux by a dose conversion factor, and the number of mean free paths is obtained by multiplying the flux by the appropriate total macroscopic cross section ($\frac{1}{\text{cm}}$) for the region. The distances through the various regions used in subroutine ANAEST are calculated in subroutine CYLGOM.

- (6) The distance the particle travels to the next collision is calculated in subroutine CMONTE.
- (7) Whether the particle experiences an absorption, scattering, or pair production reaction upon collision is determined by comparing a random number with the probability of absorption, scattering or pair production.
- (8) If scattering occurs, the energy of the scattered particle as well as its new direction are calculated by means of subroutine KNSCAT (Ref. 1).
- (9) If pair production occurs, then the annihilation particles as well as the particles born due to bremsstrahlung reaction of the beta released in pair production along with the direction cosines of the particles are calculated in subroutine PAIRPR.
- (10) If the particle is absorbed, a new particle is then picked to be followed. If there are no more particles to be followed, the results are written on an output tape and the problem terminated.

III. INPUT

The method of inputting information when running a problem is given in detail on the input forms (Table 1).

Table 1 lists the order in which the M-1 input is to be entered, and includes the following information for each group or unit of information:

First line: Mode of input number (Fix, Flo, Oct).

Second line: Description of input units.

Third line: The symbol(s) used for the information to be entered.

Additional and more detailed information on the various inputs is given in the subsections which follow.

A. MODE

The input is entered into the machine in one of three modes which are described below.

Mode 1. Fix = fixed point number (no decimal point); the number is punched so that its last digit is in either column 12, 24, 36, 48, 60, or 72 depending on whether it is the 1st, 2nd, 3rd, 4th, 5th, or 6th piece of information on the card.

Mode 2. Oct = octal fixed point number (same as Fix, but the number is an octal number, i.e., a number to the base eight).

Mode 3. Flo = floating point number (decimal point and exponent required); the number is placed so that the last digit of the exponent is in either column 12, 24, 36, 48, 60, or 72 depending on whether it is the 1st, 2nd, 3rd, 4th, 5th, or 6th piece of information on the card. The format of all floating point numbers is E12.5. See IBM Reference Manual 709/7090 Fortran Programming System, page 40. Example: -36 could appear as -0.36 + 2 or -36. + 0 or -3.6 + 1 or -36.0 and +0.021 could appear as 0.21 - 1 or 0.021 + 0 or 21. - 3 or 0.021.

TABLE 1
M-1 Input

1 2 3 4 5 6 7 8 9 10 11 12	13 14 15 16 17 18 19 20 21 22 23 24	25 26 27 28 29 30 31 32 33 34 35 36	37 38 39 40 41 42 43 44 45 46 47 48	49 50 51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70 71 72	Comments
						73 74 75 76 77 78 79 80
Card No. 1 contains 72 pieces of holarith information.						
Card No. 2 contains 72 pieces of holarith information.						
{ FIX Number of energy groups + 1 JC	FLO Energy interval width DELE	OCT Initial random number RAN				JC ≤ 31
{ FLO End points of the energy interval (Mev) E(1)	. . .	E(J)	. . .	. . .	E(JC-1)	
{ FIX Number of axial subdivisions KK MAX						KK MAX ≤ 14
{ FIX Number of radial subdivisions in each axial subdivision LL MAX (1)	. . .	. . .	LL MAX (JZ)	. . .	LL MAX (KK MAX)	LL MAX (JZ) ≤ 20
{ FLO Coordinates of axial subdivisions (cm) ZC (1)	. . .	. . .	ZC (JZ)	. . .	ZC (KK MAX + 1)	
{ FLO Coordinates of radial subdivisions for first axial subdivision (cm) R(1, 1)	. . .	. . .	R(1, L)	. . .	R(1, LL MAX (1))	
{ FIX Material code numbers of radial subdivisions for first axial subdivision MMN (1, 1)	. . .	. . .	MMN (1, L)	. . .	MMN (1, LL MAX (1))	
. . .	. . .	. . .	. . .	. . .	. .	
. . .	. . .	. . .	. . .	. . .	. . .	
{ FLO Coordinates of radial subdivisions for K th axial subdivision R (K, 1)	. . .	. . .	R (K, L)	. . .	R (K, LL MAX (K))	
{ FIX Material code numbers of radial subdivisions for K th axial subdivision MMN (K, 1)		. . .	MMN (K, L)	. . .	MMN (K, LL MAX (K))	
. . .	. . .	. . .	. . .	. . .	. . .	
. . .	. . .	. . .	. . .	. . .	. . .	
{ FLO Coordinates of radial subdivisions for KK MAX axial subdivision R (KK MAX, 1)	. . .	. . .	R (KK MAX, L)	. . .	R (KK MAX, LL MAX (KK MAX))	
{ FIX Material code numbers of radial subdivisions for KKMAX axial subdivision MMN (KKMAX, 1)		. . .	MMN (KK MAX, L)	. . .	MMN (KK MAX, LL MAX (KK MAX))	
{ FIX Number of different materials MN MAX						MN MAX ≤ 15

TABLE 1 (continued)

1 2 3 4 5 6 7 8 9 10 11 12												13 14 15 16 17 18 19 20 21 22 23 24												25 26 27 28 29 30 31 32 33 34 35 36												37 38 39 40 41 42 43 44 45 46 47 48												49 50 51 52 53 54 55 56 57 58 59 60												61 62 63 64 65 66 67 68 69 70 71 72												Comments 73 74 75 76 77 78 79 80							
FIX Number of isotopes that are beta and/or gamma emitters KSP MAX																																																																								KSP MAX ≤ 15							
FIX Code numbers of isotopes that are beta and/or gamma emitters, in ascending order NC (1)												FLO Decay constant (disintegration/sec) and beta spectrum for isotope having code number NC (1), (number of betas/disintegration/atom) ALMDA (NC (1))												SB (NC (1), 1)												SB (NC (1), J)												...												NC (KSP MAX)																			
FLO Decay constant and beta spectrum for isotope having code number NC (1), (number of betas/disintegration/atom) ALMDA (NC (1))												SB (NC (1), 1)												...												SB (NC (1), J)												...												SB (NC (1), JC-1)																			
...												...												...												...												...																															
FLO Decay constant and beta spectrum for isotope having code number NC (K) ALMDA (NC (K))												SB (NC (K), 1)												...												SB (NC (K), J)												...												SB (NC (K), JC-1)																			
FLO Decay constant and beta spectrum for isotope having code number NC (KSP MAX) ALMDA (NC (KSP MAX))												SB (NC (KSP MAX), 1)												...												SB (NC (KSP MAX), J)												...												SB (NC (KSP MAX), JC-1)																			
FLO Gamma spectrum for isotope having code number NC (1), (number of gammas/disintegration/atom) SG (NC (1), 1)												...												...												SG (NC (1), 1)												...												SG (NC (1), JC-1)																			
FLO Gamma spectrum for isotope having code number NC (K) SG (NC (K), 1)												...												...												SG (NC (K), J)												...												SG (NC (K), JC-1)																			
FLO Gamma spectrum for isotope having code number NC (KSP MAX) SG (NC (KSP MAX), 1)												...												...												SG (NC (KSP MAX), J)												...												SG (NC (KSP MAX), JC-1)																			
FIX Number of axial subdivisions in which gamma sources are to be calculated KF MAX																																																																								KF MAX ≤ 10							
FIX Code number of axial subdivisions in which gamma sources are to be calculated KRF (1)												...												...												KRF (KF)												...												KRF (KF MAX)																			
FIX Number of radial subdivisions within each axial subdivision in which sources are to be calculated LF MAX (1)												...												...												LF MAX (KF)												...												LF MAX (KF MAX)												LF MAX (KF) ≤ 10							
FIX Code numbers of radial subdivisions within first axial subdivision in which sources are to be calculated LRF (1, 1)												...												...												LRF (1, LF)												...												LRF (1, LF MAX (1))																			
FIX Code numbers of radial subdivisions within K th axial subdivision in which sources are to be calculated LRF (KF, 1)												...												...												LRF (KF, LF)												...												LRF (KF, LF MAX (KF))																			
FIX Code numbers of radial subdivisions within KF MAX axial subdivision in which sources are to be calculated LRF (KF MAX, 1)												...												...												LRF (KF MAX, LF)												...												LRF (KF MAX, LF MAX (KF MAX))																			

TABLE 1 (continued)

																																																												Comments																			
1 2 3 4 5 6 7 8 9 10 11 12												13 14 15 16 17 18 19 20 21 22 23 24												25 26 27 28 29 30 31 32 33 34 35 36												37 38 39 40 41 42 43 44 45 46 47 48												49 50 51 52 53 54 55 56 57 58 59 60												61 62 63 64 65 66 67 68 69 70 71 72												73 74 75 76 77 78 79 80							
{FIX Number of axial subdivisions in which results are to be tabulated KR MAX																																																																								KR MAX ≤ 10							
{FIX Code number of axial subdivisions in which answers are to be tabulated KREG (1)												...												...												KREG (KR)												...												KREG (KRMAX)																			
{FIX Number of radial subdivisions within each axial subdivision for which answers are to be tabulated LR MAX (1)												...												...												LR MAX (KR)												...												LR MAX (KR MAX)												LR MAX (KR) ≤ 10							
{FIX Code numbers of radial subdivisions for first axial subdivision in which answers are to be tabulated LREG (1, 1)												...												...												LREG (1, LR)												...												LREG (1, LR MAX (1))																			
... ..												...												...												...												...												...																			
{FIX Code numbers of radial subdivisions for KR th axial subdivision in which answers are to be tabulated LREG (KR, 1)												...												...												LREG (KR, LR)												...												LREG (KR, LR MAX (KR))																			
... ..												...												...												...												...												...																			
{FIX Code numbers of radial subdivisions for KR MAX th axial subdivision in which answers are to be tabulated LREG (KR MAX, 1)												...												...												LREG (KR MAX, LR)												...												LREG (KR MAX, LR MAX (KR MAX))																			
{FLO Number of particles to be followed due to bremsstrahlung from radial subdivisions corresponding to first axial subdivision in which there are sources BN (1, 1)												...												...												BN (1, LF)												...												BN (1, LF MAX (1))																			
... ..												...												...												...												...												...																			
{FLO Number of particles to be followed due to bremsstrahlung from radial subdivisions corresponding to the KF th axial subdivision in which there are sources BN (KF, 1)												...												...												BN (KF, LF)												...												BN (KF, LF MAX (KF))																			
... ..												...												...												...												...												...																			
{FLO Number of particles to be followed due to bremsstrahlung from radial subdivisions corresponding to the KF MAX subdivision in which there are sources BN (KF MAX, 1)												...												...												BN (KF MAX, LF)												...												BN (KF MAX, LF MAX (KF MAX))																			
{FLO Number of particles to be followed due to non-bremsstrahlung particles from radial subdivisions corresponding to the first axial subdivision in which there are sources GN (1, 1)												...												...												GN (1, LF)												...												GN (1, LF MAX (1))																			
... ..												...												...												...												...												...																			
{FLO Number of particles to be followed due to non-bremsstrahlung particles from radial subdivisions corresponding to the KF th axial subdivision in which there are sources GN (KF, 1)												...												...												GN (KF, LF)												...												GN (KF, LF MAX (KF))																			
... ..												...												...												...												...												...																			
{FLO Number of particles to be followed due to non-bremsstrahlung particles from radial subdivisions corresponding to the KF MAX th axial subdivision in which there are sources GN (KF MAX, 1)												...												...												GN (KF MAX, LF)												...												GN (KF MAX, LF MAX (KF MAX))																			
... ..												...												...												...												...												...																			

TABLE 1 (continued)

																																																												Comments																							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80				
{FLO Dose conversion factors for each energy group (units to convert flux to desired dose units) DCN (1)												. . .												. . .												DCN (J)												. . .												DCN (JC-1)												LS MAX ≤ 6											
{FLO Criterion to be used in game of Russian roulette WEIGHT																																																																																			
{FLO Maximum distance a particle can travel in traveling from one collision to the next DISTMX																																																																																			
{FIX Number of volumes in which splitting occurs LS MAX												FLO Number of mean free paths traveled before splitting occurs DXMV												FLO Center of the volumes (with respect to Z coordinate) in which splitting occurs (cm) Z CENTR																																																											
{FLO Radial bounds of volumes in which splitting occurs (cm) RMKS (1)												. . .												. . .												RMKS (LS)												. . .												RMKS (LS MAX)																							
{FLO Number of particles into which each particle is split in each of the volumes DBL (1)												. . .												. . .												DBL (LS)												. . .												DBL (LS MAX)																							
{FLO Axial bounds of volumes in which splitting occurs (cm) (refer to Section I, B, 8 of this report) ZMK (1)												. . .												. . .												ZMK (LS)												. . .												ZMK (2*LS MAX)																							

B. GEOMETRY OF SYSTEM

The system includes all regions described in the input. The system of interest is defined as the set of regions which lie in the straight line path from source to detector regions and which include the source and detector regions, or the system of interest can be defined as the set of regions which mock up the object under study, whichever set is the larger. The system must completely enclose and include the systems of interest. Consider the geometry of the system as shown in Fig. 1, as an example.

The system of interest is the shaded set of regions. The complete system encloses and includes the system of interest. The diagonal drawn in the figure intersects the Z axis and the intersections of the top and bottom plane with the outermost radius of the system of interest. The outermost boundaries of the complete system must be at least $3 \times \text{DISTMX}$ distance away from its nearest boundary in the system of interest.

The need for the system of interest and for the complete system as well as for DISTMX is due to the way in which the code calculates distances through regions. The subroutine CYLGOM (which calculates distances through regions) requires a starting point, direction cosines, and a point far enough removed from the starting point (the end point) so that distances through regions in the system of interest are calculated. If the end point is (X', Y', Z') and the starting point and direction cosines are respectively $(X, Y, Z), (\alpha, \beta, \gamma)$, then

$$X' = X + \text{DISTMX} * \alpha$$

$$Y' = Y + \text{DISTMX} * \beta$$

$$Z' = Z + \text{DISTMX} * \gamma$$

If the end point is not outside the system of interest, all the distances required to make an analytic estimation of flux may not be calculated. If the end point is beyond the last boundary described in the geometry, CYLGOM becomes confused. To remedy this situation, the complete system was invented. The M-1 code also checks the end point before entering CYLGOM, and if the end point is outside the complete system, it is assumed that the particle has escaped from the system of interest and a new particle is chosen to be followed.

The geometry of the system is cylindrical. The system allows for 14 subdivisions in the Z direction by means of planes perpendicular to the Z axis (a total of 15 planes must be used to describe 14 subdivisions in the Z direction) and for a maximum of 15 cylinders of revolution about the Z axis in each Z subdivision.

Fig. 1. System Geometry,

C. DISTMX

DISTMX is the distance from the particle source or last collision point which is used in the analytic estimation routine. A minimum value for DISTMX is two times the diagonal of the system of interest.

D. WEIGHT

WEIGHT is used to play Russian roulette with the weight of the particle. Experience with the effect of WEIGHT on the calculation can be gained through use of the code.

E. RUNNING TIME VERSUS NUMBER OF REGIONS IN WHICH ANSWERS ARE REQUESTED

Requesting answers in the maximum number of regions possible (100) as compared with requesting answers in only one region has very little effect on the running time of the code.

F. RUNNING TIME VERSUS NUMBER OF ENERGY GROUPS

The running time for one history is not directly proportional to the number of energy groups used. If the maximum number of energy groups are used, it will require more histories to obtain a continuous representation of the flux versus energy; however, the time to run one history is not greatly affected.

G. INITIAL RANDOM NUMBER

The initial random number used to start any problem is a 12-digit number to the base eight with the condition that the first number of the 12-digit number be either 0, 1, 2, or 3. If a series of runs on the same problem is to be made, the random number printed at the end of the results for run N should be used as the initial random number for run N + 1.

H. SPLITTING

To increase the validity of the answers in regions that are far removed from the source, a technique called splitting is employed. To use the splitting technique, the system is divided into a maximum of six volumes which are superimposed over the system and which are described in Fig. 2.

Fig. 2. Method of Dividing System for Splitting

Each particle splits DBL (i) times after traveling at least DXMU mean free paths. When splitting occurs, the weight W of each particle of the split is designated as the weight of the particle before splitting times $\frac{1}{\text{DBL}(i)}$. Furthermore, each split particle must travel at least DXMU mean free paths before it can split again. It should be noted that splitting does not occur exactly at DXMU mean free paths; the particle must travel at least DXMU mean free paths to a collision before splitting can take place. The number of particles into which each particle splits, DBL(i), can be different for each volume the boundaries of which are described by radii RMKS(1) and Z coordinates ZMK(k). It is not possible to delete the splitting by deleting the input required for splitting; however, splitting can be ignored by requiring that there be only one volume (the volume of the complete system) in which splitting does occur and by setting DBL(1) to 1. In this way, the calculation required for the splitting is minimized.

I. ZCENTR

The input number ZCENTR required for use in the splitting technique is the Z coordinate that is the midpoint of the innermost volume in which splitting occurs.

IV. FLOW DIAGRAMS

The flow diagrams included with this report provide a detailed description of the code. The flow diagram (Fig. 3) titled Main Flow shows the program which controls the flow of the calculation. Entries into and exits out of all subroutines except RANNO are controlled by Main Flow. The subroutines used are described below.

- (1) RSQVOL computes the volume of each region and squares the radii of each region. The square of the radii is used by CYLGOM (see Fig. 4).
- (2) GNOB computes the number of nonbremsstrahlung gammas in each region and energy group that are to be followed by the code. The subroutine also computes the weight to be assigned to each gamma (see Fig. 5).
- (3) BREMG computes the number of bremsstrahlung gammas in each region and energy group that are to be followed by the code. The subroutine also computes the weight to be assigned to each of the gammas (see Fig. 6).
- (4) XSECT computes the probabilities of scattering and absorption as well as the total macroscopic cross section for each energy group and material in the system. A material is defined as a mixture of isotopes (see Fig. 7).
- (5) COORDX picks the cartesian coordinates of a gamma starting its life history in a region. The distribution of gammas starting their life history in a region is assumed to be uniformly distributed within that region (see Fig. 8).
- (6) COORDA picks the direction cosines of gammas that are starting their life history. The direction cosines are assumed to be distributed isotropically (see Fig. 9).
- (7) RNEXP selects the number of mean free paths traveled by a particle from an exponential distribution. This is a function subroutine (see Fig. 10).
- (8) CYLGOM computes the distance traveled by a gamma with direction α , β , γ , through each region from some initial point x , y , z , to the exterior of the system of interest (see Fig. 11).
- (9) CMONTE computes the Cartesian coordinates (x , y , z) of the point at which collision occurs given the number of mean free paths traveled to the point of collision (see Fig. 12).

Fig. 4. Subroutine RSQVOL

Fig. 6. Subroutine BREMG

Fig. 7. Subroutine XSECT

Fig. 8. Subroutine COORDX

Fig. 9. Subroutine COORDA

Fig. 10. Subroutine RNEXP

FUNCTION SUBPROGRAM K FIND OF SUBROUTINE CYLGOM

$$\begin{aligned} & \text{(CYLGOM)} \\ \text{OUTPUT: } & \ell_{\min}, K, \ell_{\max}, K \rightarrow K = 1, 2, K_{\max} \\ & D_{K, \ell} \rightarrow \begin{cases} K = 1, 2, \dots, K_{\max} \\ \ell = \ell_{\min}, K, \ell_{\min}, K + 1, \dots, \ell_{\max}, K \end{cases} \\ & \vec{|\mathcal{P}|} = \sum_K \sum_{\ell} D_{K, \ell} \\ & K(X_3) \\ & K(Y_2) \end{aligned}$$

FUNCTION SUBPROGRAM LFIND OF SUBROUTINE CYLGOM

Fig. 11. Subroutine CYLGOM

Fig. 12. Subroutine CMONTE

Fig. 13. Subroutine ANAEST

Fig. 14. Subroutine PAIR PR

Fig. 15. Subroutine KNSCAT

Fig. 16. Subroutine RANNO

- (10) ANAEST computes the analytical estimation of flux and dose in each region traversed by the gamma (see Fig. 13).
- (11) PAIRPR calculates the number of gammas and the energies of the gammas resulting from a collision involving pair production (see Fig. 14).
- (12) KNSCAT picks from an isotropic distribution the angle of scattering, and gives the energy of the scattered particle (see Fig. 15).
- (13) RANNO picks a random number from a constant probability density (see Fig. 16).

V. TEST PROBLEMS

Two problems were used to check the results of the M-1 code. The first problem used the moments method of NYO 3075. A point source of 3-Mev gammas was mocked up in an essentially infinite medium (iron); the pair production part of the calculation was removed to agree with the moments method of treating pair production as absorption. To obtain answers in accordance with Fig. 17, the volume surrounding the source was divided into various regions. A comparison of the results obtained for a series regions between the fifth and sixth axial boundaries (Table 2) reveals the weak and strong points of this particular Monte Carlo solution.

TABLE 2
Comparison of Moments Method with Monte Carlo

<u>Region</u>	<u>Number of Mean Free Paths from Source</u>	<u>Moments Method Dose (r/hr)</u>	<u>Monte Carlo Dose (r/hr)</u>
5, 3	1.86	2.8×10^4	4.38×10^4
5, 5	5.16	6.55×10^2	5.24×10^2
5, 7	9.56	1.84	16
5, 9	24.41	3.65×10^{-4}	0.18972×10^{-2}
5, 11	27.71	1.02×10^{-8}	0.64596×10^{-3}

One thousand particles were followed; splitting took place after the particle had traveled a minimum of two mean free paths from some point of collision or from birth. No splitting occurred until the particle was 4 cm removed from the centerline of the system; between 4 and 10 cm from the centerline, the particle split into two particles; between 10 and 40 cm, the particle split into five particles; between 40 and 1900 cm, the particle split into two particles. No splitting occurred in the axial direction. Examination of the results by the moments method calculation, and, examination of the fluxes where the agreement is poor, reveals the reason for the lack of correlation; i.e., the fluxes indicate that the statistics in the region are very poor; many of the energy groups are void of any flux, and the energy groups that are occupied vary greatly in magnitude.

The 5-watt Strontium-90 fueled weather station generator was chosen for the second problem. In this problem, the results of the Monte Carlo

Weather station
power source

Fig. 17. Weather Station Power Source

code were verified by comparing the actual dose rate measurements of the weather station. (The generator and the associated weather data telemetry equipment were installed on Axel Heiberg Island in the Canadian Arctic during August 1961.)

The generator (refer to Fig. 1) is assembled in two main sections: the biological shield container and the biological shield closure assembly. The shield closure assembly consists of two separate sections assembled in one final unit. The upper section comprises the closure flange and 3.9 inches of lead shielding cast into a stainless-steel housing; the lower section, a Hastelloy-C housing containing the completely assembled and wired Strontium-90 generator. The inner generator design includes a strontium titanate fuel capsule containing 17,500 curies of Strontium-90 in the form of strontium titanate, a Hastelloy-C fuel housing, 60 thermoelectric subassemblies and a heat sink. The region between the generator and main shield assemblies is filled with mercury to provide better heat transfer through the system. To properly shield the strontium titanate fuel capsule, a 4.4-inch lead shield cast into a stainless-steel structure completely surrounds the biological shield closure assembly. This thickness of biological shield reduces the radiation dosage to 3 mr/hr at a distance of one meter from the centerline.

The shield thicknesses were designed by calculations performed with a generalized shielding program coded for the IBM 709 computer.

After the generator was fueled, dose rates (listed in Table 3) were measured:

TABLE 3
Dose Rates of Fueled Generator

<u>Distance from Fuel Centerline</u>	<u>Dose Rate*</u>	
	<u>Top</u> <u>(mr/hr)</u>	<u>Side</u> <u>(mr/hr)</u>
1 meter	7	3
<u>Distance from Shield Container Surface</u> <u>(in.)</u>		
0	90	28
3	62	24
6	40	17
9	30	11
12	22	9

*Dose rates were measured by a Victoreen 592 instrument.

TABLE 3 (continued)

Distance from Shield Container Surface (in.)	Dose Rate	
	Top (mr/hr)	Side (mr/hr)
15	16	6.5
18	12	5.4
21	10	4.3
24	8	3.7
36	4	2.0
63	2	1.0

The idealized system used for preparing input for the Monte Carlo code is shown in Fig. 18, and a larger cross-sectional view of the idealized generator is shown in Fig. 19. The various radii and Z (axial) dimensions are given in Table 4. The upper numbers in this table are the radii; the lower numbers are material code numbers.

The code gives answers according to zones defined by (K, L)--axial zone number and radial zone numbers. Results were calculated for zones (8, 11) and (8, 15) which correspond to the reading in Table 1, three inches from the surface and one meter from the centerline of the capsule.

Table 5 compares the results obtained in regions (8, 11) and (8, 15) with experimental results obtained for the same regions.

TABLE 5
Comparison of Weather Station
Experimental Results and M-1 Code

Region	Dose Rate (mr/hr)	
	Measured	Calculated
8, 11	24.0	1.89×10^3
8, 15	2.0	1.17×10^2

The results compared in Table 5 were obtained by examining 500 particles; splitting took place after the particle had traveled a minimum of three mean free paths from some point of collision or birth. Splitting took place at 7 cm, 15 cm, 20 cm, 22 cm, 40 cm, and 1×10^4 cm from the centerline of the system into 2, 5, 5, 5, 5, 2 particles,

Fig. 18. Idealized System for Preparing Input Data to Code

Fig. 19. Idealized 5-Watt Weather Station Generator

TABLE 4
Dimensions and Materials of Idealized 5-Watt
Weather Station Generator

	<u>K</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>
5000.0	15																
2047.8485	14	10,000 8															
2046 1023	13	10 3187 5	10 795 8	22 701 5	10,000 8												
2036 9900	12	10 001 6	10 635 5	10 975 8	11 271 5	22 066 6	22 701 5	10,000 8									
2035 7200	11	10 001 2	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8										
2031 9100	10	7 775 3	9.525 7	10 001 2	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8								
2030 8000	9	3 81 2	7 775 3	9 520 7	10 001 2	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8							
2018 0086	8	2 324 1	3 810 2	7 777 3	9 525 7	10 001 2	10 318 4	10 795 5	22 006 6	22 701 5	29 821 8	30 821 8	90 94 8	91 94 8	99 5 8	100 5 8	10,000 8
2017 2136	7	3 81 2	7 7775 3	9 525 7	10 001 2	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8							
2012 6060	6	7 777 3	9 525 7	10 001 2	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8								
2011 3360	5	10 001 2	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8										
2011 0185	4	10 318 4	10 795 5	22 066 6	22 701 5	10,000 8											
2010 5410	3	10 795 5	22 066 6	22 701 5	10,000 8												
2000 0	2	22 066 6	22 701 5	10,000 8	Radu Material Code												
0	1	10,000 8															

Material Code

- 1 Strontium titanate
- 2 Hastelloy C
- 3 Insulation
- 4 Mercury
- 5 Stainless steel
- 6 Lead
- 7 Aluminum
- 8 Air

respectively, in each of the regions. Again, as was revealed by the moments method calculation, the weather station calculation showed poor agreement because of the poor statistics in the region of interest.

VI. CONCLUSIONS

From the results of the two problems used to check the M-1 code, it is apparently necessary to increase the number of particles of all energies which reach the regions in which answers are required; this can be accomplished by any one of the four following means:

- (1) The initial number of particles can be increased.
- (2) The number of particles into which a given particle splits in each volume can be changed.
- (3) The number of mean free paths traveled before splitting occurs can be decreased.
- (4) The volumes in which splitting can occur can be rearranged.

The change that would create the greatest effect on both the moments method and the weather station results and would bring them into agreement with the moments method and experimental measurement, respectively, would be item No. 3 above. Changing the number of mean free paths traveled before splitting would, in essence, increase the number of particles reaching the regions where answers are requested and would, at the same time, reduce the weight of each particle so that no few particles would become the major contributors to the answers.

Of course, increasing the initial number of particles (item No. 1 above) would add validity to the results and redistributing the splitting in each volume (item No. 2 above) would help to keep running time per problem at a minimum if done properly.

These suggested means of improving the moments method and weather station results were not put into effect because of the time required to run such problems. It is estimated that between two and three hours on the 7090 would be required. The results reported here for the weather station required three minutes, and those reported for the moments method required 19.2 minutes of running time on the 7090.

M-1 is a versatile code, but, as is the case with all Monte Carlo codes, it is not a tool for parametric studies--it is, rather to be used as a check on other less sophisticated methods of calculation or as a check on some relatively stable final design product.

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1. Kahn, H., "Applications of Monte Carlo," AECU 3259, 19 April 1954.
2. "Monte Carlo Method," U.S. Department of Commerce, Applied Math Series 12, p 12 (Various Techniques Used in Connection with Random Digits, by John Von Neuman).
3. Feller, W., "An Introduction to Probability Theory and Its Applications," Volume VI, Second Edition, p 168.
4. Evans, R. D., "The Atomic Nucleus," pp 615 to 617.
5. Ibid (3) above plus Part I, pp 62 to 65.
6. Ibid (4) above plus pp 674 to 684.

APPENDIX A

NOMENCLATURE

The symbols used in the flow diagrams presented in this report are listed and described below. An attempt has been made to make this list of symbols as complete as possible; however, some of the symbols which were needed for intermediate calculations were necessary only because of peculiarities of the system of coding and thus may have been omitted. In many cases, symbols have identical definitions; this is mandatory because different values of a particular variable must be preserved in several locations and this can be accomplished only by changing the name of the variables.

ABSQ	= $\alpha^2 + \beta^2$
Alpha	= α = direction cosine with respect to the x axis
A(N)	= Atomic weight of element whose code number is N
(AN)	= The Avogadro number
ASP	= Fork in the main flow, if ASP is: <ol style="list-style-type: none"> 1. Pick new particle to follow 2. Subroutine KNSCAT is entered 3. Subroutine PAIRPR is entered
Beta	= β = direction cosine with respect to the y axis
BN(KF, LF)	= The number of bremsstrahlung gammas to be followed from region (K, L) if a source exists in that region. BN(KF, LF) is an input number.
C(MN, N)	= $\frac{P(MN, M)}{A(N)}$ = density of isotope No. M in material MN divided by the atomic weight of the Mth element in material MN (the code number of the element is N)
CN	= Count on the number of collisions experienced by the gammas being followed

CONST	= $\frac{P(MN, M) (N)}{A(N)} = C(MN, N) (N)$ where (N) is the decay constant of the isotope whose code number is N
CONST (2)	= $(AN) * E * V (K, L)$
CSIGA(MN, J)	= Macroscopic absorption cross section for material MN, energy group J, divided by the Avogadro number
CSIGP(MN, J)	= Macroscopic pair production cross section for material MN, energy group J, divided by the Avogadro number
CSIGS(MN, J)	= Macroscopic scattering cross section for material MN, energy group J, divided by the Avogadro number
CSIGT(MN, J)	= Macroscopic total cross section for material MN, energy group J, divided by the Avogadro number
(CT)	= Constant = $7 \times 10^{-4} \text{ (Mev}^{-1}\text{)}$
BDL(LS)	= Number of particles into which a particle will split for volume LS
DBW(KCO)	= Weight of the KCOth set of particles arising from splitting
DBLWEIG(KCO)	= Minimum weight at which the game of Russian roulette is played for the KCOth set of particles arising from splitting
DBYPP(KCO)	= x, y, z coordinate for the KCOth set of particles arising from splitting
DBENER(KCO)	= Energy of each particle in the KCOth set of particles arising from splitting (Mev)
DCN(KD, J)	= Dose conversion factor for energy group J whose code number is KD. Input number
DELTA E	= ΔE = increment in energy (Mev)
DISTMX	= Distance along a radius from outermost part of scattering to the outer point of the system (cm). Input

D(K, L)	= Distance (cm) traveled by a gamma in region K, L
DOSEB(KR, LR)	= Dose due to bremsstrahlung gammas in region identified by KR, LR. Output
DOSE(KR, LR)	= Dose due to nonbremsstrahlung gammas in region identified by KR, LR. Output
E	= Energy (Mev)
E(J + 1/2)	= $E(J) + 1/2 \Delta E$ (Mev)
E(J)	= Energy at the lower bound of energy interval J (Mev)
FINBG	= A fork set in the code: 1. Follow nonbremsstrahlung gammas or stop calculation 0. Follow bremsstrahlung gammas
FOLBG(KF, LF, J)	= Number of bremsstrahlung gammas in energy group J followed by the code for a region identified by KF, LF
GN(KF, LF)	= Number of nonbremsstrahlung gammas to be followed from a region identified by KF, LF if a source exists in that region. Input
HEE(I)	= $\frac{1}{E(I + 1/2)}$, (Mev ⁻¹)
HE(J)	= $\frac{1}{E(J + 1/2)}$, (Mev ⁻¹)
I	= Index on energy groups
J	= Index on energy groups
JC	= Maximum number of energy groups plus one
JDB(KCO)	= Energy group index of the KCOth set of particles arising from splitting
JJ	= Count of number of particles to be followed whose existence is due to pair production reaction

JMC	= Energy group index of the gammas due to annihilation of positrons and electrons following pair production
JPP	= Energy group index of particle born in a pair production reaction
K	= Index indicating the Z region
KDBL(KCO)	= The KCOth count on the number of particles to be followed due to splitting
KDBLP(LS)	= DBL(LS)-1
KCO	= Index on the number of sets of storage locations allotted in core. Each time a particle splits, one is added to KCO; when all the particles due to splitting, have been followed, KCO is reduced by one. If KCO is 15, all 15 sets are written on tape to be followed at a later time; KCO is set to zero.
L	= Index on the radial regions
Lambda(N)	= $\lambda(N)$ = decay constant for isotope N ($\frac{\text{disintegrations}}{\text{sec}}$)
LLMAX(K)	= Maximum number of radial regions in axial region K. Input
LMAX(K)	= Largest radial region index for a given K region for which the distance is calculated
LMIN(K)	= Smallest radial region index for a given K region for which the distance is calculated
M	= Counter on the number of isotopes in a material
MFPATH	= Mean free path
MMAX(MN)	= The maximum number of isotopes in material (MN). Input
MN(K, L)	= The material code number in region K, L. Input
MNMAX	= The maximum number of different materials. Input

MP(MN, M)	= The Mth code number for an isotope in material MN. Input
N	= Used as a code number for isotopes in code
PALPHA(JJ)	= The JJth α of the particle to be followed whose existence is due to pair production reaction
PA(MN, J)	= Probability of absorption in material MN, energy group J
PBETA(JJ)	= The JJth β of the particle to be followed whose existence is due to pair production reaction
PCN	= The collision number stored in subroutine BORN
PGAMMA(JJ)	= The JJth γ of the particle to be followed whose existence is due to pair production reaction
ρ (MN, M)	= The density of the Mth isotope in material MN (gm/cm ³). Input
PPB	= Indicates if the gamma is due to bremsstrahlung or nonbremsstrahlung source
PXP	= The x coordinate of the particle to be followed whose existence is due to pair production reaction
PXPP	= The x coordinate used in subroutine PAIRPR
PYP	= The y coordinate of the particle to be followed whose existence is due to pair production reaction
PYPP	= The y coordinate used in subroutine PAIRPR
PZP	= The z coordinate of the particle to be followed whose existence is due to pair production reaction
PZPP	= The z coordinate used in subroutine PAIRPR
RAS(MN)	= $\sum_M \frac{\rho(MN, M)}{A(M)}$

R(K, L)	= The outer radius of region K, L (cm). Input
RSQR(K, L)	= The outer radius squared of region K, L
S	= Index calculated by the code which is used to determine the distance traveled by the particle
Psi	= Random number
PS(MN, J)	= The probability of scattering for material MN, energy group J
PW(JJ)	= The weight of the JJth particle whose existence is due to pair production reaction
SB(MP, I)	= Beta spectrum (the number of betas per disintegration per atom for isotope MP, energy group I). Input
SG(N, J)	= Gamma spectrum (the number of gammas per disintegration per atom for isotope N, energy group J). Input
SIGA(MP, J)	= Microscopic absorption cross section for isotope MP, energy group J (barns/atom). Input
SIGP(MP, J)	= Microscopic scattering cross section for isotope MP, energy group J (barns/atom). Input
SKIPCO	= Fork index set in the code which determines whether or not the COLISN routine should be entered
SKIPMC	= Fork index set in the code which determines whether or not the CMONTE routine should be entered
SSBB(MN, J)	= Intermediate calculation of the bremsstrahlung particles
SSB(J)	= $\sum_{MP} (HE(J) - HEE(I)) SB(MP, I)$, intermediate calculation for the bremsstrahlung particles

SSG(MN, J)	= Intermediate calculation of the nonbremsstrahlung particles
TBG	= Total number of bremsstrahlung particles to be followed
TRBG(KF, LF)	= Total number of bremsstrahlung particles to be followed from a region identified by KF, LF
TREBG(KF, LF, J)	= Total number of bremsstrahlung particles to be followed in energy group J from a region identified by KF, LF
TRESG(KF, LF, J)	= Total number of nonbremsstrahlung particles to be followed from energy group J from a region identified by KF, LF
TRSG(KF, LF)	= Total number of nonbremsstrahlung particles to be followed from a region identified by KF, LF
TSG	= Total number of nonbremsstrahlung particles to be followed
V(K, L)	= Volume of region K, L
W	= Weight of the particle being followed
WANA	= Weight of the particle being followed in subroutine ANAEST
WB(KF, LF)	= Weight of the bremsstrahlung particles to be followed in a region identified by KF, LF
WEIGHT	= Fraction of the weight with which the particle begins life, which is used in playing the game of Russian roulette. Input
WG(KF, LF)	= Weight of the nonbremsstrahlung particles to be followed in a region identified by KF, LF
X	= x coordinate
XMFP(KR, LR, J)	= Number of mean free paths traveled by gammas in energy group J and in a region identified by KR, LR

XMU	=	Number of mean free paths
XP(1)	=	x coordinate used in CYLGOM
XP(2)	=	y coordinate used in CYLGOM
XP(3)	=	z coordinate used in CYLGOM
XPP	=	x coordinate
XST(MN, J)	=	Total macroscopic cross section for material MN, energy group J
XXMFPI	=	Number of mean free paths
Y	=	y coordinate
YPP	=	y coordinate
Z	=	z coordinate
ZCENTR	=	z coordinate that is the midpoint of the innermost volume in which splitting occurs (cm). Input
Z(K)	=	z coordinate (lower bound) or region K
ZPP	=	z coordinate
ZRAS(MN)	=	$\sum_{MP} \frac{z(MP) \rho(MN, MP)}{A(MP)}$
ZZ	=	z coordinate
ZZZ	=	z coordinate

APPENDIX B

NONBREMSSTRAHLUNG GAMMAS

The number of gammas per disintegration per atom for an isotope indexed by M in energy group J to J + 1 is $SG_{(M, K, L, J+1/2)} \frac{(E_{J+1} - E_J)}{E_{J+1/2}}$. A mock gamma spectrum versus J is shown in Fig. B-1.

Fig. B-1. Mock Gamma Spectrum Versus J

The number of gammas emitted per second in energy group J, region K, L isotope M is

$$TRMESG_{M, J, K, L} = SG_{M, K, L, J+1/2} \frac{(E_{J+1} - E_J)}{E_{J+1/2}} \lambda_{M, K, L} \rho_{M, K, L} \frac{AN}{A_{M, K, L}} V_{K, L}$$

The number of gammas emitted from all materials and all energy groups in region K, L is

$$TRSG_{K, L} = \sum_J \sum_M TREMSG_{M, J, K, L}$$

The total number of gammas emitted from all regions is

$$TSG = \sum_K \sum_L TRSG_{K, L}$$

The weight assigned to each nonbremsstrahlung gamma in region K, L is

$$WG_{K,L} = \frac{TRSG(K,L)}{GN(K,L)}$$

$$WG_{K,L} = \frac{TRSG_{K,L}}{GN_{K,L}}$$

Details of the calculation can be found in the flow diagram of sub-routine GNOB

APPENDIX C

BREMSSTRAHLUNG GAMMAS

The function $f(E, E_{I+1/2})$ is proportional to the probability density (Ref. 3) function of gammas being emitted from isotope N at energy E due to one beta in energy group I.

The energy of the gammas in energy group J, (J to J+1), due to one beta in energy group I interacting with isotope N is

$$\int_{E_J}^{E_{J+1}} f(E, E_{I+1/2}) dE = \frac{2 AI_{I,N}}{E_{I+1/2}} \left[1 - \frac{E_{J+1/2}}{E_{I+1/2}} \right]$$

where

$$E_{J+1/2} = \frac{E_{J+1} + E_J}{2}$$

and $AI_{I,N} = (CT) Z_N E_{I+1/2}^2$ (Ref. 4) is the average total energy of the bremsstrahlung gamma per beta disintegration, and $CT = 7 \times 10^{-4} \text{ Mev}^{-1}$. Z_N is the atomic number of the isotope N with which the beta reacts.

This uncomplicated treatment of the problem solved by the last formula is, at best, a compromise, since no dependence between AI , Z and E is to be found. Even experimental results (Ref. 4) for various energy ranges do not present clearly the relationship between AI , Z and E . Therefore, the approximate relationship suggested by Evans (Ref. 4) was used. The number of betas emitted per second in energy group I due to isotope M in region K, L is

$$TRMEBG_{M,I,K,L} =$$

$$SB_{M,K,L,I+1/2} \frac{E_{I+1} - E_I}{E_{I+1/2}} \lambda_{M,K,L} \rho_{M,K,L} \frac{AN}{A_{M,K,L}} V_{K,L}.$$

Where the number of betas per disintegration per atom for an isotope indexed by M in energy group I to I + 1, region K, L is

$$SB_{M,K,L,I+1/2} \frac{E_{I+1} - E_I}{E_{I+1/2}}$$

A mock beta spectrum versus I is shown in Fig. C-1.

Fig. C-1. Mock Beta Spectrum Versus I

The fraction of the atoms that are isotope N in region K, L are

$$\frac{\rho_{N,K,L}}{A_{N,K,L}} \bigg/ \sum_N \frac{\rho_{N,K,L}}{A_{N,K,L}}$$

The number of gammas generated per second (due to bremsstrahlung reaction with material N) in energy group J from betas originating in isotope M, in energy group I, and in region K, L is

$$\frac{\rho_{N,K,L}}{A_{N,K,L}} \frac{TRMEBG}{E_{J+1/2}} \int_{E_J}^{E_{J+1}} f(E_I, E_{I+1/2}) dE =$$

$$SB_{M,I+1/2,K,L} \frac{E_{I+1} - E_I}{E_{I+1/2}} \lambda_{M,K,L} \rho_{M,K,L} \frac{A_N}{A_{M,K,L}} V_{K,L} \frac{(CT)E_{I+1/2}^2}{E_{I+1/2}^2 E_{J+1/2}}$$

$$\left[E_{I+1/2} - E_{J+1/2} \right] \left[E_{J+1} - E_J \right] \frac{\frac{Z_{N,K,L} \rho_{N,K,L}}{A_{N,K,L}}}{\sum_N \frac{\rho_{N,K,L}}{A_{N,K,L}}}$$

The number of gammas born per second due to betas from isotope M in region K, L is

$$\text{TRMBG}_{K, L} =$$

$$\sum_{I=2}^{JC} \sum_{J=1}^{I-1} \text{SB}_{M, I+1/2, K, L} (E_{I+1} - E_I) \lambda_{M, K, L} \frac{AN}{A_{M, K, L}} V_{K, L}$$

$$\frac{(CT) P_{M, K, L}}{E_{I+1/2} E_{J+1/2}} \left[E_{I, 1/2} - E_{J+1/2} \right] \left[E_{J+1} - E_J \right]$$

The following simplifications will be made

$$E_I = E_J \text{ if } I = J$$

$$E_{J+1} - E_J = \Delta E \text{ for all } 0 \leq J \leq JC$$

Thus,

$$\text{TRMBG}_{M, K, L} =$$

$$\sum_{I=2}^{JC} \sum_{J=1}^{I-1} \text{SB}_{M, I+1/2, K, L} (E_{I+1/2} - E_{J+1/2}) \lambda_{M, K, L} \frac{AN}{A_{M, K, L}} V_{K, L}$$

$$\frac{(CT) \rho_{M, K, L}}{E_{I+1/2} E_{J+1/2}} \frac{1}{\Delta E^2} \frac{\sum_N \frac{Z_{N, K, L} \rho_{N, K, L}}{A_{N, K, L}}}{\sum_N \frac{\rho_{N, K, L}}{A_{N, K, L}}}$$

The number of bremsstrahlung gammas born per second in region K, L is

$$\text{TRBG}_{K, L} = \sum_M \text{TRMBG}_{K, L}$$

The weight assigned to each bremsstrahlung gamma in region K, L is

$$\text{WB}_{K, L} = \frac{\text{TRBG}_{K, L}}{\text{BN}_{K, L}}$$

Details of the calculation can be found in the flow diagram of sub-routine BREMG.

APPENDIX D

PAIR PRODUCTION

When pair production takes place, a negatron and a positron are created; each particle has energy

$$EB = 1/2 (\text{Energy} - M_0 C^2)$$

The trajectories of the bremsstrahlung gammas resulting from the negatron are followed from the point of pair production; as in all other cases, these gammas are emitted isotropically. The bremsstrahlung gammas are born in each energy group below the energy group of the incident photon according to the materials present and in compliance with the probability density function $f(E, E_{I+1/2})$ described in Appendix

C. The positron is annihilated by collision with an electron (at the point of pair production). The rest energy of the positron-electron pair appears as two gammas, traveling in opposite directions, each with energy $M_0 C^2$. The direction of the first of the gammas (due to the positron-electron reaction) is picked from an isotropic distribution. Details of the calculation can be found in the flow diagram of subroutine PAIRPR.

APPENDIX E

KLEIN NISHINA ELASTIC SCATTERING

It can be shown (Refs. 5 and 6) that if a gamma ray of energy α (in $M_0 C^2$ units) is traveling in a cloud of free electrons, then it has a probability $g(x, \alpha) dx dl$ of having a collision in the distance dl and emerging from this collision with an energy α' such that

$$g(x, \alpha) dx = \begin{cases} n\pi a_0^2 (\cos^2 \theta - 1 + x + \frac{1}{x}) \frac{dx}{x^2}, & 1 \leq x \leq 1 + 2\alpha \\ 0, & x \leq 1, 1 + 2\alpha \leq x \end{cases}$$

where

$$\cos \theta = \frac{1}{\alpha} - \frac{x}{\alpha} + 1$$

$\cos \theta$ = cosine of angle of scattering

a_0 = classical radius of electron

n = number of electrons per cc

α' = $x\alpha$ = energy of gamma ray after scattering

This formula is the Klein Nishina differential collision cross section for incident unpolarized gamma rays. The details for picking out of this distribution can be found in the flow diagram of subroutine KNSCAT.

APPENDIX F

PRINTOUT OF MOMENTS METHOD AND
WEATHER STATION INPUT AND RESULTSI. MOMENTS METHOD

A. INPUT

```

***      M J KNIEDLER      THE MARTIN MARIETTA CO      DEC 1961      ***
      * * INPUT * *
MOMENTS METHOD      1000 HISTORIES      NO PAIRPRODUCTION
M J KNIEDLER
INITIAL RANDOM NUMBER = 106713133355
NUMBER OF ENERGY INTERVALS PLUS ONE = JC=      31
ENERGY INTERVAL WIDTH = DELE= 1.00000E-01
END POINTS OF ENERGY INTERVAL = E
0.      1.00000E-01 0.20000E-00 0.30000E-00 0.40000E-00 0.50000E 00
0.60000E 00 0.70000E 00 0.80000E 00 0.90000E 00 0.10000E 01 0.11000E 01
0.12000E 01 0.13000E 01 0.14000E 01 0.15000E 01 0.16000E 01 0.17000E 01
0.18000E 01 0.19000E 01 0.20000E 01 0.21000E 01 0.22000E 01 0.23000E 01
0.24000E 01 0.25000E 01 0.26000E 01 0.27000E 01 0.28000E 01 0.29000E 01
0.30000E 01
NUMBER OF AXIAL SUBDIVISIONS =KKMAX=      9
MAX NUMBER OF RADIAL SUBDIVISIONS IN EACH AXIAL SUBDIVISION = LLMAX
      1      3      9      3      12      3
      9      3      1
COORDINATES OF AXIAL SUBDIVISIONS=ZC
0.      0.19930E 04 0.19950E 04 0.19970E 04 0.19995E 04 0.20005E 04
0.20030E 04 0.20050E 04 0.20070E 04 0.40000E 04
COORDINATES OF RADIAL SUBDIVISIONS = R
0.20000E 04
0.65000E 01 0.70000E 01 0.20000E 04
0.65000E 01 0.70000E 01 0.18500E 02 0.19000E 02 0.34500E 02 0.35000E 02
0.88500E 02 0.89000E 02 0.20000E 04
0.65000E 01 0.70000E 01 0.20000E 04
0.56420E 00 0.65000E 01 0.70000E 01 0.18500E 02 0.19000E 02 0.34500E 02
0.35000E 02 0.88500E 02 0.89000E 02 0.10000E 03 0.10100E 03 0.20000E 04
0.65000E 01 0.70000E 01 0.20000E 04
0.65000E 01 0.70000E 01 0.18500E 02 0.19000E 02 0.34500E 02 0.35000E 02
0.88500E 02 0.89000E 02 0.20000E 04
0.65000E 01 0.70000E 01 0.20000E 04
0.20000E 04

```


MATERIAL CODE NUMBER FOR EACH REGION INDEXED BY K,L = MMN

1					
1	1	1			
1	1	1	1	1	1
1	1	1			
1	1	1			
1	1	1	1	1	1
1	1	1	1	1	1
1	1	1			
1	1	1	1	1	1
1	1	1			
1	1	1			

NUMBER OF DIFFERENT MATERIALS = MNMAX= 1

NUMBER OF ISOTOPES IN EACH OF THE MATERIALS = MMAX

CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER 1

DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIIC CODE NUMBERS LISTED ABOVE FOR MATERIAL NUMBER 1

0.76000E 01

TOTAL NUMBER OF ISOTOPES = MMPMAX= 1

CODE NUMBERS OF THE ISOTOPES=MMP

A= 0.55850E 02 Z= 0.26000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 1

SIGA

0.15500E 03	0.54000E 01	0.11000E 01	0.42000E-00	0.21000E-00	0.13000E-00
0.82000E-01	0.59000E-01	0.43000E-01	0.34000E-01	0.28000E-01	0.23000E-01
0.20000E-01	0.17000E-01	0.15000E-01	0.14000E-01	0.13000E-01	0.12000E-01
0.11000E-01	1.00000E-02	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

SIGS

0.14200E 02	0.11500E 02	0.98900E 01	0.86500E 01	0.78600E 01	0.72400E 01
0.67300E 01	0.63100E 01	0.59600E 01	0.56600E 01	0.54000E 01	0.51500E 01
0.49400E 01	0.47300E 01	0.45600E 01	0.44000E 01	0.42400E 01	0.41000E 01
0.39800E 01	0.38600E 01	0.37500E 01	0.36400E 01	0.35400E 01	0.34700E 01
0.33800E 01	0.33000E 01	0.32200E 01	0.31800E 01	0.30900E 01	0.30200E 01

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.27000E-01	0.39000E-01	0.55000E-01	0.74000E-01
0.96000E-01	0.12000E-01	0.14000E-01	0.17000E-01	0.18900E-00	0.21100E-00
0.23200E-00	0.25200E-00	0.27200E-00	0.29300E-00	0.31800E-00	0.33800E-00

NUMBER OF ISOTOPES THAT ARE BETTA EMITTERS = KSPMAX = 1

CODE NUMBERS OF ISOTOPES THAT ARE BETTA EMITTERS

DECAY CONSTANT= ALMDA= 0.41600E-08 FOR ISOTOPE NUMBER 1
WHOSE CORRESPONDING BETTA DECAY SPECTRUM=SB

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

GAMMA DECAY SPECTRUM =SG FOR ISOTOPE NUMBER						1
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.10000E 01
NUMBER OF AXIAL SUBDIVISIONS IN WHICH GAMMA SOURCES ARE TO BE						
CALCULATED = KFMAX= 1						
CODE NUMBER OF AXIAL SUBDIVISIONS IN WHICH GAMMA SOURCES ARE TO BE						
CALCULATED = KRF =						
5						
NUMBER OF RADIAL SUBDIVISIONS FOR EACH AXIAL SUBDIVISION IN WHICH						
SOURCES ARE TO BE CALCULATED =LFMAX						
1						
CODE NUMBERS OF THE RADIAL SUBDIVS. (LRF) OF AXIAL SUBDIV. SET NO						1
FOR WHICH THE SOURCES ARE TO BE CALCULATED.						
1						
NO. OF AXIAL SUBDIVS. IN WHICH ANSWERS ARE TO BE TABULATED=KRMAX=						7
CODE NO. OF AXIAL SUBDIVS. IN WHICH ANSWERS ARE TO BE TABULATED= KREG						
2	3	4	5	6	7	
8						
NO. RADIAL SUBDIVS. CORRESPONDING TO THE AXIAL SUBDIV. CODE NUMBERSKREG						
IN WHICH ANSWERS ARE TO BE TABULATED =LRMAX						
1	4	1	5	1	4	
1						
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						1
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
2						
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						2
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
2	4	6	8			
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						3
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
2						
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						4
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
3	5	7	9	11		
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						5
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
2						
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						6
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
2	4	6	8			
CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO.						7
FOR WHICH THE ANSWERS ARE TO BE TABULATED						
2						
NO. OF PARTICLES DUE TO BREMSSTRAHLUNG REACTION TO BE FOLLOWED (BN)						
FROM THE RADIAL SUBDIVS. CORRESPONDING TO LRF WHOSE AXIAL SUBDIV. CODE						
NUMBER IS 5						
0.						

NO. OF PARTICLES DUE TO NON BREMSSTRAHLUNG REACTION TO BE FOLLOWED (GN)
FROM THE RADIAL SUBDIVS. CORRESPONDING TO LRF WHOSE AXIAL SUBDIV. CODE

NUMBER IS 5

0.10000E 04

DOSE CONVERSION FACTORS

0.13200E-06 0.26500E-06 0.49000E-06 0.77000E-06 0.93000E-06 0.11300E-05

0.13300E-05 0.15100E-05 0.16900E-05 0.18500E-05 0.20000E-05 0.21500E-05

0.23000E-05 0.24200E-05 0.25800E-05 0.27000E-05 0.28200E-05 0.29600E-05

0.30800E-05 0.32000E-05 0.33000E-05 0.34000E-05 0.35200E-05 0.36400E-05

0.37400E-05 0.38400E-05 0.39500E-05 0.40500E-05 0.41500E-05 0.42500E-05

CRITERION USED IN RUSSIAN ROULETTE GAME WITH THE WEIGHT OF THE PARTICLE
= WEIGHT = 0.

THE MAXIMUM DISTANCE A PARTICLE CAN TRAVEL AND STILL REMAIN IN THE
SYSTEM =DISTMX = 0.10000E 04

NUMBER OF MEAN FREE PATHS TRAVELED BEFORE SPLITTING = 0.20000E 01

RADII AT WHICH SPLITTING OCCURS

0.40000E 01 0.10000E 02 0.20000E 02 0.30000E 02 0.40000E 02 0.19000E 04

NO INTO WHICH PARTICLE IS SPLIT

0.10000E 01 0.20000E 01 0.50000E 01 0.50000E 01 0.50000E 01 0.20000E 01

Z COORDINATES AT WHICH SPLITTING OCCURS

0.39940E 04 0.39950E 04 0.39960E 04 0.39970E 04 0.39980E 04 0.39990E 04

Z COORDINATES AT WHICH SPLITTING OCCURS

0.60000E 01 0.50000E 01 0.40000E 01 0.30000E 01 0.20000E 01 0.10000E 01

NO REGIONS IN WHICH SPLITTING OCCURS = 6

B. RESULTS

GAMMA SOURCES FOR REGION K,L=

5

1

BREMSSTRAHLUNG GAMMA SOURCES (FOLBG) STARTING WITH LOWEST ENERGY

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

WEIGHT OF BREMSSTRAHLUNG GAMMAS (WB) = 0.

NON BREMSSTRAHLUNG GAMMA SOURCES (FOLSG) STARTING WITH LOWEST ENERGY

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.10000E 04

WEIGHT OF NON BREMSSTRAHLUNG GAMMAS (WG) = 0.11596E 11

ANSWERS FOR REGION INDEXED BY K,L= 2 2

VOLUME = 0.42411E 02 = REGION VOLUME

DOSE = 0.14902E 05 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.14902E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.54172E 11	0.58200E 11	0.39302E 11	0.28023E 11	0.18208E 11
J= 6	0.13718E 11	0.49050E 10	0.49939E 10	0.60008E 09	0.28068E 10
J=11	0.36128E 10	0.64329E 09	0.25674E 10	0.13563E 10	0.39840E 08
J=16	0.32580E 10	0.36496E 10	0.16155E 10	0.55653E 09	0.15145E 10
J=21	0.11789E 10	0.24523E 10	0.31818E 10	0.13500E 10	0.12281E 10
J=26	0.56560E 09	0.	0.14266E 10	0.85325E 09	0.13071E 11

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.91806E 08	0.98749E 09	0.10255E 10	0.88594E 09	0.64697E 09
J= 6	0.53374E 09	0.20647E 09	0.22483E 09	0.28664E 08	0.14135E 09
J=11	0.19085E 09	0.35658E 08	0.14843E 09	0.81925E 08	0.24824E 07
J=16	0.20979E 09	0.24292E 09	0.11066E 09	0.39047E 08	0.11187E 09
J=21	0.89811E 08	0.19228E 09	0.24467E 09	0.10516E 09	0.97494E 08
J=26	0.45660E 08	0.	0.11779E 09	0.71791E 08	0.11161E 10

ANSWERS FOR REGION INDEXED BY K,L= 3 2

VOLUME = 0.42411E 02 = REGION VOLUME

DOSE = 0.25383E 05 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.25383E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.78070E 11	0.16275E 12	0.83630E 11	0.32474E 11	0.38728E 11
J= 6	0.12537E 11	0.16994E 11	0.73511E 10	0.14866E 09	0.92052E 10
J=11	0.15909E 11	0.32945E 10	0.23814E 10	0.40044E 10	0.31924E 10
J=16	0.86883E 10	0.27522E 10	0.21873E 10	0.17048E 10	0.39239E 10
J=21	0.73658E 09	0.18284E 10	0.13461E 10	0.	0.46887E 10
J=26	0.43906E 09	0.25619E 10	0.	0.	0.21963E 11

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.13231E 09	0.27614E 10	0.21820E 10	0.10266E 10	0.13761E 10
J= 6	0.48779E 09	0.71533E 09	0.33096E 09	0.71012E 07	0.46357E 09
J=11	0.84044E 09	0.18262E 09	0.13767E 09	0.24189E 09	0.19891E 09
J=16	0.55947E 09	0.18319E 09	0.14983E 09	0.11961E 09	0.28984E 09
J=21	0.56113E 08	0.14336E 09	0.10351E 09	0.	0.37222E 09
J=26	0.35444E 08	0.21037E 09	0.	0.	0.18754E 10

ANSWERS FOR REGION INDEXED BY K,L= 3 4

VOLUME = 0.11781E 03 = REGION VOLUME

DOSE = 0.63233E 03 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.63233E 03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.81416E 11	0.48730E 11	0.64734E 10	0.19097E 10	0.52818E 10
J= 6	0.67147E 09	0.23655E 10	0.72117E 08	0.49361E 08	0.20339E 10
J=11	0.40820E 09	0.35005E 10	0.26975E 09	0.23623E 08	0.47565E 09
J=16	0.38785E 08	0.53582E 07	0.12216E 09	0.23532E 08	0.
J=21	0.25104E 08	0.15260E 08	0.	0.89595E 07	0.88784E 08
J=26	0.48993E 08	0.	0.64540E 07	0.	0.50904E 09

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.49671E 08	0.29765E 09	0.60804E 08	0.21734E 08	0.67563E 08
J= 6	0.94049E 07	0.35847E 08	0.11689E 07	0.84882E 06	0.36874E 08
J=11	0.77631E 07	0.69852E 08	0.56140E 07	0.51370E 06	0.10669E 08
J=16	0.89909E 06	0.12839E 06	0.30124E 07	0.59438E 06	0.
J=21	0.68847E 06	0.43076E 06	0.	0.25126E 06	0.25374E 07
J=26	0.14238E 07	0.	0.19183E 06	0.	0.15648E 08

ANSWERS FOR REGION INDEXED BY K,L= 3 6

VOLUME = 0.21834E 03 = REGION VOLUME

DOSE = 0.30691E 02 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.30691E 02 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.59133E 10	0.58317E 10	0.39305E 09	0.30984E 09	0.16101E 09
J= 6	0.92457E 09	0.67932E 09	0.18090E 08	0.26108E 05	0.21245E 06
J=11	0.36009E 04	0.93513E 05	0.	0.	0.
J=16	0.96883E 06	0.16805E 05	0.	0.	0.
J=21	0.	0.14521E 06	0.39451E 08	0.	0.65822E 07
J=26	0.25275E 06	0.21902E 06	0.54823E 08	0.87847E 06	0.27418E 07

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.19466E 07	0.19220E 08	0.19920E 07	0.19027E 07	0.11113E 07
J= 6	0.69874E 07	0.55544E 07	0.15820E 06	0.24224E 03	0.20782E 04
J=11	0.36950E 02	0.10069E 04	0.	0.	0.
J=16	0.12118E 05	0.21727E 03	0.	0.	0.
J=21	0.	0.22117E 04	0.58926E 06	0.	0.10150E 06
J=26	0.39633E 04	0.34935E 04	0.87923E 06	0.14357E 05	0.45478E 05

ANSWERS FOR REGION INDEXED BY K,L= 3 8

VOLUME = 0.55763E 03 = REGION VOLUME

DOSE = 0.87113E-03 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.87113E-03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.22218E 07	0.11447E 06	0.30488E-03	0.94093E-10
J= 6	0.50159E-13	0.52245E-09	0.19640E-17	0.26030E-05	0.85242E-07
J=11	0.52166E-07	0.71119E-09	0.90005E-06	0.28616E-05	0.
J=16	0.	0.26037E-03	0.	0.15523E-02	0.
J=21	0.	0.	0.	0.	0.31738E-01
J=26	0.	0.98495E-01	0.	0.	0.45904E-00

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.28672E 04	0.22716E 03	0.73308E-06	0.25428E-12
J= 6	0.14843E-15	0.16726E-11	0.67250E-20	0.94566E-08	0.32649E-09
J=11	0.20960E-09	0.29983E-11	0.39575E-08	0.13147E-07	0.
J=16	0.	0.13181E-05	0.	0.82834E-05	0.
J=21	0.	0.	0.	0.	0.19163E-03
J=26	0.	0.61514E-03	0.	0.	0.29812E-02

ANSWERS FOR REGION INDEXED BY K,L= 4 2

VOLUME = 0.53014E 02 = REGION VOLUME

DOSE = 0.34071E 05 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.34071E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
 K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.37053E 12	0.37978E 12	0.20689E 12	0.12861E 12	0.90233E 11
J= 6	0.13123E 11	0.28865E 11	0.14702E 11	0.18415E 11	0.80657E 10
J=11	0.71770E 10	0.16863E 10	0.65054E 10	0.11061E 10	0.24514E 10
J=16	0.29270E 10	0.13631E 10	0.12389E 10	0.20957E 10	0.22074E 09
J=21	0.34271E 10	0.17736E 10	0.20641E 09	0.19310E 10	0.57217E 10
J=26	0.56183E 10	0.99403E 09	0.10250E 10	0.23604E 10	0.43653E 11

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.50235E 09	0.51550E 10	0.43184E 10	0.32527E 10	0.25649E 10
J= 6	0.40845E 09	0.97202E 09	0.52953E 09	0.70369E 09	0.32495E 09
J=11	0.30331E 09	0.74778E 08	0.30087E 09	0.53452E 08	0.12220E 09
J=16	0.15078E 09	0.72583E 08	0.67894E 08	0.11763E 09	0.13044E 08
J=21	0.20886E 09	0.11125E 09	0.12698E 08	0.12034E 09	0.36338E 09
J=26	0.36284E 09	0.65299E 08	0.67700E 08	0.15888E 09	0.29821E 10

ANSWERS FOR REGION INDEXED BY K,L= 5 3

VOLUME = 0.21206E 02 = REGION VOLUME

DOSE = 0.43833E 05 =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.43833E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.90197E 11	0.17391E 12	0.64926E 11	0.47034E 11	0.24499E 11
J= 6	0.14598E 11	0.23016E 11	0.11320E 11	0.58080E 10	0.49758E 10
J=11	0.24038E 10	0.15566E 10	0.18523E 10	0.96325E 09	0.20958E 10
J=16	0.19966E 10	0.29157E 10	0.22754E 09	0.30606E 10	0.
J=21	0.48941E 10	0.11886E 10	0.42473E 10	0.33167E 10	0.16036E 10
J=26	0.15964E 10	0.24790E 10	0.71747E 09	0.27169E 09	0.17043E 11

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.30571E 09	0.59016E 10	0.33880E 10	0.29739E 10	0.17410E 10
J= 6	0.11359E 10	0.19377E 10	0.10193E 10	0.55486E 09	0.50115E 09
J=11	0.25397E 09	0.17257E 09	0.21417E 09	0.11637E 09	0.26117E 09
J=16	0.25714E 09	0.38814E 09	0.31173E 08	0.42947E 09	0.
J=21	0.74567E 09	0.18640E 09	0.65320E 09	0.51674E 09	0.25461E 09
J=26	0.25775E 09	0.40713E 09	0.11847E 09	0.45720E 08	0.29106E 10

ANSWERS FOR REGION INDEXED BY K,L= 5 5

VOLUME = 0.58905E 02 = REGION VOLUME

DOSE = 0.52439E 03 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.52439E 03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.36058E 10	0.60790E 10	0.30519E 10	0.21099E 10	0.14523E 10
J= 6	0.40590E 09	0.65272E 09	0.10386E 10	0.36258E 08	0.33502E 09
J=11	0.55171E 09	0.36350E 09	0.31145E 09	0.53575E 08	0.12038E 08
J=16	0.13548E 09	0.22691E 08	0.36371E 07	0.	0.98072E 08
J=21	0.50688E 08	0.	0.87557E 07	0.25336E 09	0.78610E 07
J=26	0.	0.24291E 08	0.	0.	0.27827E 09

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.43998E 07	0.74263E 08	0.57332E 08	0.48027E 08	0.37155E 08
J= 6	0.11370E 08	0.19783E 08	0.33666E 08	0.12470E 07	0.12147E 08
J=11	0.20984E 08	0.14507E 08	0.12964E 08	0.23301E 07	0.54004E 06
J=16	0.62812E 07	0.10875E 07	0.17938E 06	0.	0.52157E 07
J=21	0.27802E 07	0.	0.48476E 06	0.14210E 08	0.44932E 06
J=26	0.	0.14361E 07	0.	0.	0.17109E 08

ANSWERS FOR REGION INDEXED BY K,L= 5 7

VOLUME = 0.10917E 03 = REGION VOLUME

DOSE = 0.16043E 02 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.16043E 02 = TOTAL DOSE 20.19

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.25386E 10	0.47060E 10	0.53481E 09	0.34216E 09	0.71205E 08
J= 6	0.92110E 07	0.13877E 08	0.11656E 06	0.18104E 07	0.24577E 04
J=11	0.10828E 07	0.	0.	0.	0.
J=16	0.61897E 05	0.75053E 05	0.	0.	0.
J=21	0.	0.	0.	0.51912E 05	0.
J=26	0.	0.24524E 06	0.	0.	0.13177E 07

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.16714E 07	0.31020E 08	0.54210E 07	0.42024E 07	0.98291E 06
J= 6	0.13922E 06	0.22694E 06	0.20387E 04	0.33596E 05	0.48082E 02
J=11	0.22221E 05	0.	0.	0.	0.
J=16	0.15484E 04	0.19407E 04	0.	0.	0.
J=21	0.	0.	0.	0.15710E 04	0.
J=26	0.	0.78233E 04	0.	0.	0.43713E 05

ANSWERS FOR REGION INDEXED BY K,L= 5 9

VOLUME = 0.27882E 03 = REGION VOLUME

DOSE = 0.18972E-02 =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.18972E-02 = TOTAL DOSE

XMPF = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.27739E 07	0.52101E-04	0.65398E-13	0.25092E-13
J= 6	0.49887E-12	0.18251E-09	0.60170E-07	0.16569E-05	0.
J=11	0.27975E-05	0.	0.	0.98618E-05	0.
J=16	0.22833E-04	0.	0.	0.	0.49679E-02
J=21	0.	0.	0.	0.	0.
J=26	0.	0.45206E-01	0.	0.	0.19438E-00

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.71593E 04	0.20678E-06	0.31450E-15	0.13562E-15
J= 6	0.29524E-14	0.11686E-11	0.41207E-09	0.12039E-07	0.
J=11	0.22479E-07	0.	0.	0.90615E-07	0.
J=16	0.22365E-06	0.	0.	0.	0.55819E-04
J=21	0.	0.	0.	0.	0.

J=26	0.	0.56465E-03	0.	0.	0.25248E-02
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ANSWERS FOR REGION INDEXED BY K,L= 5 11

VOLUME = 0.63146E 03 = REGION VOLUME

DOSE = 0.64596E-03 =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.64596E-03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.21382E 07	0.27657E 03	0.39241E-04	0.
J= 6	0.58268E-14	0.	0.29179E-09	0.15085E-07	0.
J=11	0.32748E-07	0.	0.	0.22097E-06	0.
J=16	0.	0.	0.	0.	0.25269E-03
J=21	0.	0.	0.	0.	0.
J=26	0.	0.33274E-02	0.	0.	0.13135E-01

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.24367E 04	0.48466E-00	0.83323E-07	0.
J= 6	0.15226E-16	0.	0.88233E-12	0.48398E-10	0.
J=11	0.11619E-09	0.	0.	0.89651E-09	0.
J=16	0.	0.	0.	0.	0.12536E-05
J=21	0.	0.	0.	0.	0.
J=26	0.	0.18351E-04	0.	0.	0.75335E-04

ANSWERS FOR REGION INDEXED BY K,L= 6 2

VOLUME = 0.53014E 02 = REGION VOLUME

DOSE = 0.38280E 05 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.38280E 05 = TOTAL DOSE

XMPF = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.50449E 12	0.42878E 12	0.12178E 12	0.67054E 11	0.44778E 11
J= 6	0.26412E 11	0.31380E 11	0.14872E 11	0.17792E 11	0.33325E 10
J=11	0.52221E 10	0.47801E 10	0.56374E 10	0.29404E 10	0.25531E 10
J=16	0.47618E 10	0.59485E 10	0.99458E 10	0.29251E 10	0.94901E 10
J=21	0.51419E 10	0.	0.28966E 10	0.37210E 10	0.45390E 10
J=26	0.26775E 10	0.29597E 10	0.18018E 10	0.45612E 10	0.48090E 11

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.68396E 09	0.58201E 10	0.25420E 10	0.16959E 10	0.12729E 10
J= 6	0.82208E 09	0.10567E 10	0.53564E 09	0.67990E 09	0.13426E 09
J=11	0.22069E 09	0.21197E 09	0.26072E 09	0.14209E 09	0.12726E 09
J=16	0.24530E 09	0.31675E 09	0.54504E 09	0.16418E 09	0.56079E 09

J=11	0.74544E-10	0.24956E-07	0.25730E-07	0.10170E-07	0.
J=16	0.	0.20951E-05	0.62985E-06	0.	0.
J=21	0.17725E-04	0.	0.	0.61221E-04	0.
J=26	0.	0.	0.	0.	0.20683E-02

J=21	0.31337E 09	0.	0.17819E 09	0.23189E 09	0.28827E 09
J=26	0.17292E 09	0.19443E 09	0.11901E 09	0.30702E 09	0.32852E 10

ANSWERS FOR REGION INDEXED BY K,L= 7 2

VOLUME = 0.42411E 02 = REGION VOLUME

DOSE = 0.26470E 05 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.26470E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.17861E 12	0.20238E 12	0.90239E 11	0.56764E 11	0.23129E 11
J= 6	0.97660E 10	0.79767E 10	0.90012E 10	0.88361E 10	0.48501E 10
J=11	0.37041E 10	0.80274E 10	0.10112E 11	0.83792E 10	0.54348E 09
J=16	0.75140E 09	0.19801E 10	0.35483E 10	0.71446E 10	0.32016E 10
J=21	0.	0.55288E 09	0.37366E 09	0.25795E 10	0.40482E 10
J=26	0.92131E 09	0.15092E 10	0.18333E 10	0.27530E 10	0.20689E 11

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.30269E 09	0.34337E 10	0.23545E 10	0.17946E 10	0.82181E 09
J= 6	0.37996E 09	0.33577E 09	0.40525E 09	0.42207E 09	0.24424E 09
J=11	0.19568E 09	0.44497E 09	0.58461E 09	0.50615E 09	0.33864E 08
J=16	0.48385E 08	0.13180E 09	0.24306E 09	0.50127E 09	0.23648E 09
J=21	0.	0.43351E 08	0.28733E 08	0.20094E 09	0.32137E 09
J=26	0.74375E 08	0.12393E 09	0.15137E 09	0.23163E 09	0.17667E 10

ANSWERS FOR REGION INDEXED BY K,L= 7 4

VOLUME = 0.11781E 03 = REGION VOLUME

DOSE = 0.97890E 03 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.97890E 03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.46970E 11	0.39844E 11	0.17903E 11	0.11871E 11	0.1133CE 10
J= 6	0.64921E 09	0.50184E 10	0.34253E 10	0.69504E 09	0.21975E 07
J=11	0.11462E 10	0.24926E 10	0.28514E 09	0.	0.96294E 09
J=16	0.55110E 09	0.13736E 08	0.14283E 08	0.28409E 08	0.50686E 09
J=21	0.48882E 08	0.38359E 08	0.71954E 09	0.38436E 08	0.11071E 09
J=26	0.22020E 09	0.73023E 08	0.86997E 07	0.42729E 08	0.45912E 09

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.28656E 08	0.24338E 09	0.16816E 09	0.13510E 09	0.14493E 08
J= 6	0.90932E 07	0.76048E 08	0.55517E 08	0.11952E 08	0.39840E 05
J=11	0.21797E 08	0.49741E 08	0.59344E 07	0.	0.21600E 08

J=16	0.12776E 08	0.32915E 06	0.35222E 06	0.71754E 06	0.13478E 08
J=21	0.13406E 07	0.10828E 07	0.19919E 08	0.10779E 07	0.31640E 07
J=26	0.63995E 07	0.21587E 07	0.25858E 06	0.12943E 07	0.14114E 08

ANSWERS FOR REGION INDEXED BY K,L= 7 6

VOLUME = 0.21834E 03 = REGION VOLUME

DOSE = 0.32320E 02 =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.32320E 02 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.30554E 10	0.40299E 10	0.31815E 10	0.15208E 09	0.10238E 10
J= 6	0.99510E 07	0.14249E 06	0.42646E 09	0.25068E 09	0.60915E 08
J=11	0.11507E 08	0.	0.14064E 06	0.22158E 06	0.44132E 06
J=16	0.	0.29727E 06	0.10492E 08	0.17674E 07	0.22016E 07
J=21	0.36359E 06	0.	0.28934E 06	0.16857E 06	0.43495E 06
J=26	0.	0.	0.22874E 06	0.11735E 06	0.25183E 08

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10058E 07	0.13282E 08	0.16124E 08	0.93394E 06	0.70663E 07
J= 6	0.75205E 05	0.11651E 04	0.37295E 07	0.23259E 07	0.59587E 06
J=11	0.11807E 06	0.	0.15794E 04	0.25999E 04	0.53413E 04
J=16	0.	0.38434E 04	0.13960E 06	0.24086E 05	0.31589E 05
J=21	0.53803E 04	0.	0.43218E 04	0.25507E 04	0.67072E 04
J=26	0.	0.	0.36685E 04	0.19179E 04	0.41770E 06

ANSWERS FOR REGION INDEXED BY K,L= 7 8

VOLUME = 0.55763E 03 = REGION VOLUME

DOSE = 0.30198E 01 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.30198E 01 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.12991E 01	0.88219E 10	0.30645E 07	0.16243E-14	0.63607E-05
J= 6	0.56667E-11	0.11314E-09	0.10686E-09	0.70946E-08	0.23038E-08
J=11	0.18553E-07	0.59194E-05	0.58518E-05	0.22136E-05	0.
J=16	0.	0.41385E-03	0.12089E-03	0.	0.
J=21	0.30593E-02	0.	0.	0.10333E-01	0.
J=26	0.	0.	0.	0.	0.31846E-00

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.16744E-03	0.11384E 08	0.60813E 04	0.39057E-17	0.17190E-07
J= 6	0.16769E-13	0.36222E-12	0.36592E-12	0.25774E-10	0.88237E-11

ANSWERS FOR REGION INDEXED BY K,L= 8 2

VOLUME = 0.42411E 02 = REGION VOLUME

DOSE = 0.11236E 05 = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0. DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.11236E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.32960E 11	0.77909E 11	0.46747E 11	0.20420E 11	0.10289E 11
J= 6	0.79006E 10	0.63229E 10	0.12497E 11	0.17540E 10	0.36478E 10
J=11	0.10555E 10	0.63613E 10	0.66002E 09	0.	0.91026E 09
J=16	0.43915E 10	0.	0.16600E 10	0.71325E 07	0.53912E 09
J=21	0.37711E 09	0.	0.10761E 10	0.20136E 09	0.63447E 09
J=26	0.56721E 09	0.88115E 09	0.67878E 09	0.51655E 09	0.98586E 10

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.55858E 08	0.13219E 10	0.12197E 10	0.64557E 09	0.36558E 09
J= 6	0.30739E 09	0.26616E 09	0.56264E 09	0.83782E 08	0.18370E 09
J=11	0.55758E 08	0.35261E 09	0.38157E 08	0.	0.56717E 08
J=16	0.28278E 09	0.	0.11371E 09	0.50041E 06	0.39822E 08
J=21	0.28728E 08	0.	0.82744E 08	0.15686E 08	0.50368E 08
J=26	0.45790E 08	0.72355E 08	0.56043E 08	0.43462E 08	0.84184E 09

FINAL RANDOM NUMBER IS 346425322105

FINAL TIME 11.58 DATE 03/09/62

II. WEATHER STATION

A. INPUT

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***      M J KNIEDLER      THE MARTIN MARIETTA CO      DEC 1961      ***
      * * INPUT * *
W. S. ----- 500 HISTORIES ----- NON BREMSSTRAHLUNG GAMMAS
ONLY. DOSE UNITS ARE MR/ HR.              M. J. KNIEDLER
INITIAL RANDOM NUMBER = 110462051271
NUMBER OF ENERGY INTERVALS PLUS ONE = JC=          23
ENERGY INTERVAL WIDTH = DELE= 1.00000E-01
END POINTS OF ENERGY INTERVAL = E

0.      1.00000E-01 0.20000E-00 0.30000E-00 0.40000E-00 0.50000E 00
0.60000E 00 0.70000E 00 0.80000E 00 0.90000E 00 0.10000E 01 0.11000E 01
0.12000E 01 0.13000E 01 0.14000E 01 0.15000E 01 0.16000E 01 0.17000E 01
0.18000E 01 0.19000E 01 0.20000E 01 0.21000E 01 0.22000E 01
NUMBER OF AXIAL SUBDIVISIONS =KKMAX=          14
MAX NUMBER OF RADIAL SUBDIVISIONS IN EACH AXIAL SUBDIVISION =      LLMAX
      1      3      4      5      6      8
      9      16     9      8      6      7
      4      1
COORDINATES OF AXIAL SUBDIVISIONS=ZC

0.      0.20000E 04 0.20105E 04 0.20110E 04 0.20113E 04 0.20126E 04
0.20172E 04 0.20180E 04 0.20308E 04 0.20319E 04 0.20357E 04 0.20370E 04
0.20461E 04 0.20478E 04 0.50000E 04
COORDINATES OF RADIAL SUBDIVISIONS = R
0.10000E 05
0.22066E 02 0.22701E 02 0.10000E 05
0.10795E 02 0.22066E 02 0.22701E 02 0.10000E 05
0.10319E 02 0.10795E 02 0.22066E 02 0.22701E 02 0.10000E 05
0.10001E 02 0.10319E 02 0.10795E 02 0.22066E 02 0.22701E 02 0.10000E 05
0.77775E 01 0.95250E 01 0.10001E 02 0.10319E 02 0.10795E 02 0.22066E 02
0.22701E 02 0.10000E 05
0.38100E 01 0.77775E 01 0.95250E 01 0.10001E 02 0.10319E 02 0.10795E 02
0.22066E 02 0.22701E 02 0.10000E 05
0.23241E 01 0.38100E 01 0.77775E 01 0.95250E 01 0.10001E 02 0.10319E 02
0.10795E 02 0.22066E 02 0.22701E 02 0.29821E 02 0.30821E 02 0.90940E 02
0.91940E 02 0.99500E 02 0.10050E 03 0.10000E 05
0.38100E 01 0.77775E 01 0.95250E 01 0.10001E 02 0.10319E 02 0.10795E 02
0.22066E 02 0.22701E 02 0.10000E 05
0.77775E 01 0.95250E 01 0.10001E 02 0.10319E 02 0.10795E 02 0.22066E 02
0.22701E 02 0.10000E 05
0.10001E 02 0.10319E 02 0.10795E 02 0.22066E 02 0.22701E 02 0.10000E 05

```

0.10001E 02 0.10635E 02 0.10795E 02 0.11271E 02 0.22066E 02 0.22701E 02

0.10000E 05

0.10319E 02 0.10795E 02 0.22701E 02 0.10000E 05

0.10000E 05

MATERIAL CODE NUMBER FOR EACH REGION INDEXED BY K,L = MMN

8					
6	5	8			
5	6	5	8		
4	5	6	5	8	
2	4	5	6	5	8
3	7	2	4	5	6
5	8				
2	3	7	2	4	5
6	5	8			
1	2	3	7	2	4
5	6	5	8	8	8
8	8	8	8		
2	3	7	2	4	5
6	5	8			
3	7	2	4	5	6
5	8				
2	4	5	6	5	8
6	5	8	5	6	5
8					
5	8	5	8		
8					

NUMBER OF DIFFERENT MATERIALS = MNMAX= 8

NUMBER OF ISOTOPES IN EACH OF THE MATERIALS = MMAX

5	5	3	1	4	1
3	2				
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					1
11	10	4	5	2	
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					2
8	7	12	6	13	
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					3
2	3	7			
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					4
14					
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					5
7	6	8	12		
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					6
15					
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					7
3	9	7			
CODE NUMBERS (MP) OF THE ISOTOPES IN MATERIAL NUMBER					8
2	1				

DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIIC CODE NUMBERS LISTED ABOVE FOR MATERIAL NUMBER 1

0.56800E 00 0.11360E 01 0.22200E 00 0.11860E 01 0.11570E 01

DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIIC CODE NUMB

ERS LISTED ABOVE FOR MATERIAL NUMBER 2					
0.47400E 01 0.53700E 00 0.17010E 01 0.15210E 01 0.44800E-00					
DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIC CODE NUMB					
ERS LISTED ABOVE FOR MATERIAL NUMBER 3					
0.13760E-00 0.15360E-00 1.00000E-02					
DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIC CODE NUMB					
ERS LISTED ABOVE FOR MATERIAL NUMBER 4					
0.13550E 02					
DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIC CODE NUMB					
ERS LISTED ABOVE FOR MATERIAL NUMBER 5					
0.54250E 01 0.13460E 01 0.95100E 00 0.19800E-00					
DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIC CODE NUMB					
ERS LISTED ABOVE FOR MATERIAL NUMBER 6					
0.10590E 02					
DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIC CODE NUMB					
ERS LISTED ABOVE FOR MATERIAL NUMBER 7					
0.25500E 01 0.21000E-00 0.40000E-01					
DENSITIES (RHO) OF THE ISOTOPES CORRESPONDING TO THE ISOTOPIC CODE NUMB					
ERS LISTED ABOVE FOR MATERIAL NUMBER 8					
0.91000E-03 0.28000E-03					
TOTAL NUMBER OF ISOTOPES = MMPMAX= 15					
CODE NUMBERS OF THE ISOTOPES=MMP					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15			
A= 0.14008E 02 Z= 0.70000E 01 FOR ISOTOPE WHOSE CODE NUMBER IS 1					
SIGA					
0.39000E-00 1.00000E-02 0.30000E-02 0.14000E-02 0. 0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.		
SIGS					
0.39300E 01 0.31100E 01 0.26800E 01 0.23800E 01 0.21300E 01 0.19600E 01					
0.18200E 01 0.17100E 01 0.16000E 01 0.15200E 01 0.14400E 01 0.13800E 01					
0.13200E 01 0.12700E 01 0.12300E 01 0.11700E 01 0.11400E 01 0.11000E 01					
0.10700E 01 0.10300E 01 0.10100E 01 0.96000E 00					
SIGP					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.25800E-02	0.35500E-02	0.47000E-02
0.61000E-02 0.77000E-02 0.94000E-02 0.11100E-01					
A= 0.16000E 02 Z= 0.80000E 01 FOR ISOTOPE WHOSE CODE NUMBER IS 2					
SIGA					
0.73000E 00 0.20000E-01 0.50000E-02 0.17000E-02 0. 0.					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.		

SIGS

0.44800E 01	0.35300E 01	0.30000E 01	0.26400E 01	0.24000E 01	0.22100E 01
0.20600E 01	0.19300E 01	0.18200E 01	0.17300E 01	0.16500E 01	0.15700E 01
0.15100E 01	0.14500E 01	0.14000E 01	0.13500E 01	0.13000E 01	0.12600E 01
0.12200E 01	0.11800E 01	0.11500E 01	0.11200E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.23000E-02	0.33000E-02	0.46000E-02	0.61000E-02
0.79000E-02	1.00000E-02	0.12000E-01	0.15000E-01		

A= 0.26980E 02 Z= 0.13000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 3

SIGA

0.73000E 01	0.20000E-00	0.47000E-01	0.18000E-01	0.92000E-02	0.54000E-02
0.34000E-02	0.23000E-02	0.16000E-02	0.12000E-02	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.		

SIGS

0.72600E 01	0.57800E 01	0.49100E 01	0.43400E 01	0.39400E 01	0.36200E 01
0.33600E 01	0.31500E 01	0.29700E 01	0.28300E 01	0.27000E 01	0.25800E 01
0.24800E 01	0.23700E 01	0.22900E 01	0.22100E 01	0.21300E 01	0.20600E 01
0.20000E 01	0.19300E 01	0.18800E 01	0.18300E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.64000E-02	0.90000E-02	0.12000E-01	0.17000E-01
0.21000E-01	0.28000E-01	0.34000E-01	0.39000E-01		

A= 0.40080E 02 Z= 0.20000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 4

SIGA

0.50600E 02	0.16000E 01	0.34000E-00	0.13000E-00	0.66000E-01	0.37500E-01
0.24300E-01	0.17800E-01	0.13800E-01	0.11200E-01	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.		

SIGS

0.11200E 02	0.89500E 01	0.75500E 01	0.65500E 01	0.60500E 01	0.55500E 01
0.51500E 01	0.48400E 01	0.45800E 01	0.43400E 01	0.41200E 01	0.39500E 01
0.38000E 01	0.36200E 01	0.34900E 01	0.33700E 01	0.32300E 01	0.31200E 01
0.30400E 01	0.29600E 01	0.28800E 01	0.27900E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.70000E-02	0.11000E-01	0.16500E-01	0.23500E-01	0.33000E-01	0.44000E-01
0.57000E-01	0.72500E-01	0.88500E-01	0.10300E-00		

A= 0.47900E 02 Z= 0.22000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 5

SIGA

0.76800E 02	0.25000E 01	0.50000E 00	0.18000E-00	0.94000E-01	0.57000E-01
0.38000E-01	0.27000E-01	0.21000E-01	0.17000E-01	0.14000E-01	0.12000E-01
1.00000E-02	0.	0.	0.	0.	0.
0.	0.	0.	0.		

SIGS

0.12200E 02	0.98000E 01	0.83400E 01	0.73500E 01	0.66500E 01	0.61300E 01
0.57000E 01	0.53400E 01	0.50400E 01	0.47900E 01	0.45500E 01	0.43500E 01
0.41800E 01	0.40100E 01	0.38500E 01	0.37200E 01	0.35800E 01	0.34800E 01
0.37700E 01	0.32600E 01	0.31700E 01	0.30900E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.18000E-01	0.26000E-01	0.36000E-01	0.49000E-01

0.64000E-01 0.80000E-01 0.98000E-01 0.12000E-00

A= 0.52010E 02 Z= 0.24000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 6

SIGA

0.11100E 03	0.37000E 01	0.76000E 00	0.27000E-00	0.14000E-00	0.82000E-01
0.54000E-01	0.38000E-01	0.28000E-01	0.22000E-01	0.19000E-01	0.14000E-01
0.13000E-01	0.12000E-01	0.11000E-01	0.	0.	0.
0.	0.	0.	0.		

SIGS

0.13300E 02	0.10700E 02	0.92000E 01	0.81000E 01	0.72400E 01	0.66600E 01
0.62000E 01	0.58000E 01	0.54900E 01	0.52100E 01	0.49600E 01	0.47500E 01
0.45500E 01	0.43700E 01	0.42100E 01	0.40600E 01	0.39360E-00	0.38000E 01
0.36700E 01	0.35600E 01	0.34600E 01	0.33500E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.22000E-01	0.33000E-01	0.45000E-01	0.62000E-01

0.80000E-01 1.00000E-01 0.12000E-00 0.14000E-00

A= 0.55850E 02 Z= 0.26000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 7

SIGA

0.15500E 03	0.54000E 01	0.11000E 01	0.42000E-00	0.21000E-00	0.13000E-00
0.83000E-01	0.59000E-01	0.43000E-01	0.34000E-01	0.28000E-01	0.23000E-01
0.20000E-01	0.17000E-01	0.15000E-01	0.14000E-01	0.13000E-01	0.12000E-01
0.11000E-01	1.00000E-02	0.	0.		

SIGS

0.14200E 02	0.11500E 02	0.98900E 01	0.86500E 01	0.78600E 01	0.72400E 01
0.67300E 01	0.63100E 01	0.59600E 01	0.56600E 01	0.54000E 01	0.51500E 01
0.49400E 01	0.47300E 01	0.45600E 01	0.44000E 01	0.42400E 01	0.41000E 01
0.39800E 01	0.38600E 01	0.37500E 01	0.36400E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.27000E-01	0.39000E-01	0.55000E-01	0.74000E-01

0.96000E-01 0.12000E-00 0.14000E-00 0.17000E-00

A= 0.58710E 02 Z= 0.28000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 8

SIGA

0.21000E 03	0.76000E 01	0.15000E 01	0.57000E 00	0.30000E-00	0.18000E-00
0.12000E-00	0.80000E-01	0.59000E-01	0.45000E-01	0.35000E-01	0.29000E-01
0.25000E-01	0.21000E-01	0.19000E-01	0.17000E-01	0.15000E-01	0.14000E-01
0.13000E-01	0.12000E-01	0.11000E-01	0.		

SIGS

0.15600E 02	0.12400E 02	0.10600E 02	0.93500E 01	0.85000E 01	0.78100E 01
0.72600E 01	0.68000E 01	0.64200E 01	0.61000E 01	0.58000E 01	0.55500E 01
0.53200E 01	0.51100E 01	0.49200E 01	0.47400E 01	0.45800E 01	0.44300E 01
0.42900E 01	0.41600E 01	0.40400E 01	0.39400E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.32000E-01	0.45000E-01	0.63000E-01	0.84000E-01
0.11000E-00	0.14000E-00	0.16000E-00	0.19000E-00		

A= 0.65380E 02 Z= 0.30000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 9

SIGA

0.27000E 03	0.10000E 02	0.22000E 01	0.82000E 00	0.41000E-00	0.24000E-00
0.16000E-00	0.11500E-00	0.85000E-01	0.67000E-01	0.55000E-01	0.46000E-01
0.40000E-01	0.35000E-01	0.31500E-01	0.28500E-01	0.26000E-01	0.24000E-01
0.22000E-01	0.20000E-01	0.19000E-01	0.17500E-01		

SIGS

0.17300E 02	0.13700E 02	0.11700E 02	0.10300E 02	0.94000E 01	0.86400E 01
0.80300E 01	0.75200E 01	0.71000E 01	0.67500E 01	0.64000E 01	0.61400E 01
0.58800E 01	0.56500E 01	0.54400E 01	0.52400E 01	0.50600E 01	0.49000E 01
0.47500E 01	0.46000E 01	0.44800E 01	0.43600E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.37000E-01	0.52000E-01	0.71000E-01	0.94000E-01
0.12000E-00	0.15000E-00	0.19000E-00	0.22000E-00		

A= 0.88000E 02 Z= 0.38000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 10

SIGA

0.70100E 03	0.28500E 02	0.59000E 01	0.22500E 01	0.11500E 01	0.69000E 00
0.46000E-00	0.34000E-00	0.26500E-00	0.21600E-00	0.17800E-00	0.14500E-00
0.12400E-00	0.10900E-00	0.96000E-01	0.87000E-01	0.79000E-01	0.72500E-01
0.67000E-01	0.62500E-01	0.58500E-01	0.54500E-01		

SIGS

0.21700E 02	0.16900E 02	0.14600E 02	0.12700E 02	0.11500E 02	0.10600E 02
0.98200E 01	0.92000E 01	0.86500E 01	0.81800E 01	0.78000E 01	0.74500E 01
0.71500E 01	0.68500E 01	0.66000E 01	0.63500E 01	0.61500E 01	0.59500E 01
0.57800E 01	0.56000E 01	0.54200E 01	0.52800E 01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.29000E-01	0.43000E-01	0.64000E-01	0.89000E-01	0.12000E-00	0.15700E-00
0.20400E-00	0.25500E-00	0.30500E-00	0.35500E-00		

A= 0.90000E 02 Z= 0.38000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 11

SIGA

0.70100E-03	0.28500E-02	0.59000E-01	0.22500E-01	0.11500E-01	0.69000E-00
0.46000E-00	0.34000E-00	0.26500E-00	0.21600E-00	0.17800E-00	0.14500E-00
0.12400E-00	0.10900E-00	0.96000E-01	0.87000E-01	0.79000E-01	0.72500E-01
0.67000E-01	0.62500E-01	0.58500E-01	0.54500E-01		

SIGS

0.21700E-02	0.16900E-02	0.14600E-02	0.12700E-02	0.11500E-02	0.10600E-02
0.98200E-01	0.92000E-01	0.86500E-01	0.81800E-01	0.78000E-01	0.74500E-01
0.71500E-01	0.68500E-01	0.66000E-01	0.63500E-01	0.61500E-01	0.59500E-01
0.57800E-01	0.56000E-01	0.54200E-01	0.52800E-01		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.29000E-01	0.43000E-01	0.64000E-01	0.89000E-01	0.12000E-00	0.15700E-00
0.20400E-00	0.25500E-00	0.30500E-00	0.35500E-00		

A= 0.95950E 02 Z= 0.42000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 12

SIGA

0.10000E-04	0.43000E-02	0.94000E-01	0.35000E-01	0.18000E-01	0.11000E-01
0.73000E-00	0.53000E-00	0.40000E-00	0.32000E-00	0.27000E-00	0.23000E-00
0.20000E-00	0.17500E-00	0.15500E-00	0.14000E-00	0.13000E-00	0.11500E-00
0.10500E-00	0.97000E-01	0.97000E-01	0.83000E-01		

SIGS

0.23500E-02	0.18600E-02	0.16000E-02	0.14000E-02	0.12700E-02	0.11700E-02
0.10800E-02	0.10200E-02	0.96000E-01	0.91300E-01	0.87000E-01	0.83000E-01
0.79800E-01	0.75500E-01	0.73600E-01	0.71000E-01	0.68600E-01	0.66300E-01

0.64200E-01	0.62400E-01	0.60600E-01	0.59000E-01		
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SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.78000E-01	0.11000E-00	0.15000E-00	0.20000E-00
0.26000E-00	0.32000E-00	0.38000E-00	0.43000E-00		

A= 0.18386E 03 Z= 0.74000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 13

SIGA

0.15000E-04	0.41000E-03	0.92000E-02	0.40000E-02	0.22000E-02	0.14000E-02
0.93000E-01	0.69000E-01	0.53000E-01	0.43000E-01	0.36000E-01	0.30000E-01
0.26000E-01	0.23000E-01	0.20000E-01	0.18000E-01	0.16000E-01	0.15000E-00
0.13500E-01	0.12500E-01	0.11500E-01	0.11000E-01		

SIGS

0.41300E-02	0.33000E-02	0.28200E-02	0.24600E-02	0.22400E-02	0.20600E-02
0.19200E-02	0.18000E-02	0.16900E-02	0.16000E-02	0.15300E-02	0.14600E-02
0.14000E-02	0.13400E-02	0.12900E-02	0.12500E-02	0.12000E-02	0.11700E-02
0.11300E-02	0.11000E-02	0.10700E-02	0.10300E-02		

SIGP

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.34000E-00	0.47000E-00	0.62000E-00	0.79000E-00
0.99000E-00	0.12000E-01	0.14000E-01	0.16000E-01		

A= 0.20061E 03 Z= 0.80000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 14

SIGA

0.15000E 04 0.55000E 03 0.14000E 03 0.55000E 02 0.31000E 02 0.19000E 02
 0.13000E 02 0.94000E 01 0.74000E 01 0.60000E 01 0.49000E 01 0.42000E 01
 0.36000E 01 0.32000E 01 0.29000E 01 0.26000E 01 0.23000E 01 0.21000E 01
 0.19000E 01 0.17500E 01 0.16000E 01 0.15000E 01

SIGS

0.44800E 02 0.35300E 02 0.30000E 02 0.26400E 02 0.24000E 02 0.22100E 02
 0.20600E 02 0.19300E 02 0.18200E 02 0.17300E 02 0.16500E 02 0.15700E 02
 0.15100E 02 0.14500E 02 0.14000E 02 0.13500E 02 0.13000E 02 0.12600E 02
 0.12200E 02 0.11800E 02 0.11500E 02 0.11200E 02

SIGP

0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0.
 0. 0. 0.42000E-00 0.58000E 00 0.77000E 00 0.98000E 01
 0.12000E 01 0.15000E 01 0.17000E 01 0.20000E 01

A= 0.19866E 03 Z= 0.79000E 02 FOR ISOTOPE WHOSE CODE NUMBER IS 15

SIGA

0.17800E 04 0.54700E 03 0.12800E 03 0.58400E 02 0.31000E 02 0.19200E 02
 0.13700E 02 0.10000E 02 0.76600E 01 0.61100E 01 0.50100E 01 0.42800E 01
 0.36500E 01 0.32800E 01 0.29200E 01 0.26400E 01 0.23700E 01 0.21900E 01
 0.20100E 01 0.19100E 01 0.17300E 01 0.16400E 01

SIGS

0.44000E 02 0.35300E 02 0.29800E 02 0.26300E 02 0.23800E 02 0.21900E 02
 0.20400E 02 0.19200E 02 0.18100E 02 0.17100E 02 0.16300E 02 0.15600E 02
 0.14900E 02 0.14300E 02 0.13800E 02 0.13300E 02 0.12800E 02 0.12400E 02
 0.12100E 02 0.11700E 02 0.11300E 02 0.11100E 02

SIGP

0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0.
 0. 0. 0.43500E-00 0.58300E 00 0.77100E 00 0.10200E 01
 0.12100E 01 0.14000E 01 0.16800E 01 0.19600E 01

NUMBER OF ISOTOPEs THAT ARE BETTA EMITTERS = KSPMAX = 1

CODE NUMBERS OF ISOTOPEs THAT ARE BETTA EMITTERS

11

DECAY CONSTANT= ALMDA= 0.78500E-09 FOR ISOTOPE NUMBER 11

WHOSE CORRESPONDING BETTA DECAY SPECTRUM=SB

0.16105E-00 0.47925E-00 0.71600E 00 0.76020E 00 0.51884E 00 0.39765E-00
 0.44070E-00 0.50700E 00 0.56610E 01 0.61275E 01 0.64680E 01 0.66815E 00

0.66750E 00 0.67500E 00 0.64960E 01 0.60295E 01 0.53130E 01 0.44100E-00
 0.33485E-00 0.21450E-00 0.10250E-00 0.25800E-01

GAMMA DECAY SPECTRUM =SG FOR ISOTOPE NUMBER 11

0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0.
 0. 0. 0. 0. 0. 0.

NUMBER OF AXIAL SUBDIVISIONS IN WHICH GAMMA SOURCES ARE TO BE
 CALCULATED = KFMAX= 1

CODE NUMBER OF AXIAL SUBDIVISIONS IN WHICH GAMMA SOURCES ARE TO BE
 CALCULATED = KRF =

8

NUMBER OF RADIAL SUBDIVISIONS FOR EACH AXIAL SUBDIVISION IN WHICH
SOURCES ARE TO BE CALCULATED = LFMAX

1

CODE NUMBERS OF THE RADIAL SUBDIVS. (LRF) OF AXIAL SUBDIV. SET NO. 1
FOR WHICH THE SOURCES ARE TO BE CALCULATED.

1

NO. OF AXIAL SUBDIVS. IN WHICH ANSWERS ARE TO BE TABULATED = KRMAX = 10

CODE NO. OF AXIAL SUBDIVS. IN WHICH ANSWERS ARE TO BE TABULATED = KREG

3

4

5

6

7

8

9

10

11

12

NO. RADIAL SUBDIVS. CORRESPONDING TO THE AXIAL SUBDIV. CODE NUMBERS KREG
IN WHICH ANSWERS ARE TO BE TABULATED = LRMAX

3

5

6

6

6

10

6

6

6

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 1
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 2
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 3
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 4
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 5
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 6
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

11

12

13

14

15

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 7
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 8
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 9
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

CODE NUMBERS OF THE RADIAL SUBDIVS. (LREG) OF AXIAL SUBDIV. SET NO. 10
FOR WHICH THE ANSWERS ARE TO BE TABULATED

1

2

3

4

5

6

NO. OF PARTICLES DUE TO BREMSSTRAHLUNG REACTION TO BE FOLLOWED (BN)
FROM THE RADIAL SUBDIVS. CORRESPONDING TO LRF WHOSE AXIAL SUBDIV. CODE
NUMBER IS 8

0.50000E 03

NO. OF PARTICLES DUE TO NON BREMSSTRAHLUNG REACTION TO BE FOLLOWED (GN)
FROM THE RADIAL SUBDIVS. CORRESPONDING TO LRF WHOSE AXIAL SUBDIV. CODE
NUMBER IS 8

0.50000E 03

DOSE CONVERSION FACTORS

0.13200E-03 0.26500E-03 0.49000E-03 0.72000E-03 0.93000E-03 0.11300E-02

0.13300E-02 0.15100E-02 0.16900E-02 0.18500E-02 0.20000E-02 0.21500E-02

0.23000E-02 0.24200E-02 0.25800E-02 0.27000E-02 0.28200E-02 0.29600E-02

0.30800E-02 0.32000E-02 0.33000E-02 0.34000E-02

CRITERION USED IN RUSSIAN ROULETTE GAME WITH THE WEIGHT OF THE PARTICLE
= WEIGHT = 1.00000E-21

THE MAXIMUM DISTANCE A PARTICLE CAN TRAVEL AND STILL REMAIN IN THE
SYSTEM =DISTMX = 0.10000E 04

NUMBER OF MEAN FREE PATHS TRAVELED BEFORE SPLITTING = 0.30000E 01
RADII AT WHICH SPLITTING OCCURS

0.70000E 01 0.15000E 02 0.20000E 02 0.22000E 02 0.40000E 02 0.10000E 05

NO INTO WHICH PARTICLE IS SPLIT *

0.20000E 01 0.50000E 01 0.50000E 01 0.50000E 01 0.50000E 01 0.20000E 01

Z COORDINATES AT WHICH SPLITTING OCCURS

0.20410E 04 0.20420E 04 0.20430E 04 0.20440E 04 0.20450E 04 0.20460E 04

Z COORDINATES AT WHICH SPLITTING OCCURS

0.60000E 01 0.50000E 01 0.40000E 01 0.30000E 01 0.20000E 01 0.10000E 01

NO REGIONS IN WHICH SPLITTING OCCURS = 6

B. RESULTS

GAMMA SOURCES FOR REGION K,L=

8

1

BREMSSTRAHLUNG GAMMA SOURCES (FOLBG) STARTING WITH LOWEST ENERGY

0.28221E 03	0.83608E 02	0.44451E 02	0.27952E 02	0.18951E 02	0.13300E 02
0.94293E 01	0.66221E 01	0.45351E 01	0.30989E 01	0.21474E 01	0.15253E 01
0.10386E 01	0.63778E 00	0.31641E 00	0.12288E 00	0.33787E 01	0.12424E 01
0.50116E 02	0.15559E 02	0.30916E 03	0.24593E 04		

WEIGHT OF BREMSSTRAHLUNG GAMMAS (WB) = 0.21135E 12

NON BREMSSTRAHLUNG GAMMA SOURCES (FOLSG) STARTING WITH LOWEST ENERGY

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

WEIGHT OF NON BREMSSTRAHLUNG GAMMAS (WG) = 0.

ANSWERS FOR REGION INDEXED BY K,L=

3

1

VOLUME = 0.17463E 03 = REGION VOLUME

DOSE = 0.

=DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.52825E 05 DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.52825E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.40555E-15	0.27859E 06	0.52869E 09	0.61053E 10	0.96558E 08
J= 6	0.62118E 08	0.86516E 09	0.38423E 09	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.33971E 07	0.	0.	0.
J=21	0.29446E 07	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.15120E-18	0.10709E 04	0.31837E 07	0.44697E 08	0.79753E 06
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J= 6	0.56267E 06	0.84788E 07	0.40309E 07	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.61909E 05	0.	0.	0.
J=21	0.50533E 05	0.			

ANSWERS FOR REGION INDEXED BY K,L= 3 2

VOLUME = 0.55503E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.28572E 05DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.28572E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.70332E 04	0.15938E 08	0.99995E 08	0.29166E 08
J= 6	0.44602E 03	0.12871E 06	0.44856E 06	0.14869E 10	0.19224E 08
J=11	0.43344E 10	0.85952E 07	0.91253E 07	0.	0.
J=16	0.	0.	0.76687E 07	0.	0.
J=21	0.	0.89163E 04			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.67558E 00	0.56495E 04	0.66033E 05	0.29769E 05
J= 6	0.60699E 00	0.21111E 03	0.85922E 03	0.32286E 07	0.46327E 05
J=11	0.11377E 08	0.24183E 05	0.27515E 05	0.	0.
J=16	0.	0.	0.27478E 05	0.	0.
J=21	0.	0.33926E 02			

ANSWERS FOR REGION INDEXED BY K,L= 3 3

VOLUME = 0.42599E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.41945E 01DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.41945E 01 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
 K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.	0.	0.36662E-05	0.
J= 6	0.	0.	0.	0.	0.47130E 05
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.	0.	0.11003E-06	0.
J= 6	0.	0.	0.	0.	0.22673E 04
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.

J=21	0.	0.			
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ANSWERS FOR REGION INDEXED BY K,L= 4 1

VOLUME = 0.10638E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.21855E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.21855E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.30473E-05	0.11532E 11	0.32442E 11	0.79315E 11	0.48481E 09
J= 6	0.20364E 09	0.22625E 10	0.82009E 09	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.61752E 07	0.	0.	0.
J=21	0.47100E 07	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.45432E-09	0.45378E 07	0.43952E 08	0.22441E 09	0.70302E 07
J= 6	0.11411E 07	0.15509E 08	0.65811E 07	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.88502E 05	0.	0.	0.
J=21	0.73296E 05	0.			

ANSWERS FOR REGION INDEXED BY K,L= 4 2

VOLUME = 0.10041E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.12269E 04DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.12269E 04 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.76006E 03	0.33803E 07	0.11488E 08	0.
J= 6	0.	0.83105E 03	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.50813E 02	0.35403E 06	0.14628E 07	0.
J= 6	0.	0.14165E 03	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 4 3

VOLUME = 0.37003E 03 = REGION VOLUME

DOSE = 0. = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.41528E 05 DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.41528E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.35307E 04	0.17078E 08	0.12244E 09	0.52367E 08
J= 6	0.53843E 03	0.15217E 06	0.52687E 06	0.16395E 10	0.20053E 08
J=11	0.40574E 10	0.74501E 07	0.76439E 07	0.	0.
J=16	0.	0.	0.66639E 07	0.	0.
J=21	0.	0.92447E 04			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.50870E 00	0.90801E 04	0.12128E 06	0.80173E 05
J= 6	0.10991E 01	0.37439E 03	0.15138E 04	0.53396E 07	0.72485E 05
J=11	0.15974E 08	0.31441E 05	0.34572E 05	0.	0.
J=16	0.	0.	0.35816E 05	0.	0.
J=21	0.	0.52763E 02			

ANSWERS FOR REGION INDEXED BY K,L= 4 4

VOLUME = 0.28400E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.21311E-09DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.21311E-09 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
 K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.	0.	0.65752E-05	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.	0.	0.29599E-06	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 4 5

VOLUME = 0.99905E 08 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.66970E 00DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.66970E 00 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.22760E 05	0.25436E 07	0.32769E 07	0.43278E 07	0.28478E 07
J= 6	0.24416E-00	0.35232E 01	0.16004E 03	0.12253E 04	0.
J=11	0.48613E 04	0.	0.18649E 03	0.34967E 04	0.
J=16	0.	0.74702E 02	0.	0.	0.51285E 01
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.98524E 00	0.15943E 03	0.24174E 03	0.36234E 03	0.26342E 03
J= 6	0.24530E-04	0.38010E-03	0.18417E-01	0.14980E-00	0.
J=11	0.65667E 00	0.	0.27516E-01	0.53703E 00	0.
J=16	0.	0.12749E-01	0.	0.	0.96073E-03
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 5 1

VOLUME = 0.39906E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.89392E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.89392E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.11099E 13	0.49704E 12	0.18250E 12	0.19880E 12	0.24720E 10
J= 6	0.10631E 10	0.12229E 11	0.41237E 10	0.	0.
J=11	0.11827E 11	0.	0.	0.	0.
J=16	0.	0.24039E 08	0.	0.	0.
J=21	0.24102E 08	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10144E 09	0.47169E 09	0.35749E 09	0.51508E 09	0.74873E 07
J= 6	0.36009E 07	0.45357E 08	0.16490E 08	0.	0.
J=11	0.56121E 08	0.	0.	0.	0.
J=16	0.	0.16852E 06	0.	0.	0.
J=21	0.15859E 06	0.			

ANSWERS FOR REGION INDEXED BY K,L= 5 2

VOLUME = 0.25781E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.30133E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.30133E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.28813E 11	0.40714E 10	0.24099E 12	0.
J= 6	0.	0.	0.	0.	0.48483E 07
J=11	0.10850E 11	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.46784E 08	0.22760E 08	0.28135E 10	0.
J= 6	0.	0.	0.	0.	0.19775E 06
J=11	0.48184E 09	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 5 3

VOLUME = 0.40098E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.94379E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.94379E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.35620E 06	0.21510E 08	0.83912E 09	0.
J= 6	0.	0.77651E 02	0.	0.33967E 10	0.29259E 08
J=11	0.59939E 10	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.59630E 04	0.56410E 06	0.26754E 08	0.
J= 6	0.	0.33142E 01	0.	0.16463E 09	0.14953E 07
J=11	0.32162E 09	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 5 5 4

VOLUME = 0.14777E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.59750E 05DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.59750E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.34526E 08	0.20956E 08	0.30079E 10	0.11374E 11
J= 6	0.23070E 05	0.64569E 07	0.20274E 08	0.33414E 11	0.40140E 09
J=11	0.39085E 10	0.84876E 08	0.75983E 08	0.	0.
J=16	0.	0.	0.76684E 08	0.	0.
J=21	0.	0.21537E 06			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.12456E 04	0.27899E 04	0.74606E 06	0.43602E 07
J= 6	0.11792E 02	0.39779E 04	0.14587E 05	0.27250E 08	0.36333E 06
J=11	0.38532E 07	0.89694E 05	0.86052E 05	0.	0.
J=16	0.	0.	0.10320E 06	0.	0.
J=21	0.	0.30779E 03			

ANSWERS FOR REGION INDEXED BY K,L= 5 5

VOLUME = 0.11342E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.94028E-07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.94028E-07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.	0.	0.35739E-05	0.79477E-02
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.	0.	0.40286E-07	0.10107E-03
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 5 6

VOLUME = 0.39898E 09 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.67034E 00DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.67034E 00 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION

K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.91002E 05	0.10164E 08	0.13098E 08	0.17302E 08	0.11383E 08
J= 6	0.97651E 00	0.14085E 02	0.63968E 03	0.48983E 04	0.
J=11	0.19429E 05	0.	0.74488E 03	0.13972E 05	0.
J=16	0.	0.29836E 03	0.	0.	0.20485E 02
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.98639E 00	0.15953E 03	0.24196E 03	0.36274E 03	0.26366E 03
J= 6	0.24567E-04	0.38051E-03	0.18432E-01	0.14995E-00	0.
J=11	0.65718E 00	0.	0.27521E-01	0.53733E 00	0.
J=16	0.	0.12751E-01	0.	0.	0.96093E-03
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 6 1

VOLUME = 0.87567E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.48583E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.48583E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION

K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.20990E 11	0.81835E 11	0.32418E 11	0.41530E 11	0.15625E 11
J= 6	0.14107E 09	0.17124E 10	0.57286E 09	0.96170E 10	0.93644E 09
J=11	0.58983E 10	0.	0.	0.	0.
J=16	0.	0.38502E 07	0.16639E 08	0.	0.
J=21	0.32608E 07	0.15879E 06			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.25107E 09	0.22878E 10	0.10934E 10	0.15967E 10	0.66257E 09
J= 6	0.65081E 07	0.84975E 08	0.30339E 08	0.54020E 09	0.55276E 08
J=11	0.36507E 09	0.	0.	0.	0.
J=16	0.	0.30085E 06	0.13402E 07	0.	0.
J=21	0.28548E 06	0.14233E 05			

ANSWERS FOR REGION INDEXED BY K,L= 6 2

VOLUME = 0.43771E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.43770E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.43770E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1 0.47453E 11 0.14493E 12 0.23928E 12 0.14396E 12 0.82045E 11

J= 6	0.57768E 09	0.38050E 09	0.15929E 10	0.29435E 11	0.17543E 11
J=11	0.23796E 11	0.	0.23864E 09	0.	0.
J=16	0.	0.	0.18212E 09	0.	0.
J=21	0.	0.41414E 06			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.74132E 08	0.83855E 09	0.17363E 10	0.11985E 10	0.75556E 09
J= 6	0.58017E 07	0.41211E 07	0.18416E 08	0.36104E 09	0.22593E 09
J=11	0.32153E 09	0.	0.35112E 07	0.	0.
J=16	0.	0.	0.31963E 07	0.	0.
J=21	0.	0.80649E 04			

ANSWERS FOR REGION INDEXED BY K,L= 6 3

VOLUME = 0.13455E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.44398E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.44398E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.56749E 10	0.24126E 13	0.30797E 12	0.86461E 11	0.51081E 11
J= 6	0.	0.48307E 10	0.56439E 10	0.17220E 11	0.10561E 11
J=11	0.14343E 10	0.	0.31843E 09	0.	0.
J=16	0.	0.	0.11636E 09	0.	0.
J=21	0.	0.28668E 06			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.15382E 07	0.67907E 10	0.17892E 10	0.66442E 09	0.45888E 09
J= 6	0.	0.53140E 08	0.66854E 08	0.21755E 09	0.14105E 09
J=11	0.20186E 08	0.	0.49071E 07	0.	0.
J=16	0.	0.	0.21275E 07	0.	0.
J=21	0.	0.57102E 04			

ANSWERS FOR REGION INDEXED BY K,L= 6 4

VOLUME = 0.93543E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.11435E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.11435E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.99599E 02	0.15564E 12	0.65266E 11	0.11030E 12	0.57360E 11
J= 6	0.	0.44755E 10	0.49504E 10	0.14679E 11	0.89376E 10
J=11	0.	0.	0.22039E 09	0.	0.
J=16	0.	0.	0.14997E 09	0.	0.

J=21	0.	0.25419E 06
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FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.16887E-01	0.69650E 08	0.10056E 09	0.35492E 09	0.27316E 09
J= 6	0.	0.34887E 08	0.45178E 08	0.15019E 09	0.10047E 09
J=11	0.	0.	0.30868E 07	0.	0.
J=16	0.	0.	0.16032E 07	0.	0.
J=21	0.	0.45291E 04			

ANSWERS FOR REGION INDEXED BY K,L= 6 5

VOLUME = 0.14549E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.46351E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.46351E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.11615E-09	0.12787E 07	0.10584E 10	0.11289E 11	0.11218E 11
J= 6	0.	0.17030E 10	0.22262E 10	0.34221E 10	0.48566E 10
J=11	0.	0.14079E 09	0.11748E 09	0.	0.
J=16	0.	0.	0.54069E 08	0.	0.
J=21	0.	0.16861E 06			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.51975E-13	0.58995E 04	0.76503E 07	0.99198E 08	0.11121E 09
J= 6	0.	0.20032E 08	0.28032E 08	0.45713E 08	0.68407E 08
J=11	0.	0.21825E 07	0.18999E 07	0.	0.
J=16	0.	0.	0.10349E 07	0.	0.
J=21	0.	0.35481E 04			

ANSWERS FOR REGION INDEXED BY K,L= 6 6

VOLUME = 0.53617E 04 = REGION VOLUME

DOSE = 0. = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.78718E 05 DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.78718E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.24219E 08	0.44047E 11	0.19585E 12	0.11607E 12
J= 6	0.46420E 09	0.36918E 11	0.34318E 11	0.	0.64462E 11
J=11	0.31108E 07	0.12855E 11	0.22598E 09	0.	0.
J=16	0.	0.	0.20975E 09	0.	0.
J=21	0.	0.16630E 07			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.24081E 03	0.16162E 07	0.13388E 08	0.12264E 08
J= 6	0.65395E 05	0.62685E 07	0.68049E 07	0.	0.16081E 08
J=11	0.84522E 03	0.37439E 07	0.70535E 05	0.	0.
J=16	0.	0.	0.77800E 05	0.	0.
J=21	0.	0.65502E 03			

ANSWERS FOR REGION INDEXED BY K,L= 7 1

VOLUME = 0.36255E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.54567E 08DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.54567E 08 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.77332E 13	0.25778E 13	0.12241E 13	0.25363E 12	0.24494E 12
J= 6	0.	0.47015E 08	0.49155E 10	0.18631E 12	0.18605E 11
J=11	0.36943E 11	0.	0.	0.	0.
J=16	0.	0.23605E 08	0.	0.	0.
J=21	0.25687E 08	0.37621E 07			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.77792E 10	0.26927E 11	0.26393E 11	0.72333E 10	0.81661E 10
J= 6	0.	0.19194E 07	0.21609E 09	0.87353E 10	0.92224E 09
J=11	0.19295E 10	0.	0.	0.	0.
J=16	0.	0.18215E 07	0.	0.	0.
J=21	0.18604E 07	0.27809E 06			

ANSWERS FOR REGION INDEXED BY K,L= 7 2

VOLUME = 0.11482E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.92696E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.92696E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.26704E 10	0.96691E 10	0.44251E 10	0.17864E 11	0.73323E 10
J= 6	0.37023E 08	0.30103E 09	0.	0.	0.16262E 10
J=11	0.64996E 09	0.	0.	0.	0.
J=16	0.	0.	0.12442E 08	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.24360E 09	0.20615E 10	0.11382E 10	0.52381E 10	0.23712E 10
J= 6	0.13026E 08	0.11392E 09	0.	0.	0.73209E 09

J=11	0.30680E 09	0.	0.	0.	0.
J=16	0.	0.	0.76431E 07	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 7 3

VOLUME = 0.75517E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.46285E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.46285E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.52754E 11	0.11904E 12	0.33274E 11	0.35618E 11	0.73793E 10
J= 6	0.	0.56269E 10	0.70701E 10	0.	0.
J=11	0.	0.	0.16616E 09	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.47769E 09	0.39923E 10	0.13995E 10	0.17189E 10	0.39389E 09
J= 6	0.	0.35324E 09	0.47378E 09	0.	0.
J=11	0.	0.	0.14170E 08	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 7 4

VOLUME = 0.23213E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.11862E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.11862E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.10868E 09	0.13973E 12	0.10731E 11	0.12630E 11	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.17075E 06	0.22796E 10	0.36138E 09	0.56255E 09	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 7 5

VOLUME = 0.16139E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.95736E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.95736E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.13657E 02	0.28684E 10	0.15771E 11	0.43978E 11	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.18035E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.13422E-01	0.74401E 07	0.14084E 09	0.82022E 09	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.13759E 09	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 7 6

VOLUME = 0.25101E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.38723E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.38723E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.25254E-10	0.14348E 05	0.37313E 09	0.27273E 10	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.14471E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.65501E-13	0.38369E 03	0.15632E 08	0.13891E 09	0.
J= 6	0.	0.	0.	0.	0.
J=11	0.	0.13003E 09	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 1

VOLUME = 0.21705E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.44371E 09DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.44371E 09 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.10892E 16	0.51431E 14	0.15538E 14	0.73133E 13	0.45787E 13
J= 6	0.22301E 13	0.14868E 13	0.10831E 13	0.47322E 12	0.41431E 12
J=11	0.13610E 12	0.10286E 12	0.12909E 12	0.28222E 11	0.32475E 11
J=16	0.59166E 08	0.14019E 10	0.14704E 10	0.21015E 09	0.15306E 09
J=21	0.79479E 07	0.37767E 06			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.49366E 12	0.26160E 12	0.13469E 12	0.78894E 11	0.56098E 11
J= 6	0.30089E 11	0.21752E 11	0.16980E 11	0.78928E 10	0.72981E 10
J=11	0.25213E 10	0.19990E 10	0.26092E 10	0.59514E 09	0.70915E 09
J=16	0.13371E 07	0.32746E 08	0.35298E 08	0.50153E 07	0.38704E 07
J=21	0.20561E 06	0.99617E 04			

ANSWERS FOR REGION INDEXED BY K,L= 8 2

VOLUME = 0.36626E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.11426E 09DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.11426E 09 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.35102E 15	0.56927E 14	0.21463E 14	0.68858E 13	0.55209E 13
J= 6	0.18335E 13	0.14130E 13	0.77235E 12	0.96158E 12	0.38185E 12
J=11	0.28073E 12	0.24767E 12	0.10820E 12	0.76176E 11	0.39063E 11
J=16	0.17157E 11	0.42471E 10	0.11343E 10	0.10322E 10	0.13075E 09
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.34953E 11	0.58861E 11	0.45807E 11	0.19439E 11	0.18220E 11
J= 6	0.67665E 10	0.57102E 10	0.33609E 10	0.44627E 10	0.18736E 10
J=11	0.14514E 10	0.13425E 10	0.61255E 09	0.45095E 09	0.23805E 09
J=16	0.10820E 09	0.32440E 08	0.76190E 07	0.70793E 07	0.91687E 06
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 3

VOLUME = 0.18474E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.19533E 08DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.19533E 08 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.44625E 12	0.49236E 12	0.27195E 12	0.31699E 12	0.10602E 12
J= 6	0.45221E 11	0.75011E 11	0.59219E 11	0.37234E 11	0.11286E 11
J=11	0.43877E 10	0.32105E 10	0.36639E 10	0.35456E 10	0.11019E 10
J=16	0.81195E 09	0.21161E 09	0.18277E 08	0.18828E 08	0.58947E 07
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.25302E 10	0.65244E 10	0.43478E 10	0.57770E 10	0.21309E 10
J= 6	0.98885E 09	0.17644E 10	0.14866E 10	0.99137E 09	0.31578E 09
J=11	0.12873E 09	0.98773E 08	0.11725E 09	0.11846E 09	0.38026E 08
J=16	0.29014E 08	0.78378E 07	0.69783E 06	0.73983E 06	0.23898E 06
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 4

VOLUME = 0.12150E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.12509E 08DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.12509E 08 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.21696E 13	0.33150E 13	0.21572E 13	0.10933E 13	0.32846E 12
J= 6	0.96990E 11	0.13746E 12	0.21302E 12	0.12745E 12	0.32024E 11
J=11	0.16091E 11	0.77968E 10	0.12982E 11	0.13393E 11	0.39632E 10
J=16	0.30740E 10	0.78326E 09	0.	0.66699E 08	0.22283E 08
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.12210E 10	0.69099E 10	0.56393E 10	0.32793E 10	0.10897E 10
J= 6	0.35092E 09	0.53636E 09	0.88721E 09	0.56319E 09	0.14858E 09
J=11	0.78327E 08	0.39711E 08	0.68810E 08	0.74255E 08	0.22678E 08
J=16	0.18203E 08	0.48034E 07	0.	0.43332E 06	0.14933E 06
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 5

VOLUME = 0.37349E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.93272E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.93272E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
 K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.48390E 13	0.73570E 13	0.18828E 13	0.82234E 12	0.27693E 12
J= 6	0.11312E 12	0.80842E 11	0.12315E 12	0.74247E 11	0.19800E 11
J=11	0.99768E 10	0.41642E 10	0.79240E 10	0.87169E 10	0.24680E 10
J=16	0.20414E 10	0.42158E 09	0.	0.42937E 08	0.15263E 08
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.47252E 09	0.74599E 10	0.39407E 10	0.22766E 10	0.89623E 09
J= 6	0.40938E 09	0.32037E 09	0.52555E 09	0.33792E 09	0.75316E 08
J=11	0.50582E 08	0.22135E 08	0.43991E 08	0.50605E 08	0.14750E 08
J=16	0.12624E 08	0.31578E 07	0.	0.28880E 06	0.10496E 06
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 11

VOLUME = 0.24368E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.18932E 05DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.18932E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.54977E 04	0.18392E 06	0.21228E 07	0.41173E 07	0.15371E 07
J= 6	0.14344E 02	0.14129E 02	0.10931E 03	0.41101E 03	0.37298E 03
J=11	0.17370E 04	0.	0.	0.16364E 04	0.
J=16	0.61926E 03	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.97566E 04	0.47262E 06	0.64202E 07	0.14132E 08	0.58290E 07
J= 6	0.59082E 02	0.62492E 02	0.51568E 03	0.20600E 04	0.19670E 04
J=11	0.96193E 04	0.	0.	0.10304E 05	0.
J=16	0.41884E 04	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 12

VOLUME = 0.29415E 06 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.53362E 04DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.53362E 04 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.69775E 06	0.10687E 08	0.43698E 08	0.14698E 09	0.58469E 08
J= 6	0.48178E 02	0.77611E 03	0.20481E 04	0.16781E 05	0.19119E 05
J=11	0.90929E 05	0.	0.	0.63853E 05	0.
J=16	0.77163E 04	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10258E 05	0.22751E 06	0.10949E 07	0.41795E 07	0.18369E 07
J= 6	0.16440E 01	0.28438E 02	0.80044E 02	0.69677E 03	0.83528E 03
J=11	0.41717E 04	0.	0.	0.33307E 04	0.
J=16	0.43235E 03	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 13

VOLUME = 0.73489E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.12903E 03DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.12903E 03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.28868E 04	0.17623E 06	0.65300E 01	0.99327E-02	0.74691E 05
J= 6	0.21623E-00	0.12414E 02	0.	0.24833E 03	0.29053E 03
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.16988E 04	0.15017E 06	0.65489E 01	0.11305E-01	0.93924E 05
J= 6	0.29534E-00	0.18208E 02	0.	0.41272E 03	0.50805E 03
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 14

VOLUME = 0.58158E 05 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.12300E 03DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.12300E 03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
 K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.21717E 05	0.13309E 07	0.49357E 02	0.75056E-01	0.56313E 06
J= 6	0.16346E 01	0.93845E 02	0.	0.18772E 04	0.21962E 04
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.16149E 04	0.14330E 06	0.62548E 01	0.10795E-01	0.89482E 05
J= 6	0.28211E-00	0.17392E 02	0.	0.39424E 03	0.48529E 03
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 8 15

VOLUME = 0.80368E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.11740E 03DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.11740E 03 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.28585E 04	0.17568E 06	0.65215E 01	0.99157E-02	0.74251E 05
J= 6	0.21605E-00	0.12405E 02	0.	0.24816E 03	0.29034E 03
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.15382E 04	0.13689E 06	0.59805E 01	0.10320E-01	0.85379E 05
J= 6	0.26983E-00	0.16636E 02	0.	0.37713E 03	0.46425E 03
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 9 1

VOLUME = 0.50620E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.65853E 08DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.65853E 08 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.20635E 14	0.10047E 14	0.22073E 13	0.19159E 12	0.25743E 12
J= 6	0.34175E 12	0.	0.14471E 12	0.27183E 11	0.

J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.14867E 11	0.75168E 11	0.34087E 11	0.39135E 10	0.61471E 10
J= 6	0.91253E 10	0.	0.45562E 10	0.91282E 09	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 9 2

VOLUME = 0.16032E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.18209E 08DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.18209E 08 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION

K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.38968E 10	0.47180E 11	0.59510E 10	0.80470E 10	0.11817E 11
J= 6	0.15355E 11	0.12287E 11	0.35912E 09	0.	0.19172E 09
J=11	0.	0.37967E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.25460E 09	0.72044E 10	0.10963E 10	0.16899E 10	0.27370E 10
J= 6	0.38692E 10	0.33305E 10	0.10388E 09	0.	0.61814E 08
J=11	0.	0.13460E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 9 3

VOLUME = 0.10544E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.96365E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.96365E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.27824E 11	0.22532E 12	0.21236E 12	0.27101E 10	0.82367E 10
J= 6	0.17326E 11	0.20509E 11	0.	0.41747E 10	0.
J=11	0.	0.18082E 11	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.18045E 09	0.54122E 10	0.63970E 10	0.93670E 08	0.31489E 09
J= 6	0.72237E 09	0.92212E 09	0.	0.21257E 09	0.
J=11	0.	0.10612E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 9 4

VOLUME = 0.32411E 02 = REGION VOLUME

DOSE = 0. = DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.48121E 07 DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.48121E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.20705E 09	0.27258E 12	0.61743E 11	0.30552E 11	0.48370E 10
J= 6	0.83068E 09	0.13330E 11	0.	0.	0.
J=11	0.	0.11543E 11	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.23298E 06	0.31850E 10	0.14892E 10	0.97466E 09	0.18039E 09
J= 6	0.34643E 08	0.60873E 09	0.	0.	0.
J=11	0.	0.70704E 09	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 9 5

VOLUME = 0.22533E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.29704E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.29704E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.14281E 01	0.84722E 12	0.67957E 11	0.40587E 11	0.56660E 10
J= 6	0.45659E 10	0.13067E 11	0.	0.	0.
J=11	0.	0.97627E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10052E-02	0.15739E 10	0.43465E 09	0.54215E 09	0.11201E 09
J= 6	0.12079E 09	0.42287E 09	0.	0.	0.
J=11	0.	0.53343E 09	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 9 6

VOLUME = 0.35047E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.14429E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.14429E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.14087E-11	0.15731E 10	0.10129E 09	0.43918E 10	0.12830E 10
J= 6	0.13654E 10	0.53701E 10	0.	0.	0.
J=11	0.	0.61476E 10	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.26169E-14	0.30130E 08	0.30392E 07	0.16021E 09	0.52801E 08
J= 6	0.61626E 08	0.26223E 09	0.	0.	0.
J=11	0.	0.39562E 09	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 10 1

VOLUME = 0.72403E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.66892E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.66892E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.46016E 10	0.54471E 11	0.50714E 11	0.21657E 11	0.26079E 11
J= 6	0.19092E 11	0.99659E 10	0.96764E 10	0.16619E 10	0.63451E 09
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.66571E 08	0.18418E 10	0.20688E 10	0.10071E 10	0.13375E 10
J= 6	0.10652E 10	0.59812E 09	0.61979E 09	0.11290E 09	0.45299E 08
J=11	0.	0.	0.	0.	0.

J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 10 2

VOLUME = 0.36191E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.96504E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.96504E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.54606E 11	0.21894E 12	0.56296E 12	0.73349E 11	0.19084E 12
J= 6	0.10103E 12	0.15941E 12	0.53507E 10	0.91031E 09	0.53424E 08
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10317E 09	0.15322E 10	0.49407E 10	0.73859E 09	0.21256E 10
J= 6	0.12271E 10	0.20881E 10	0.74818E 08	0.13504E 08	0.33215E 06
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 10 3

VOLUME = 0.11125E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.41810E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.41810E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.64241E 12	0.18615E 12	0.10677E 12	0.21212E 10	0.15119E 12
J= 6	0.67542E 11	0.52142E 11	0.27805E 10	0.64127E 10	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.21060E 09	0.63370E 09	0.75026E 09	0.19714E 08	0.16427E 10
J= 6	0.82063E 09	0.69373E 09	0.39835E 08	0.97985E 08	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 10 4

VOLUME = 0.77344E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.25368E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.25368E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.59335E 06	0.10385E 13	0.20385E 12	0.49761E 11	0.14864E 12
J= 6	0.63656E 11	0.46226E 11	0.22323E 10	0.45359E 10	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.12167E 03	0.56205E 09	0.37985E 09	0.19365E 09	0.85613E 09
J= 6	0.49063E 09	0.43582E 09	0.24640E 08	0.56128E 08	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 10 5

VOLUME = 0.12030E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.14949E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.14949E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.73882E-10	0.15906E 07	0.23983E 11	0.66001E 11	0.19400E 11
J= 6	0.19348E 11	0.16580E 11	0.87979E 09	0.18098E 10	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.39986E-13	0.88756E 04	0.20965E 09	0.70143E 09	0.23261E 09
J= 6	0.25441E 09	0.23588E 09	0.13398E 08	0.29239E 08	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 10 6

VOLUME = 0.44332E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.24897E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.24897E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.22370E-35	0.11864E 14	0.28076E 13	0.75290E 12	0.12727E 12
J= 6	0.26506E 12	0.73915E 11	0.27528E 10	0.38367E 10	0.
J=11	0.	0.19621E 11	0.	0.	0.22236E 08
J=16	0.	0.10274E 10	0.	0.23676E 08	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.14268E 09	0.12459E 09	0.62248E 08	0.16264E 08
J= 6	0.45161E 08	0.15179E 08	0.66017E 06	0.10430E 07	0.
J=11	0.	0.69116E 07	0.	0.	0.90767E 04
J=16	0.	0.45131E 06	0.	0.10822E 05	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 11 1

VOLUME = 0.39906E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.48744E 07DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.48744E 07 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.11761E 13	0.48327E 13	0.72911E 12	0.52199E 12	0.11261E 12
J= 6	0.13285E 12	0.97815E 11	0.84565E 11	0.14818E 11	0.55700E 10
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10749E 09	0.45862E 10	0.14282E 10	0.13525E 10	0.34109E 09
J= 6	0.44997E 09	0.36279E 09	0.33774E 09	0.63117E 08	0.25083E 08
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 11 2

VOLUME = 0.25781E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.69303E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.69303E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.10241E-11	0.15868E 10	0.33409E 10	0.40471E 11	0.76847E 10
J= 6	0.39177E 10	0.31142E 10	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.63000E-15	0.25765E 07	0.18676E 08	0.47250E 09	0.13278E 09
J= 6	0.90587E 08	0.88080E 08	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 11 3

VOLUME = 0.40099E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.26513E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.26513E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.19476E 05	0.54777E 08	0.31063E 10	0.44420E 10
J= 6	0.97848E 09	0.	0.13100E 08	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.32602E 03	0.14365E 07	0.99038E 08	0.15978E 09
J= 6	0.38599E 08	0.	0.59848E 06	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 11 4

VOLUME = 0.14777E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.57797E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.57797E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.55453E 04	0.51634E 13	0.34190E 12	0.22957E 13	0.23747E 12
J= 6	0.20947E 10	0.80935E 10	0.25787E 10	0.70595E 09	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.13288E 08	0.	0.20803E 06	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.63869E-01	0.18628E 09	0.45518E 08	0.56940E 09	0.91038E 08
J= 6	0.10707E 07	0.49862E 07	0.18553E 07	0.57572E 06	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.17511E 05	0.	0.28527E 03	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 11 5

VOLUME = 0.11342E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.73108E 05DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.73108E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.12230E 01	0.97459E 09	0.15755E 11	0.55464E 03	0.12338E-00
J= 6	0.13874E 03	0.95351E 03	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.19899E 05	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.70204E-03	0.57680E 07	0.14608E 09	0.62519E 01	0.15690E-02
J= 6	0.19349E 01	0.14388E 02	0.	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.50100E 03	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 11 6

VOLUME = 0.39898E 09 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.32294E-00DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.32294E-00 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.93082E 05	0.20580E 07	0.15879E 07	0.19745E 08	0.32461E-01
J= 6	0.33005E 02	0.24803E 03	0.34491E 03	0.13424E 01	0.51821E 03
J=11	0.	0.90101E 04	0.	0.	0.30469E 03
J=16	0.95313E 04	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.10089E 01	0.32301E 02	0.29332E 02	0.41395E 03	0.75186E-06
J= 6	0.83032E-03	0.67003E-02	0.99383E-02	0.41095E-04	0.16691E-01
J=11	0.	0.31975E-00	0.	0.	0.12112E-01
J=16	0.39374E-00	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 12 1

VOLUME = 0.28632E 04 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.72897E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.72897E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.31891E-05	0.11453E 14	0.28442E 13	0.20121E 13	0.36358E 12
J= 6	0.16662E 12	0.	0.39398E 12	0.70243E 11	0.44006E 10
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.18957E-10	0.21327E 09	0.19543E 09	0.25757E 09	0.71937E 08
J= 6	0.43955E 08	0.	0.14629E 09	0.29566E 08	0.20558E 07
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 12 2

VOLUME = 0.37452E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.41945E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.41945E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.16460E 12	0.15593E 12	0.15668E 09	0.10427E 10
J= 6	0.22802E 09	0.19539E 11	0.	0.	0.27465E 09
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.29502E 09	0.43782E 09	0.53485E 06	0.40155E 07
J= 6	0.96304E 06	0.89285E 08	0.	0.	0.15028E 07
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,I= 12 3

VOLUME = 0.98153E 02 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.16624E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.16624E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.41107E 06	0.22550E 07	0.33630E 05	0.64901E 05
J= 6	0.50152E 04	0.45481E 06	0.	0.	0.65069E 04
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.26226E 08	0.16933E 09	0.28659E 07	0.61105E 07
J= 6	0.51287E 06	0.49942E 08	0.	0.	0.85193E 06
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 12 4

VOLUME = 0.30067E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.16666E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.16666E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.	0.13651E 11	0.45981E 11	0.22259E 10	0.12358E 10
J= 6	0.24003E 09	0.85205E 10	0.	0.	0.12139E 09
J=11	0.	0.	0.	0.	0.

J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.	0.30476E 08	0.16082E 09	0.94645E 07	0.59284E 07
J= 6	0.12628E 07	0.48498E 08	0.	0.	0.82735E 06
J=11	0.	0.	0.	0.	0.
J=16	0.	0.	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 12 5

VOLUME = 0.10302E 05 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.13420E 06DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.13420E 06 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.75205E 13	0.23488E 14	0.45962E 13	0.12649E 13	0.18608E 12
J= 6	0.11464E 11	0.11356E 12	0.37223E 10	0.14462E 10	0.10503E 10
J=11	0.	0.	0.	0.	0.
J=16	0.	0.73787E 07	0.	0.	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.12425E 08	0.12155E 09	0.87772E 08	0.45002E 08	0.10232E 08
J= 6	0.84055E 06	0.10035E 08	0.38415E 06	0.16919E 06	0.13636E 06
J=11	0.	0.	0.	0.	0.
J=16	0.	0.13949E 04	0.	0.	0.
J=21	0.	0.			

ANSWERS FOR REGION INDEXED BY K,L= 12 6

VOLUME = 0.81376E 03 = REGION VOLUME

DOSE = 0. =DOSE PER UNIT VOLUME DUE TO NON BREMSSTRAHLUNG GAMMAS

DOSEB = 0.30335E 05DOSE PER UNIT VOLUME DUE TO BREMSSTRAHLUNG GAMMAS

DOSE+DOSEB = 0.30335E 05 = TOTAL DOSE

XMFP = NUMBER OF MEAN FREE PATHS TRAVELED PER SEC IN REGION
K,L FOR THE ENERGY GROUP INDEXED BY J

J= 1	0.79227E 11	0.15541E 11	0.41217E 11	0.11297E 01	0.63648E 00
J= 6	0.87069E 03	0.27192E 04	0.18555E 05	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.17586E 06	0.	0.67855E 04	0.
J=21	0.	0.			

FLUX (GAMMAS PER CENTIMETER SQUARED PER SEC)

J= 1	0.63386E 07	0.12819E 08	0.53264E 08	0.17749E-02	0.11281E-02
J= 6	0.16925E 01	0.57188E 01	0.41773E 02	0.	0.
J=11	0.	0.	0.	0.	0.
J=16	0.	0.68776E 03	0.	0.23811E 02	0.
J=21	0.	0.			

FINAL RANDOM NUMBER IS 116555740141

FINAL TIME 18.98 DATE 03/06/62

Listing of the input deck for the moments method calculation.

MOMENTS METHOD	1000 HISTORIES		NO PAIRPRODUCTION		
M J KNIEDLER					
31	.10176747060401				
0	.1	.2	.3	.4	.5 2/1
.6	.7	.8	.9	1.0	1.1 2/2
1.2	1.3	1.4	1.5	1.6	1.7 2/3
1.8	1.9	2.0	2.1	2.2	2.3 2/4
2.4	2.5	2.6	2.7	2.8	2.9 2/5
3.0					2/6
9					3
1	3	9	3	12	3 4/1
9	3	1			4/2
0	1993.0	1995.0	1997.0	1999.5	2000.5 5/1
2003.0	2005.0	2007.0	4000.0		5/2
2000.0					6/1
1					6/2
6.5	7.0	2000.0			6/3
1	1	1			6/4
6.5	7.0	18.5	19.0	34.5	35.0 6/5
88.5	89.0	2000.0			6/5
1	1	1	1	1	1 6/6
1	1	1			606
6.5	7.0	2000.0			6/7
1	1	1			6/8
.5642	6.5	7.0	18.5	19.0	34.56/9
35.0	88.5	89.0	100.0	101.0	2000.06/9
1	1	1	1	1	16/10
1	1	1	1	1	16/10
6.5	7.0	2000.0			6/11
1	1	1			6/12
6.5	7.0	18.5	19.0	34.5	35.06/13
88.5	89.0	2000.0			6/13
1	1	1	1	1	16/14
1	1	1			6/14
6.5	7.0	2000.0			6/15
1	1	1			6/16
2000.0					6/17
1					6/18
1					7
1					8
1					9/1
7.6					9/2
1					10
1					11
55.85	26.0				12/1

1.55E2	5.4	1.1	.42	.21	.13 12/2
.0820	.0590	.0430	.0340	.0280	.0230 12/3
.0200	.0170	.0150	.0140	.0130	.0120 12/4
.0110	.0100	0	0	0	0 12/5
0	0	0	0	0	0 12/6
14.2	11.5	9.89	8.65	7.86	7.24 12/7
6.73	6.31	5.96	5.66	5.40	5.15 12/8
4.94	4.73	4.56	4.40	4.24	4.10 12/9
3.98	3.86	3.75	3.64	3.54	3.47 12/10
3.38	3.30	3.22	3.18	3.09	3.02 12/11
0	0	0	0	0	0 12/12
0	0	0	0	0	0 12/13
.096	.012	.0270	.0390	.055	.074 12/14
.232	.252	.0140	.017	.189	.211 12/15
1		.272	.293	.318	.338 12/16
1					13
4.16E-9	0	0	0	0	14
0	0	0	0	0	0 15/1
0	0	0	0	0	0 15/2
0	0	0	0	0	0 15/3
0	0	0	0	0	0 15/4
0	0	0	0	0	0 15/5
0	0	0	0	0	15/6
0	0	0	0	0	0 16/1
0	0	0	0	0	0 16/2
0	0	0	0	0	0 16/3
0	0	0	0	0	0 16/4
1	0	0	0	0	1.0 16/5
5					17
1					18
1					19
7					20
2	3	4	5	6	KFMAX
8					7KRF/1
1	4	1	5	1	KRF/2
1					4LRMAX/1
2					LFMAX/2
2	4	6	8		LRF/1
2					LRF/2
3	5	7	9	11	LRF/3
2					LFF/4
2	4	6	8		LRF/5
2					LLRF/6
0					LRF/7
					25

500.0					
1.32E-7	2.65E-7	4.90E-7	7.70E-7	9.30E-7	1.13E-6 26/1
1.33E-6	1.51E-6	1.69E-6	1.85E-6	2.00E-6	2.15E-6 26/2
2.30E-6	2.42E-6	2.58E-6	2.70E-6	2.82E-6	2.96E-6 26/3
3.08E-6	3.20E-6	3.30E-6	3.40E-6	3.52E-6	3.64E-6 26/4
3.74E-6	3.84E-6	3.95E-6	4.05E-6	4.15E-6	4.25E-6 26/5
0.0					
1000.0					
6	2.0	.2+3			
4.0	10.0	20.0	30.0	40.0	1900.0
1.0	2.0	5.0	5.0	5.0	2.0
3994.0	3995.0	3996.0	3997.0	3998.0	3999.0
6.0	5.0	4.0	3.0	2.0	1.0
1					