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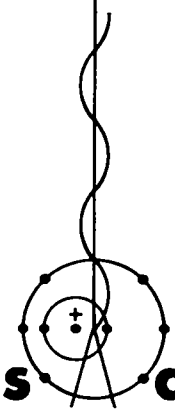
INFORMAL REPORT

Monte Carlo Photon Codes: MCG and MCP



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MONTE CARLO PHOTON CODES: MCG AND MCP

by

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ABSTRACT

A description of the Monte Carlo photon codes, MCG and MCP, is given. Since these codes contain many features in common with the Monte Carlo neutron code MCN, which is described in LA-4751, we concentrate on the details peculiar to processing photons in each of these programs. This report leans heavily on LA-4751 and is intended to be used in conjunction with it when dealing with a photon problem. The parts of the photon codes which are the same as in MCN are clearly indicated.

In Part I, an account is given of MCG. This code is suitable for solving a wide variety of gamma transport problems. The physical processes treated are pair production, Compton scattering, and photoelectric absorption. The collision routine assumes photons with energies between 1 keV and 100 MeV. The possible sources, geometry, and output available to the user are described, together with the Monte Carlo methods and cross section data employed.

Part II describes MCP, which has a more sophisticated Monte Carlo collision routine for photons of energy 1 keV to 15 MeV colliding with atoms of $Z = 1, 2, \cdots, 94$ at rest. The routine takes account of incoherent and coherent scattering factors, and of the possibility of fluorescent emission following photo-electric absorption, as well as absorption in pair production with local emission of annihilation radiation.

In Part III, a sample problem is set up and run using both MCG and MCP, with the complete computer listing displayed in each case.

PART I

MCG: A MONTE CARLO GAMMA CODE FOR HIGH ENERGY PHOTON TRANSPORT

A. INTRODUCTION

The Monte Carlo gamma code MCG has many features in common with the neutron code MCN, which is described in LA-4751.[1] In the interests of brevity, we will not describe in detail the features which are the same in the two codes but merely point out that they are identical, and we refer the reader to LA-4751 for the details.

Setting up a problem for MCG is quite similar to setting up one for MCN, with only a few differences resulting from the altered collision routine

for photons as well as from the slight modifications of the output tallies.

The units used in MCG are the same as those used in MCN and are as follows:

1. Lengths in centimeters.
2. Times in shakes (10^{-8} sec).
3. Energies in MeV.
4. Atomic densities in units of 10^{24} atoms/cm^3.
5. Cross sections in barns (10^{-24} cm^2).

B. GEOMETRY

The three-dimensional geometry package in MCG is identical to that in MCN. The code will handle spatial cells bounded by first- and second-degree surfaces, as well as some fourth-degree surfaces (elliptical tori). The reader is strongly urged to read the description of the geometry in LA-4751, since the most common errors made in setting up a problem occur in specifying the geometry.

C. COLLISION ROUTINE

The physical processes treated are photoelectric effect, pair production, and Compton scattering on free electrons (alternatively, the code provides for Thomson scattering in place of Compton scattering, at the option of the user). These are more fully described in the following.

Since the code is intended primarily for higher energy photons, the photoelectric effect is regarded as an absorption (without fluorescence), scattering (Compton) is on free electrons (without use of form factors), and the highly forward coherent scattering is ignored. Thus the total cross section σ_t is regarded as the sum of three components.

$$\sigma_t = \sigma_{pe} + \sigma_{pp} + \sigma_s$$

(An alternative code, MCP, designed to incorporate low energy effects, is another of our family of Monte Carlo codes. This code deals with fluorescent re-emission, in addition to coherent and incoherent scattering as influenced by the appropriate form factors cf. Part II.)

1. Cross Sections. The Howerton Photon Interaction Library in ENDF/B format (Ref: UCRL-50400, Vol. VI) was the source of cross sections used in the code. The latter yields tables of values of $\sigma^i_{pe}(Z)$, $\sigma^i_{pp}(Z)$, $\sigma^i_s(Z)$, and $\sigma^i_t(Z)$ for elements with the atomic numbers Z = 1, 2, ···, 83, 86, 90, 92, and 94 at a common sequence of 166 energies E_i, i = 1, 2, ···, 166. These energies include the photoelectric edges above 10 keV of all elements provided for and were otherwise so chosen that linear interpolation yields good accuracy at intermediate points. Always consecutive energy values are spaced so that the change in energy is 10% or less.

An initiation code prepares, for each material region in the problem, a single list of macroscopic total cross sections Σ^i_t and required probabilities. This is a simplification allowed by the use of an energy mesh common to all elements Z, and it allows considerable saving in machine time for problems involving highly composite media.

2. Photoelectric Effect. This is treated as an absorption, with a corresponding reduction in the photon weight W, and hence does not result in the loss of a particle history. On every collision, the weight $W\,\sigma_{pe}/\sigma_t$ and energy $EW\sigma_{pe}/\sigma_t$ are tallied in the appropriate bins. The non-captured weight $W(1 - \sigma_{pe}/\sigma_t)$ is then forced to suffer either pair production or Compton scattering with the proper dependent probabilities.

3. Pair Production. In a collision resulting in pair production (probability $\sigma_{pp}/(\sigma_t - \sigma_{pe})$), it is assumed that the kinetic energy W(E - 1.022) MeV of the electron-positron pair produced is deposited as thermal energy at the time and point, with isotropic production of one gamma of energy 0.511 MeV, and weight 2W, which is followed further.

4. Compton Scattering. The alternative to pair production (when both are possible) is Compton scattering on a free electron, with probability $\sigma_s/(\sigma_t - \sigma_{pe})$. In the event of such a collision, the objective is to determine the energy E′ of the scattered photon, and $\mu = \cos\theta$ for the angle θ of deflection from the line of flight. This yields at once the energy W(E - E′) deposited at the point of collision and the new direction of the scattered photon.

The differential cross section for the process is given by the Klein-Nishina formula

$$K(\alpha,\mu)d\mu = \pi r_o^2\,(\alpha'/\alpha)^2\,(\alpha'/\alpha + \alpha/\alpha' + \mu^2 - 1)d\mu \quad ,$$

where r_o is the classical electron radius, α and α' are the incident and final photon energies in units of 0.511 MeV ($\alpha = E/(mc^2)$, where m is the mass of the electron and c is the speed of light), and

$$\alpha' = \alpha/[1 + \alpha(1 - \mu)] \quad .$$

Changing variables from μ to $x = 1/[1 + \alpha(1-\mu)]$ on $\xi \equiv (1 + 2\alpha)^{-1} \leq x \leq 1$, one finds the probability density function for x to be

$$p(x) = g(x)/G(\xi) \quad ,$$

where $g(x) = x + x^{-1} + \mu^2 - 1$,

$$\mu = 1 + \alpha^{-1} - (\alpha x)^{-1} \quad ,$$

and $$G(x) = \int_x^1 g(x)dx \quad .$$

Thus, a random number r determines x by the implicit relation

$$r = G(x)/G(\xi)$$

and consequently the required $\mu = 1 + \alpha^{-1} - (\alpha x)^{-1}$ and $\alpha' = \alpha x$, $E' = 0.511\ \alpha'$.

An accurate approximation[2,3] for the inverse $x = H(y)$ of the function $y = G(x)$ allows rapid determination of $x = H[rG(\xi)]$, and this is now used in place of earlier methods.

5. Thomson Scattering. One may optionally choose Thomson scattering in place of the Klein-Nishina scattering function. Here the photon scatters with the probability density function in μ given by

$$p(\mu)d\mu = \frac{3}{8}(1 + \mu^2)d\mu \quad ,$$

with no loss in energy. If a table of values for μ_i is stored, where

$$\frac{i}{N} = \frac{3}{8}\int_{\mu_i}^1 (1 + \mu^2)d\mu \quad , \quad i = 0, 1, \cdots, N \quad ,$$

then by choosing the integer i randomly on its range yields N equally likely discrete scattering cosines μ_i. In the present code N = 128 (a power of two is used because of the ease of selecting i on a binary machine). One may, if more accuracy is desired, linearly interpolate between these equally likely values of μ_i but the present code does not include this feature.

D. ESTIMATION OF ERRORS

The error analysis in MCG is identical to that in MCN, and we refer the reader to Sec. IV of LA-4751. In brief, for the tallies printed out, the code gives the relative error in the quantity scored, defined as the ratio of one standard deviation to the sample mean.

E. SAMPLING TECHNIQUES

The discussion in MCN carries over verbatim to MCG, with the same options available in the latter code.

Standard Tallies. Same as in MCN, with the same definitions used for currents and fluxes as in the neutron code. (The reader accustomed to the use of other terms such as flux and mean intensity for what we call current and flux, respectively, should take careful note of the fact that we are using terminology commonly used in neutron transport theory.)

F. EXECUTION OF MONTE CARLO PROGRAMS

(In the following, much of the description for MCG is the same as for MCN--simply substitute MCG for MCN, and MCGI, the initiation code, for the corresponding neutron initiation code, MCNI.) We shall list below the photon programs corresponding to those listed in LA-4751. When they are identical, except for the obvious changes mentioned above, we shall simply indicate by the words "same as in MCN".

1. Initiation. Same as in MCN.

2. Running. Same as in MCN, except that the run card has a different format. Now the 2nd entry on the run card is weight WR, and the 8th entry (the run card in MCN has only 7 entries) is a weight WC < WR. (Both WR and WC are set by the user, subject to the condition WR > WC). When the weight W of a photon has $W < [WC \cdot I(\text{source})]/I(n)$ -- where I(source) is the importance of the source region and I(n) is the importance of cell n where the photon

is located -- then if a random number $r < W/[WR \cdot I(source)/I(n)]$, the weight of the photon is taken to be $[WR \cdot I(source)]/I(n)$; otherwise the photon history is terminated.

3. File Manipulation. Same as in MCN.

4. Card Format. Same as in MCN.

5. Problem ID Card. Same as in MCN.

6. Cell Cards. Same as in MCN.

7. Surface Cards. Same as in MCN.

8. Data Cards.

a. Cell Specification Cards. Cards IO and Y6 apply to MCG in exactly the same manner as in MCN. The thermal specification cards RO, R1, ···, Rn do not apply. The Y7 card in MCG specifies the energy cutoff for each cell, below which energy the photon is dropped and not followed further.

b. Source Cards. Same as in MCN.

c. L Card. Does not apply to MCG.

d. Function Cards. The description in LA-4751 of these cards carries over to MCG, with a couple of exceptions.

(1) The first exception is for n = 5: Flux tally at points. In addition to the F5, E5, and T5 cards, an additional card, called the A card, has been added. This card contains the list of cells which contribute to the fluxes at the point detectors; that is, collisions in these cells, and only these cells, are allowed to contribute to the flux at each of the designated points. If the A card is missing, collisions in all cells contribute to the fluxes at the point detectors.

(2) The second exception occurs for n = 6: Capture tally in cells. Here MCG departs from MCN. MCG automatically (without any action on the part of the user) gives for each cell in the problem the number (i.e., the weight) and energy of photons captured (from the photoelectric effect), the number and energy of photons lost to energy cutoff, the number of photons creating a pair and the energy lost in the process, and the energy lost in Compton scattering collisions.

e. DO Card. This section does not apply. A DO card in MCG means that Thomson scattering replaces Compton scattering. The energy cutoff in MCG is given per cell and, as described above, appears on the Y7 card.

f. Material Cards. The section applies to MCG if the nuclide cross section ID is replaced by the Z (atomic number) of the element.

APPENDIX A
CONTROL CARD DECKS

Same as in MCN.

APPENDIX B
SOURCE SUBROUTINES

Same as in MCN, except for Sec. V - Random Number Generators. The function FRNS (KRN) is replaced by 2*FRN(KRN) - 1.

PART II

MCP: A GENERAL MONTE CARLO PHOTON CODE

A. INTRODUCTION

The general photon code MCP has many features in common with the gamma code MCG, namely, the variety of sources, the output, the variance reducing techniques, and the general geometry routine. In fact, the two codes are virtually identical to use. However, the collision subroutine in MCG was intended only for photons of relatively high energy, with fluorescence and coherent scattering ignored, and incoherent scattering subject to the unmodified Klein-Nishina cross section for free electrons.[4]

The code MCP, for photons of energies 1 keV to 15 MeV, contains a new collision routine, described below, providing for fluorescent emission, and the modification of Thomson and Klein-Nishina differential cross sections by appropriate form factors which take binding effects into account.

A library tape (LT) has been prepared, incorporating all constants required by the collision code, for elements $Z = 1, \cdots, 94$, in a form designed to expedite computation.

B. FREE PATH

The LT contains, for each Z, a table of the logarithms $L_i(Z) = \ln E_i(Z)$ of suitable energies, including the photoelectric edges, and a matrix $L_i^j(Z) = \ln \sigma_i^j(Z)$, listing for $j = 1, 2, 3, 4$, the logs of corresponding cross sections (when the latter are nonzero) for incoherent scattering, coherent scattering, photoelectric effect, and pair production, respectively. The recent compilation of data by Storm and Israel[5] was used, for all listed energies $E_i \leq 15$ MeV. In the case of scattering ($j = 1, 2$) the cited total cross sections were obtained by numerical integration, based on the same form factors used in the Monte Carlo treatment of such collisions, and referred to below.

In the collision code, a photon of energy E, starting from a point of a particular medium, has a free path

$$\lambda = 1 \Big/ \left[\sum_Z N(Z) \sum_1^4 \sigma^j(Z) \right] ,$$

where Z runs over all elements present in the medium, N(Z) is the corresponding numerical density, and $\sigma^j(Z)$ is the cross section for process j, each log-log interpolated to energy E. A random number r on (0, 1) then determines the (infinite medium) distance to collision, $d = -\lambda \ln r$; and the eventuality of escape from, or collision within, the current region, follows from the geometry routine of MCP.

In the event of collision, two random numbers, r_1 and r_2, serve to designate the element Z hit, and the process j responsible. The former results from a comparison of r_1/λ with the partial Z-sums obtained above, and present in the memory. The latter process j is determined by a similar comparison of $r_2 \sum_1^4 \sigma^j(Z)$ with the partial sums involved, the individual $\sigma^j(Z)$ being also retained from the λ computation.

Note on Interpolation. Log-log interpolation for the partial cross sections σ^j, at an energy E between tabulated energies $E_{i-1} < E_i$, leads to the result

$$\sigma^j = \left(\sigma_{i-1}^j\right)^a \left(\sigma_i^j\right)^b ,$$

where $a = (\ln E_i - \ln E)/(\ln E_i - \ln E_{i-1})$, $a + b = 1$, $a, b > 0$. It is expedient to regard as the total cross section, and as the probability of process j at energy E, the values of σ and σ^j/σ, where σ is the sum $\sum_1^4 \sigma^j$ of the σ^j so found, and not the log-log interpolated value σ' of the total cross section. For, the relation

$$\sigma = \sum_j \sigma^j = \sum_j \left(\sigma_{i-1}^j\right)^a \left(\sigma_i^j\right)^b \leq \left(\sum_j \sigma_{i-1}^j\right)^a \times \left(\sum_j \sigma_i^j\right)^b = \sigma'$$

is an obvious consequence of Hölder's inequality,

$$\sum x_j y_j \leq \left(\sum x_j^{1/a}\right)^a \left(\sum y_j^{1/b}\right)^b ,$$

strict unless $y_j^{1/b} \equiv kx_j^{1/a}$.

Hence, in practice one has $\sigma < \sigma'$, and use of σ' in place of σ may lead to absurdities; e.g., pair production, determined above by default (after the other three processes are tested), would occur at all energies $E \geq 1$ keV.

This shows that adoption of log-log interpolated <u>partial</u> cross sections is inconsistent with a log-log interpolated <u>total</u> cross section.

C. INCOHERENT SCATTERING

The objective, in the event of such a process ($j = 1$), is to determine the angle θ of scattering from the incident line of flight (and thus the new direction via the general code), the new energy E' of the photon, and the local energy deposition $E - E'$ (the recoil k.e. of the electron).

Incoherent scattering is assumed to have the differential cross section $\sigma^1(Z,\alpha,\mu)\,d\mu = I(Z,\nu) \times K(\alpha,\mu)\,d\mu$, where $I(Z,\nu)$ is an appropriate scattering factor, modifying the Klein-Nishina (K-N) cross section

$$K(\alpha,\mu)d\mu = \pi r_0^2 \left(\frac{\alpha'}{\alpha}\right)^2 \left|\frac{\alpha'}{\alpha} + \frac{\alpha}{\alpha'} + \mu^2 - 1\right| d\mu \quad .$$

As is customary, α and α' denote the incident and scattered photon energies, respectively, in units of electron rest energy mc^2, $\alpha' = \alpha/[1 + \alpha(1 - \mu)]$, $\mu = \cos\theta$, and $r_0 = e^2/mc^2 = 2.81776 \times 10^{-13}$ cm, the "classical electron radius."

Qualitatively, the effect of $I(Z,\nu)/Z$ is to decrease the K-N cross section (per electron) more extremely in the forward direction, for low E and for high Z independently. For any Z, $I(Z,\nu)$ increases from $I(Z,0) = 0$ to $I(Z,\infty) = Z$. The parameter $\nu = \nu(\alpha,\mu)$ is a given function of α and μ which, for a particular incident energy α, increases from $\nu(\alpha,1) = 0$ at $\mu = 1$ to a maximum value $\bar{\nu} = \nu(\alpha,-1)$ at $\mu = -1$. The essential features of $I(Z,\nu)$ are indicated in Fig. 1.

The complete tabulations of Cromer and Mann[6,7] (and of Brown[8] for a few low Z) are used for all $Z \geq 2$, $\nu \leq 8$, and we set $I(Z,\nu) \equiv Z$ for $\nu > 8$. These tables, for $\nu_1 = 0, \cdots, \nu_{21} = 8$, are recorded without change on the LT, and those required form

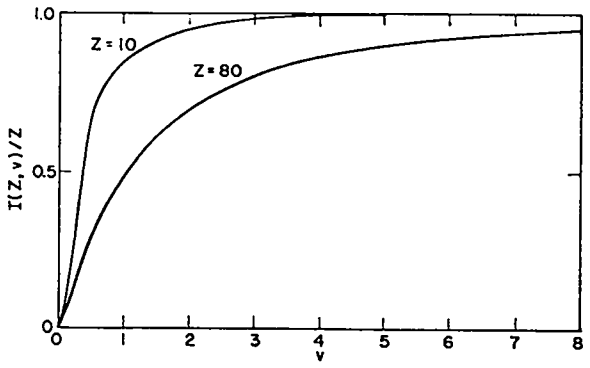

Fig. 1. Incoherent scattering factor.

part of problem storage. Linear interpolation is used as necessary. The parameter ν is here the inverse length $\nu = \sin\frac{1}{2}\theta/\lambda(\text{Å}) = K\alpha\sqrt{1 - \mu}$, $K = 10^{-8}\ mc/(\sqrt{2}\ h) = 29.1445\ \text{cm}^{-1}$, with maximal value $\bar{\nu} = \sqrt{2}\ K\alpha$ for given α.

For $Z = 1$, we use the exact formula[9] $I(1,\nu) = 1 - (1 + \nu^2)^{-4}$, with the dimensionless parameter $\nu = a\,mc\alpha\sqrt{2(1 - \mu)}/2\hbar = K'\alpha\sqrt{1 - \mu}$, $K' = \hbar c/\sqrt{2}\ e^2 = 96.9014$, $\bar{\nu} = \sqrt{2}\ K'\alpha$. Here $a = \hbar^2/me^2$ is the first "Bohr radius".

The method of sampling for $\mu = \cos\theta$, in both coherent and incoherent scattering, is based on the following:

<u>Principle</u>. Let $P(y) = C_0\,F(y)\,Q(y)$ on (a,b), where P(y) and Q(y) are probability densities, $0 \leq F(y) \leq 1$, and $C_0 > 1$ is a constant. If a particle is tentatively assigned to (y,y + dy) with probability Q(y)dy, but the assignment is ratified only with probability F(y), the process being iterated with probability $1 - \int_a^b F(y)Q(y)dy$, then the probability of the particle being definitely assigned to (y,y + dy) is P(y)dy. (The <u>value</u> of C_0 is irrelevant for the process). For, $\int_a^b F(y)Q(y)dy = C_0^{-1} < 1$, and the probability in question is seen to be

$$\sum_{k=0}^{\infty} F(y)Q(y)dy\ (1 - C_0^{-1})^k = C_0\,F(y)Q(y)dy$$

$$= P(y)dy \quad .$$

To apply this to incoherent scattering, we write $\sigma_t^1(Z,\alpha)$ and $\sigma_t(\alpha)$ for the total incoherent and

K-N cross sections, and express the probability density for scattering into $(\mu,\mu + d\mu)$ in the form

$$P(\mu) \equiv p^1(\mu) \equiv \sigma^1(Z,\alpha,\mu)/\sigma_t^1(Z,\alpha) = \frac{I(Z,\bar{\nu})\sigma_t(\alpha)}{\sigma_t^1(Z,\alpha)}$$

$$\times \frac{I(Z,\nu)}{I(Z,\bar{\nu})} \times \frac{K(\alpha,\mu)}{\sigma_t(\alpha)} = C_0 \times F(\mu) \times Q(\mu) \quad .$$

We therefore assign μ tenatively with K-N probability $Q(\mu)d\mu$, ratifying with probability $F(\mu) = I[Z,\nu(\alpha,\mu)]/(Z,\bar{\nu}) \leq 1$.

The tentative choice of μ is effected indirectly as follows. Taking in place of μ the variable $x = 1/[1 + \alpha(1 - \mu)]$ on the interval $\xi \equiv 1/(1 + 2\alpha) \leq x \leq 1$, and defining $p(x)dx = Q(\mu)d\mu$, one finds that $p(x) = g(x)/G(\xi)$, where $g(x) = x + x^{-1} + \mu^2 - 1$, $\mu \equiv 1 + \alpha^{-1} - (\alpha x)^{-1}$, and in general,

$$G(x) \equiv \int_x^1 g(x)dx \quad .$$

Thus we may determine x by $r = G(x)/G(\xi)$, where r is random on (0,1), and so obtain μ with the required density $Q(\mu)$. A recently obtained approximation[2,3] for the inverse $x = H(y)$ of the function $y = G(x)$ allows rapid and accurate determination of $x = H[rG(\xi)]$.

Having obtained μ, and $\alpha' = \alpha x$, the final energy of the photon is $E' = mc^2\alpha'$, and one deposits the energy $E-E'$ locally. If $E' < 1$ keV, E' is tallied in a cut-off bin and one returns to the source subroutine of the general code. Otherwise the new direction is found from μ, and one returns to the free path routine.

For the point detector routine of the general code, one requires, for a given μ (determined by the detector position), the probability of (incoherent) scattering to the angular range $(\mu,\mu + d\mu)$, $p^1(\mu)d\mu = I(Z,\nu)K(\alpha,\mu)d\mu/\sigma_t^1(Z,\alpha)$. The values of πr_0^2 and of $\alpha'/\alpha = 1/[1 + \alpha(1 - \mu)]$ are needed in $K(\alpha,\mu)$; $I(Z,\nu)$ is obtained by linear interpolation at the computed value of $\nu = \nu(\alpha,\mu)$; and $\sigma_t^1(Z,\alpha) = \sigma^1(Z)$, at the incident energy E, is recoverable from the free path routine.

Note on Momentum Transfer to the Electrons. The parameter ν above is, except for constants, the momentum $q = \alpha\sqrt{2(1 - \mu)}$ (units of mc). The latter seems to be used exclusively in theoretical computation of incoherent scattering factors. The following comparison of q with the relativistic momentum transfer q' to the electron in Compton (elastic) scattering of photons on free electrons at rest may therefore be of interest. In this connection, see the SORS[10] and Union Carbide[11] reports.

Since $\alpha' = \alpha/[1 + \alpha(1 - \mu)]$, we have $k = \alpha - \alpha' = \alpha\alpha'(1 - \mu)$ for the k.e. of the recoil electron, and $E = k + 1$ for its energy (units of mc^2). Thus $E^2 - 1 = k(k + 2) = (\alpha - \alpha')^2 + 2\alpha\alpha'(1 - \mu) = \alpha^2 + \alpha'^2 - 2\alpha\alpha'\mu$, and the electron momentum is

$$q = (E^2 - 1)^{1/2} = \alpha[1 + (\alpha'/\alpha)^2 - 2(\alpha'/\alpha)\mu]^{1/2},$$

(units of mc)

as compared with $q = \alpha\sqrt{2(1 - \mu)}$. To say $q' \cong q$ for $\alpha' \cong \alpha$ is not very revealing, since μ is a function of α' such that $\mu \to 1$ as $\alpha' \to \alpha$. Clearly, however, $q = 0 = q'$ exactly for $\mu = 1$.

Fixing $\alpha > 0$, and setting $x = 1 - \mu$, $0 < x \leq 2$, one finds that $F(x) \equiv q^2/q'^2 = (1 + \alpha x)^2/D$, $D = 1 + \frac{1}{2}(\alpha^2 + 2\alpha)x > 1$. Thus $F(0^+) = 1$ and $F(2) = (1 + 2\alpha)^2/(1 + \alpha)^2 > 1$. Differentiation yields $\alpha^{-1}(1 + \alpha x)^{-1}D^2 F'(x) = (1 - \frac{\alpha}{2}) + (\frac{\alpha^2}{2} + \alpha)x$.

Case I. $(\alpha \leq 2)$. Since $F'(x) > 0$, q/q' increases from 1 to $(1 + 2\alpha)/(1 + \alpha) > 1$, and the "relative error" $t(x) = q/q' - 1$ rises from 0 to its maximum value $\alpha/(1 + \alpha)$ at $\mu = -1$. For $\alpha = 2$, this amounts to 67%, while even for $\alpha = 0.2$ (E ~ 100 keV) it is already 17%.

Case II. $(\alpha > 2)$. Here, the maximum positive error is $\varepsilon(2) = \alpha/(1 + \alpha) \to 1$ as $\alpha \to \infty$. Since $F'(x_0) = 0$ at $x_0 = (\alpha - 2)/(\alpha^2 + 2\alpha)$, and $F(x_0) = 8\alpha/(\alpha + 2)^2$, we conclude that the worst negative error (at $\mu_0 = 1 - x_0$) is $\varepsilon(x_0) = (2\sqrt{2\alpha})/(\alpha + 2) - 1 \to -1$.

D. COHERENT SCATTERING

This process $(j = 2)$ involves no energy loss, only the scattering angle θ being required before returning the photon to the free path routine with its new direction, obtained from the general code.

The differential cross section is now $\sigma^2(Z,\alpha,\mu)d\mu = C^2(Z,\nu)T(\mu)d\mu$, where $C(Z,\nu)$ is a form factor modifying the (energy independent!) Thomson

cross section $T(\mu) = \pi r_0^2(1 + \mu^2)d\mu$. (Superscripts on σ's denote process number j, not an exponent).

The general effect of $C^2(Z,v)/Z^2$ is to decrease the Thomson cross section, more extremely for backward scattering, high E, and low Z, being opposite in these respects to the effect of $I(Z,v)/Z$ on $K(\alpha,\mu)$ in Section C above. For a given Z, $C(Z,v)$ decreases from $C(Z,0) = Z$ to $C(Z,\infty) = 0$. The parameter is here the $v = K\alpha\sqrt{1-\mu}$ of that section, with maximum $\bar{v} = \sqrt{2}\,K\alpha$ for given α. The qualitative features of $C(Z,v)$ are shown in Fig. 2.

The required tables of $C(Z,v)$, for $Z \geq 1$, $v \leq 6$, were compiled from various sources,[12,13,14] with values listed for $v_1 = 0, \cdots, v_{55} = 6$. (For details, see Storm and Israel[5]). We define $C(Z,v) \equiv 0$ for $v > 6$.

To improve efficiency in applying the Principle of Sec. C, we follow a device of the SORS report,[10] and reverse the roles of the coherent cross section components. Denoting by $p^2(\mu) = \sigma^2(Z,\alpha,\mu)/\sigma_t^2(Z,\alpha)$ the probability density for μ, we have

$$P(v^2)dv^2 = p^2(\mu)\left|\frac{d\mu}{dv^2}\right|dv^2 \quad ,$$

where μ is replaced by the variable $v^2 = (K\alpha)^2(1-\mu)$, $0 \leq v^2 \leq \bar{v}^2$. Since $\mu = 1 - v^2/(K\alpha)^2$, $d\mu/dv^2 = -1/(K\alpha)^2$, and we may write

$$P(v^2)dv^2 = \frac{2\pi r_0^2\, Z^2\, A(Z,\bar{v}^2)}{(K\alpha)^2\,\sigma_t^2(Z,\alpha)} \cdot \frac{1+\mu^2}{2} \cdot Q(v^2)dv^2$$

$$\equiv C_0 F(v^2) \cdot Q(v^2)dv^2 \quad ,$$

where

$$Q(v^2) = C^2(Z,v^2)Z^{-2}/A(Z,\bar{v}^2) \quad ,$$

and $$A(Z,v^2) = \int_0^{v^2} C^2(Z,v^2)\, Z^{-2}dv^2 \quad ,$$

for arbitrary v^2.

A random number r on (0,1) may therefore be used to tentatively assign v^2 with density $Q(v^2)$, by the relation $r = A(Z,v^2)/A(Z,\bar{v}^2)$, v^2 being ratified with probability $F(v^2) = \frac{1}{2}(1+\mu^2) \leq 1$, where μ is the above function of v^2.

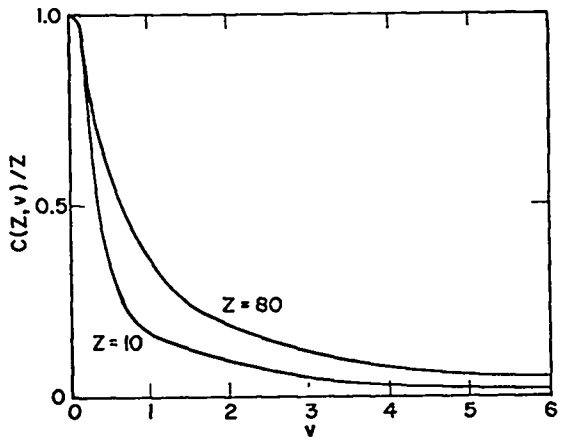

Fig. 2. Coherent scattering factor.

The required values of $A(Z,\bar{v}^2)$ and of v^2 are obtained by linear interpolation, using tables of $A(Z,v_i^2)$, $v_1^2 = 0, \cdots, v_{55}^2 = 36$, obtained by numerical integration of the data cited, and stored on the LT.

For the point detector program, one must evaluate the density $p^2(\mu) = \pi r_0^2(1+\mu^2)\, C^2(Z,v)/\sigma_t^2(Z,\alpha)$ for given μ. Although $\sigma_t^2(Z,\alpha) = \sigma^2(Z)$ is recoverable from the λ routine, the value of $C^2(Z,v)$ at $v = K\alpha\sqrt{1-\mu}$ must be interpolated in the original $C^2(Z,v_i)$ tables, separately stored on the LT for this purpose.

E. PHOTOELECTRIC EFFECT

A collision of this type (j = 3) involves the disappearance of the incident photon of energy E, the ejection from some (positively written) energy level $e \leq E$ of an orbital electron with k.e. E-e, and the transition of a second electron from a level $e' < e$ to the e-level vacancy. There are two possibilities.

(1) A (fluorescence) photon of energy $E' = e-e'$ may be emitted. In such a case, the photon energy difference $E - E' = (E - e) + e'$ consists of the k.e. of the first ejected electron, plus a residual excitation energy e' which is ultimately dissipated by further processes, with additional fluorescence of still lower energy. This we ignore, depositing all of E-E′ locally, and returning to the λ routine with the (isotropically emitted) fluorescence photon of energy E′, provided of course that $E' \geq 1$ keV.

Otherwise the event is "terminal", by which is meant that the incident photon's history terminates, its energy E being locally deposited, and the code returns to the source routine of MCP.

(2) The electron transition $e' \to e$ may not be accompanied by $E' = e - e'$ fluorescence, but by the ejection of an "Auger electron", resulting from "internal conversion". In this event, the entire incident energy E is tallied as energy deposition, and the collision is terminal.

The energy levels e are called "edge energies" because, regarded as a function of increasing E, the photoelectric cross section $\sigma(E)$, elsewhere decreasing continuously, shows a sharp discontinuity (edge) at each E = e, jumping from its lower, limiting value $\sigma(e^-)$ to its value $\sigma(e) > \sigma(e^-)$ as the photon energy E becomes sufficient to activate the e-level.

A photoelectric event is regarded as terminal for elements $Z < 12$, the possible fluorescence energy being below 1 keV.

For elements $Z \geq 12$, fluorescent emission above 1 keV is possible and allowed for to the extent indicated below, using basic data from a Union Carbide report[11] which provides, for each Z, a table of the form

(UC)				
	e_1	σ_1	Y_1	F_1
	v			
	.	.	.	.
	.	.	.	.
	.	.	.	.
	v			
	e_{f-1}	σ_{f-1}	Y_{f-1}	F_{f-1}
	e_f''	σ_f	$Y_f = 0$	$F_f = 0$

where the energies are in decreasing order. These tables have been prepared in a rather involved way, referred to in a later note. For our immediate objective, which is simply the determination of the energy of the fluorescence photons emitted, if any, the following remarks suffice.

Define in terms of the e_i, σ_i above the numbers

$$\phi_1 = \sigma_1 e_1^3 - \sigma_2 e_2^3$$
$$\cdot$$
$$\cdot$$
$$\cdot$$
$$\phi_{f-1} = \sigma_{f-1} e_{f-1}^3 - \sigma_f e_f^3$$
$$\phi_f = \sigma_f e_f^3$$

If $E < e_{f-1}$, the event is terminal. Otherwise, define ℓ as the least index $i \leq f - 1$ for which $e_i \leq E$. Then the ratio $Y_i\phi_i/(\phi_f + \cdots + \phi_\ell)$, $i = f - 1, \cdots, \ell$ represents the probability of the event resulting in a fluorescence photon of energy F_i.

The data in this form is very inconvenient for our purposes, and the LT contains instead the tables

(LT)	i	E_i	D_i	N_i	E_i'
	1	e_f	ϕ_f	$Y_f\phi_f = 0$	$F_f = 0$
	2	e_{f-1}	$\phi_f + \phi_{f-1}$	$Y_f\phi_f + Y_{f-1}\phi_{f-1}$	F_{f-1}
	.	.	.	.	.
	.	.	.	.	.
	.	.	.	.	.
	f	e_1	$\phi_f+\cdots+\phi_1$	$Y_f\phi_f+\cdots+Y_1\phi_1$	F_1

Accordingly, our method in the event $j = 3$, $Z \geq 12$, $E \geq E_2$ begins with determination of the greatest index k for which $E_k \leq E$, and formation of the product rD_k, where r is a random number on (0,1). If $rD_k > N_k$, the event is terminal. Otherwise, the greatest index i (≥ 2) for which $rD_k > N_{i-1}$ determines the energy E_i' of the fluorescent photon emitted.

Note on the Tables. For simplicity, we describe first a table of the form (UC) above, of the following nature: (1) e_1 is the energy level of the K-shell and any further e_i, $i \leq f - 1$, are average energies for the composite shells L, M, N, $\cdots$ in that order, $e_{f-1} = e_f$ being that of the outermost shell allowed for; (2) $\sigma_1 = \sigma(e_1)$ is the peak K-edge $\sigma(E)$ and for further $i \leq f - 1$, σ_i is an average of the peak $\sigma(E)$ values for the shell in question, the final σ_f being the lower limit of $\sigma(E)$ for shell $f - 1$; (3) Y_i is the probability of emission of a fluorescent photon if the i-shell is activated;

(4) F_i is an average value for the fluorescent energies resulting from transitions to the i-shell vacancy from outer shells.

The basic assumption is made that $\sigma(E)$ is of the form $\sigma_i e_i^3/E^3$ on the intervals of continuity $E < e_f = e_{f-1}$; $e_i \leq E < e_{i-1}$, $i = f-1, \cdots, 2$; and $e_1 \leq E$. If these continuous functions are extrapolated to an energy E for which e_ℓ is the greatest listed $e_\ell \leq E$, their values are $\sigma_f e_f^3/E^3 < \cdots < \sigma_\ell e_\ell^3/E^3$, and the differences $\phi_\ell, \cdots, \phi_f$, as defined above, times $1/E^3$, are regarded as the "contributions" of shells $\ell, \cdots, f-1$, and of all outer shells, to the total cross section $\sigma_\ell e_\ell^3/E^3$ at energy E. Under this second assumption, the chance of i-shell activation is $\phi_i/\phi_f + \cdots + \phi_\ell$, $i = f-1, \cdots, \ell$, and the product of this ratio with Y_i may be regarded as the probability of emission of a fluorescence photon of energy F_i.

It was indeed in this form that the original (UC) tables appeared. For $Z \geq 20$, the updated version[11] attempts to replace the average F_i for the K-shell (only!) by the individual fluorescent energies. In order to preserve the original format of the tables and the computational method, the old tables were modified in the following way.

The first row is replaced by a number of rows $i = 1, 2, \cdots, k$, one for each K-shell fluorescence considered, the renumbered remaining rows $k+1, \cdots$ following without change. The new rows $i \leq k$ all list for e_i and Y_i the original energy e_1 and (total) yield Y_1 for the K-shell, and for F_i the fluorescent energy referred to. Also, σ_1 is the original $\sigma(e_1)$, for the K-peak.

Since, for an energy $E \geq e_1$, the <u>total</u> probability of K-shell fluorescence is

$$P = Y_1(\sigma_1 e_1^3 - \sigma_{k+1} e_{k+1}^3)/\sigma_1 e_1^3$$

in terms of the new numbering, it is required to invent fictitious numbers $\sigma_2, \cdots, \sigma_k$ in such a way that

$$(\sigma_i e_i^3 - \sigma_{i+1} e_{i+1}^3)/(\sigma_1 e_1^3 - \sigma_{k+1} e_{k+1}^3) = p_i \ ,$$

$$i = 1, 2, \cdots, k-1$$

where p_i is the dependent probability of K-fluorescence of energy F_i. The p_i being known in the form of relative intensities of the "lines" F_i, it is easy to compute the desired $\sigma_2, \cdots, \sigma_k$ from these equations.

The probability of F_i emission is then

$$P \cdot p_i = Y_1(\sigma_i e_i^3 - \sigma_{i+1} e_{i+1}^3)/\sigma_1 e_1^3 \ , \quad i = 1, \cdots, k$$

for $E \geq e_1 = \ldots = e_k$, and the method is unchanged if one computes the ϕ_i as before, for <u>all</u> $i \leq f-1$, f being the total number of rows in the new table. For details of the fine structure considered, one should consult the U.C. report.[11]

F. PAIR PRODUCTION

We consider this process ($j = 4$) only in the field of a nucleus. Although the threshold is technically $2mc^2[1 + (m/M)] \cong 1.022$ MeV, M being the nuclear mass, $\sigma_1^4(Z)$ becomes positive only for $E \geq 1.5$ MeV in the tables used.[5]

In the event of such a collision, the incident photon, of energy E, vanishes; the k.e. of the created positron-electron pair, assumed to be $E - 2mc^2$, is deposited locally; the positron is considered to be annihilated with an electron at the point of collision; and a single photon of weight twice that of the incoming photon and energy mc^2 is given an isotropically distributed new direction and is transported further.

G. ENERGY RANGE

If all other effects (bremstrahlung, etc.) are ignored, nothing prevents extension of the code to the limit (100 MeV) of the Storm-Israel tables,[5] the approximation for the inverse to the Klein-Nishina scattering distribution[3] remaining good to that energy.

H. MECHANICS OF THE CODE MCP

Apart from the collision routine which has been described in some detail above, the codes MCP and MCG have few differences. As mentioned in the introduction to Part II, they are virtually identical to use and have almost identical outputs. (Both of these codes are quite similar in problem set up and output to the Monte Carlo neutron code MCN.[1]) To

avoid duplication, let us refer the reader to Sections D, E, F, Apendix A and Appendix B of Part I, and below we list the exceptions to this discussion which apply to the use of MCP.

Exceptions. (1) The second item on the run card for MCP is the energy cut-off ECF (not weight cut-off WC) and this is the same for all cells. There are no weight cut-offs WC and WR used in MCP since capture is not treated by weights (i.e., estimating the capture per collision by reducing the particle weight). Thus the run card will have only 7 entries with entry 2 modified as above.

(2) The Y7 card is not used in MCP since we do not have energy cut-offs as a function of cell.

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PART III

SAMPLE PROBLEM

In order to illustrate the steps in setting up a typical problem for the codes MCG and MCP, as well as to portray the output features of these codes, we shall set up and run the same problem with these codes. We will use the geometry shown in Figs. C-1 and C-2 in Appendix C of LA-4751 with the exception that Surface 18, the left bounding plane, is not taken to be a reflecting plane. (The reflecting plane upsets the estimation of the flux at the point detector in the present codes, including MCN.)

While the geometry is quite similar to that in LA-4751, the source is different. Also the tally bins are specified anew, to a large extent a reflection of the differences between processing neutrons and photons. In the following we shall specify completely the input to the problem, with the exception of the geometry, independently of the sample problem for MCN given in LA-4751.

A. Source. The source is assumed to be uniformly distributed in volume throughout Cell 1 and isotropic in direction. Because we are tallying mainly along the positive y direction, we biased the directional distribution, sending three-fourths of the particles isotropically with positive v (v is the y-direction cosine) and one-fourth of the particles isotropically with negative v, correcting the weights of the source particles so that one-half of the expected weight has positive v and one-half has negative v.

In addition, the energy distribution of the source has been biased in order to emphasize the source particles of higher energies. The information is displayed in Table I, with the source energy bins (WO card), the actual fractions of the particles in each source group (VO card), and the fictitious (biased) fractions in each source group (UO card). The procedure follows exactly the description of the Source Cards on pp. 10-11 of LA-4751.

If the problem has a time cut-off of 100 shakes (essentially infinite time cut-off for this problem), we ask for the following information.

TABLE I

SOURCE

Group	Energy in MeV (WO)	Fractions in Group (VO)	Track Fractions in Group (UO)
1	0.001	0.0	0.0
2	0.01	0.1	0.02
3	0.1	0.2	0.08
4	0.5	0.3	0.2
5	1.0	0.3	0.3
6	5.0	0.05	0.2
7	10.0	0.03	0.15
8	14.0	0.02	0.05

B. Currents. Tally currents across surfaces 1, 10, 11, and 14 for

energies: 0-0.005, 0.005-0.01, 0.01-1.0, 1.0-5.0, 5.0-14.0 (MeV)

times: 0-100 (shakes)

angles: 1.0-0.8, 0.8-0.6, 0.6-0.4, 0.4-0.2, 0.2-0 (values are for the cosine of the angle with the normal to the surface).

C. Flux Across Surfaces. Tally the flux integrated over surface 17 for

energies: 0-0.005, 0.005-0.01, 0.01-1.0, 1.0-5.0, 5.0-14.0 (MeV)

times: 0-0.01, 0.01-0.1, 0.1-1.0, 1.0-10.0 (shakes)

D. Flux in a Cell. Tally the average flux in Cell 3 for

energies: 0-0.1, 0.1-0.5, 0.5-1.0, 1.0-5.0, 5.0-14.0 (MeV)

times: 0-0.01, 0.01-0.1, 0.1-1.0, 1.0-10.0 (shakes)

cell volumes: 245.52 (cm^3)

E. Flux at a Point. Tally the flux at the point (0, 10, 25) for

energies: 0-0.005, 0.005-0.01, 0.01-1.0, 1.0-5.0, 5.0-14.0 (MeV)

times: 0-0.01, 0.01-0.1, 0.1-1.0, 1.0-10.0 (shakes)

cells contributing to point detector: all cells

TABLE II

CELL QUANTITIES

Cell	Importance	Energy Cut-off
1	1.0	0.001 (MeV)
2	1.0	0.001
3	2.0	0.001
4	2.0	0.001
5	1.0	0.001
6	4.0	0.001
7	4.0	0.001
8	8.0	0.001
9	8.0	0.001
10	16.0	0.001
11	8.0	0.001
12	32.0	0.001
13	16.0	0.001
14	32.0	0.001
15	1.0	0.001
16	1.0	0.001
17	1.0	0.001
18	1.0	0.001
19	1.0	0.001
20	1.0	0.001
21	1.0	0.001
22	4.0	0.001
23	4.0	0.001
24	8.0	0.001
25	8.0	0.001
26	1.0	0.001
27	1.0	0.001
28	2.0	0.001
29	2.0	0.001
30	4.0	0.001
31	1.0	0.001
32	0.0	0.001

TABLE III

MATERIAL DENSITIES

Material	Atomic Density [(atoms/cm^3 $\times$ 10^{-24}]
Al	0.0603
Normal Li	0.0463
Be	0.123
CH	0.00926
CH_2	0.1173
Fe	0.0847

time cut-off = 100 shakes

WC = 10^{-3}

WR = 10^{-4}

TABLE IV

SAMPLE RUN - MCG

```
      SUBROUTINE SOURCE
1     COMMON MXA,MXJ,MXS,MXM,MXL,MXE,MXF,MXFM,MXLC,LC3,MXE2,MXAT,NSR,NSC
     A ,I11,I12,J11,J12,K11,K12,II1,LL1,IL1,IKL1,I21,I22,J21,JZZ,II2,I41
     B ,I42,J41,J42,I14,I51,I52,J51,J52,II5,NOETX,LCD,LCP,SRC(8),SPB(24)
     C ,SWM(24),SEG(24),IDY(5),ID(8),NIF(7),LDF(6),RHO(120),VOL(120),MAT
     D (120),NCL(120),FIO(120),ECF(120),LCA(121),LCS(120),LJA(480),LCAJ(
     E 480),LAJ(960),KST(120),LSC(121),SCF(360),LCB(960),LFD(6),LPR(6),I
     F JP(60),IFP(60),P(100),COETX(25,3),R0(25),FR0(25),ECS(166),C35(124
     G 50),NDC,JDC(120),QA(120),SBL(7),GBL(10),GFIN,WTMIN,WTMAX,NPAR,NFI
     H N,REJF1,NST,IDR,IDG,NPSN,KRN,NRN,TWS,TES,NPS,NTR,NCT,TMO,E-M(6),N
     I TM(6),WTM(6),F(15000)
1     COMMON/G1/ SIG,DLS,PL,QPL,PHF,DEG,CSJA,CSA,IAP,NE,
     C NCP,KDB,X,Y,Z,U,V,W,ERG,WT,THE,
     C VL,DEL,IA,JA,NP,USQ,VSQ,WSQ,I4F,I1F,I2F,I5F,I6F
1     COMMON/DXCOM/NIR,IDETX,CSDX,CS,DDETX,DXFAC,AMFP,AMFP2,PBLSAV(13),
     1 LV2,LV3,LV4,LV5,LV6,LV7,PSC,DMUDA,AW,VOLD,VOLD,WOLD,
     2 XNU,D,W1,AK,DCAP,VCAP,WV,CTM,STM,CEP,SEP
1     COMMON/G2/JQ(2),CSN(130),TP(25),JSF(120),SG1(120),SG2(120),
     C RNK(22,100)
   C  UNIFORMLY DISTRIBUTED IN VOLUME IN SPECIFIED SPHERICAL CELL.
   C  STARTING DIRECTION ISOTROPIC, BUT BIASED IN POSITIVE V-DIRECTION.
   C  ENERGY DISTRIBUTION.
   C     57 CARD REQUIRED IN PROBLEM DECK.
   C     SRC(1)=CELL NUMBER.
   C     SRC(2)=RADIUS OF CELL IN CM.
   C     SRC(3)=FRACTION OF NEUTRONS WHOSE STARTING DIRECTION HAS
   C            POSITIVE V.
   C
   C     DISTANCE FROM ORIGIN SAMPLED FROM THE INTERVAL (0,SRC(2))
   C     DISTRIBUTED ACCORDING TO THE DISTANCE CUBED.
1        R=SRC(2)*(FRN(KRN))**.3333333333
   C     SAMPLE UNIFORMLY FROM POINTS INSIDE THE UNIT CIRCLE.
10    10 TP(1)=2.*FRN(KRN)-1.
15       TP(2)=2.*FRN(KRN)-1.
22       TP(3)=TP(1)**2+TP(2)**2
24       IF(TP(3).GT.1.) GO TO 10
   C     TP(3) DISTRIBUTED UNIFORMLY ON THE INTERVAL (0,1).  TP(4) IS
   C     THE COSINE OF THE POLAR ANGLE OF THE STARTING POINT.
30       TP(4)=2.*TP(3)-1.
31       TP(5)=R*SQRT((1.-TP(4)**2)/TP(3))
37       X=R*TP(4)
40       Y=TP(1)*TP(5)
41       Z=TP(2)*TP(5)
43       IF(FRN(KRN).GT.SRC(3)) GO TO 30
   C     SET V POSITIVE SRC(3) OF THE TIME.
51       V=ABS(V)
52       WT=0.5/SRC(3)
54    15 IA=SRC(1)
55       JA=1
56       THE=0
57       DEL=0
60       R=FRN(KRN)
63       DO 20 I=2,8
64       IF (R .LT. SPB(I)) GO TO 25
67    20 CONTINUE
72    25 ERG=SEG(I-1)+(SEG(I)-SEG(I-1))*(R-SPB(I-1))/
       1 (SPB(I)-SPB(I-1))
100   -> WT=WT*SWM(I)
102      RETURN
   C     SET V NEGATIVE 1-SRC(3) OF THE TIME.
103   30 V=-ABS(V)
105      WT=0.5/(1.-SRC(3))
110      GO TO 15
111      END
```

```
SUBPROGRAM LENGTH - SOURCE
   144

STATEMENT ASSIGNMENTS
STMT NO=  LOCATION          STMT NO=  LOCATION          STMT NO=  LOCATION          STMT NO=  LOCATION
10      =       11          15      =       55          25      =.      72          30      =      104

BLOCK NAMES AND LENGTHS
        =  100131           61      =       42          DXCOM   =.      5/          G2      =     5235

VARIABLE ASSIGNMENTS
NAME    =  LOCATION         NAME    =  LOCATION         NAME    =  LOCATION         NAME    =  LOCATION

BNK     =R    1005C04       CDETX   =R  11326C01        CRS     =R  11771C01        CSN     =R      2C04
DEL     =R      26C02       ECF     =R   1354C01        ECS     =R  11523C01        ERG     =R     22C02
ETM     =R   42657C01       F       =R  42701C01        FIO     =R   116.C01        FRO     =R  11472C01
GBL     =R   42623C01       I       =I      142         IA      =I     27C02        ID      =I    177C01
IDY     =I     172C01       IFP     =I  11066C01        IJP     =I  1077:C01        JA      =I     30C02
JDC     =I   42234C01       JQ      =I      0C04        JSF     =I    235C04        KRN     =I  42647C01
KST     =I    5725C01       LAJ     =I   4025C01        LCA     =I   1544C01        LCAJ    =I   3065C01
LCB     =I    7056C01       LCS     =I   1735C01        LDF     =I    216C01        LFD     =I  10756C01
LJA     =I    2125C01       LPR     =I  10764C01        LSC     =I   611:C01        MAT     =I    604C01
NCL     =I     774C01       NIF     =I    207C01        NTM     =I  42665C01        P       =R  11162C01
PBLSAV  =R      10C03       OA      =R  42424C01        R       =R      143         RHO     =R    224C01
RO      =R   11441C01       SBL     =R  42614C01        SCF     =R   6306C01        SEG     =R    142C01
SG1     =R     425C04       SG2     =R    615C04        SPB     =R     62C01        SRC     =R     52C01
SWM     =R     112C01       THE     =R     24C02        TP      =R    20.:04        V       =R     20C02
VOL     =R     414C01       WT      =R     23C02        WTM     =R  42673C01        X       =R     14C02
Y       =R      15C02       Z       =R     16C02

EXTERNAL ASSIGNMENTS
FRN                         RBAREX                      SQRT

START OF      -      CONSTANTS         TEMPORARIES         INDIRECTS      -      UNUSED COMPILER SPACE
                        113               117                 141                       77000




CORE MAP ************** DATE-  72/12/06***** TIME-  17.56.06************ NORMAL LOAD ****************************************************
                  FWA       LWA                      BLNK COM  LENGTH
                -------   -------                    -------   -------
         CODE    000100    147155                     047025    100131
         LOADER  143602    150071
         TABLES  143601    141724

                                                      NAMED                          LCM
FILE     PROGRAM   ADDRESS                            COMMON    ADDRESS              BLOCK     ADDRESS
-------  -------   -------                            -------   -------              -------   -------
CODETP
         IMCGPRS   032607                             GI1       000100

SYSLIB
         ACGOER    037625
         BUFFEO    037637
         ENDFIL    037721
         INPUTB    037735
         INPUTC    040112
         INPUTS    040266
         IOCHEK    040354
         LOCF      040400
         OUTPTC    040412
         OUTPTS    040550
         REWINM    040641
         SYSTEM    040674
         IBAIEX    041732
         BS4020    041763
         C4020     042543
         GETBA     042637
         IOUTIL    042673
         KODER     044164
         KRAKER    045461
         MEMORY    046522
         SKIPR     046702
         BOI       046754
         PSCALE    047020

         UNSATISFIED                  REFERENCED                             AT
         EXTERNALS                    BY                                     LOCATION
         -------   -------            -------          -------   -------   -------   -------   -------   -------   -------
```

```
                                                    MCG TEST PROBLEM
 1   45 .00926   -1,2
 2   43 .0603    1,1 -2,4,5,3
 3   44 .123    2,2 -4,4 -3,6
 4   46 .1173    2,2 4,3 15,5 -3,6
 5   46 .1173    2,2 -15,4 -3,15
 6   41 .0463    3,4,3 -5,7 -7,8
 7   43 .0603    5,6 15,16 -6,22 -7,9
 8   41 .0463    -5,9 7,6 -8,10
 9   43 .0603    5,8 7,7 -6,23 -8,11
10   41 .0463    -5,11 8,8 -9,12
11   43 .0603    5,10 8,9 -6,24 -9,13
12   44 .123    -5,13 9,10 -10,14
13   43 .0603    5,12,14 9,11 -6,25 -11,32
14   43 .0603    -5,13 10,12 -11,32
15   45 .00926    3,5 16,17 -5,16
16   43 .0603    5,15 16,18 -6,21 -15,7
17   45 .00926    -5,18 17,19 -16,15
18   43 .0603    5,17,19 18,32 -6,20 -16,16
19   43 .0603    -5,18 18,32 -17,17
20   46 .1173    6,18 18,32 -12,26 -16,21
21   46 .1173    6,16 16,20 -12,27 -15,22
22   46 .1173    6,7 15,21 -12,28 -7,23
23   46 .1173    6,9 7,22 -12,29 -8,24
24   46 .1173    6,11 8,23 -12,30 -9,25
25   46 .1173    6,13 9,24 -12,30 -11,32
26   42 .0847   12,20 18,32 -13,31 -16,27
27   42 .0847   12,21 16,26 -13,31 -15,28
28   42 .0847   12,22 15,27 -13,31 -7,29
29   42 .0847   12,23 7,28 -13,31 -8,30
30   42 .0847   12,24,25 8,29 -13,31 -11,32
31   0    13,26,27,28,29,30 18,32 -14,32 -11,32
32   0    14,31 -18,19,16,20,26,31 11,14,13,25,30,31

 1   SO 3.0
 2   SO 5.0
 3   SO 10.0
 4   KY 0 .3333333333
 5   CY 10.
 6   CY 11.
 7   PY 15.
 8   PY 20.
 9   PY 25.
10   PY 30.
11   PY 31.
12   CY 14.
13   CY 15.
14   CY 26.
15   PY 0
16   PY -12.
17   PY -16.
   18  PY  -18.

I0   1. 1. 2. 2. 1. 4. 4. 8. 8. 16. 8. 32. 16. 32. 1. 6R 4. 4. 8. 8.
     1. 1. 2. 2. 4. 1. 0
S7   1 3.0 .75
   F1  1  10  11  14
   E1  .005  .01  1.  5.  14.
T1   100.
C1   .8 .6 .4 .2 0
F2   17

   E2  .005  .01  1.  5.  14.
   T2  .01  .1  1.  10.
F4   3
E4   .1 .5 1.0 5.0 14.0
   T4  .01  .1  1.  10.
P4   245.52
F5   0 10. 25. 0
   E5  .005  .01  1.  5.  14.
   T5  .01  .1  1.  10.
   U0  0.  .02  .08  .2  .3  .2  .15  .05
   V0  0.  .1  .2  .3  .3  .05  .03  .02
   W0  .001  .01  .1  .5  1.  5.  10.  14.
   Y7  .001  31R
  M41 3  1.
  M42  26  1.
  M43  13  1.
  M44  4  1.
  M45  1  .5  6  .5
  M46  1  2.  6  1.
```

NO. CELLS= 32

PROGRAM NAME	CELLS PROBLEM NAME	TALLY FORMULA
1	1	4
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	
11	11	
12	12	
13	13	
14	14	
15	15	
16	16	
17	17	
18	18	
19	19	
20	20	
21	21	
22	22	
23	23	
24	24	
25	25	
26	26	
27	27	
28	28	
29	29	
30	30	
31	31	
32	32	

NO. SURFACES= 18

PROGRAM NAME	SURFACES PROBLEM NAME	TALLY FORMULA
1	1	1
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	1
10	10	1
11	11	
12	12	
13	13	1
14	14	
15	15	
16	16	2
17	17	
18	18	

CELL	AMB. SURF.	MATERIAL	DENSITY	10	Y7
1		45	9.2600E-03	1.0000E+00	1.0000E-03
2		43	6.0300E-02	1.0000E+00	1.0000E-03
3		44	1.2300E-01	2.0000E+00	1.0000E-03
4		46	1.1730E-01	2.0000E+00	1.0000E-03
5		46	1.1730E-01	1.0000E+00	1.0000E-03
6		41	4.6300E-02	4.0000E+00	1.0000E-03
7		43	6.0300E-02	4.0000E+00	1.0000E-03
8		41	4.6300E-02	8.0000E+00	1.0000E-03
9		43	6.0300E-02	8.0000E+00	1.0000E-03
10		41	4.6300E-02	1.6000E+01	1.0000E-03
11		43	6.0300E-02	8.0000E+00	1.0000E-03
12		44	1.2300E-01	3.2000E+01	1.0000E-03
13		43	6.0300E-02	1.6000E+01	1.0000E-03
14		43	6.0300E-02	3.2000E+01	1.0000E-03
15		45	9.2600E-03	1.0000E+00	1.0000E-03
16		43	6.0300E-02	1.0000E+00	1.0000E-03
17		45	9.2600E-03	1.0000E+00	1.0000E-03
18		43	6.0300E-02	1.0000E+00	1.0000E-03
19		43	6.0300E-02	1.0000E+00	1.0000E-03
20		46	1.1730E-01	2.0000E+00	1.0000E-03
21		46	1.1730E-01	1.0000E+00	1.0000E-03
22		46	1.1730E-01	4.0000E+00	1.0000E-03
23		46	1.1730E-01	8.0000E+00	1.0000E-03
24		46	1.1730E-01	8.0000E+00	1.0000E-03
25		46	1.1730E-01	1.6000E+01	1.0000E-03
26		42	8.4700E-02	1.0000E+00	1.0000E-03
27		42	8.4700E-02	2.0000E+00	1.0000E-03
28		42	8.4700E-02	2.0000E+00	1.0000E-03
29		42	8.4700E-02	4.0000E+00	1.0000E-03
30		42	8.4700E-02	1.6000E+00	1.0000E-03
31		0	0.	0.	1.0000E-03
32		0	0.		

FORMULA 1 -- PHOTONS CROSSING SURFACE

SURFACE	1	10	11	16	
ENERGY	5.0000E-03	1.0000E-02	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E+02				
COSINE	8.0000E-01	6.0000E-01	4.0000E-01	2.0000E-01	0.

FORMULA 2 -- FLUX INTEGRATED OVER SURFACE

SURFACE	17				
ENERGY	5.0000E-03	1.0000E-02	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E-02	1.0000E-01	1.0000E+00	1.0000E+01	

FORMULA 4 -- PATH LENGTH/VOLUME

CELL	3				
ENERGY	1.0000E-01	5.0000E-01	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E-02	1.0000E-01	1.0000E+00	1.0000E+01	
VOLUME	2.4552E+02				

FORMULA 5 -- FLUX AT DETECTOR

DETECTOR	1	X	Y	Z	NEIGHBORHOOD
		0.	1.0000E+01	2.5000E+01	0.
CELL	ALL				
ENERGY	5.0000E-03	1.0000E-02	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E+02	1.0000E-01	1.0000E+00	1.0000E+01	

SOURCE= 7

SRC(1)	SRC(2)	SRC(3)
1.0000E+00	3.0000E+00	7.5000E-01

N	ENERGY	CUM. PROB.	WT. MULT.
1	1.0000E-03	0.	0.
2	1.0000E-02	2.0000E-02	5.0000E+00
3	1.0000E-01	1.0000E-01	2.5000E+00
4	5.0000E-01	3.0000E-01	1.5000E+00
5	1.0000E+00	6.0000E-01	1.0000E+00
6	5.0000E+00	8.0000E-01	2.5000E-01
7	1.0000E+01	9.5000E-01	2.0000E-01
8	1.4000E+01	1.0000E+00	4.0000E-01

MATERIAL DATA

MAT. NO.	ELEM. NO.	FRACTION
41	3	1.00000
42	26	1.00000
43	13	1.00000
44	4	1.00000
45	1	.50000
	6	.50000
46	1	.66667
	6	.33333

INITIATION COMPLETED

```
CORE MAP ************** DATE=  72/12/06***** TIME=  17.56.10************ NORMAL LOAD ************************************************
                 FWA       LWA                    BLNK COM  LENGTH
               -------   -------                  -------   -------
         CODE  000100    130373                   030243    100131
       LOADER  143602    150071
       TABLES  143601    140067

                                                  NAMED                        LC'
FILE     PROGRAM   ADDRESS                        COMMON    ADDRESS            BLOCK     ADDRESS
-------  -------   -------                        -------   -------            -------   -------
RUNTP
         SOURCE    005453                         G1        000100
                                                  DXCOM     000142
                                                  G2        000216
         MCGPRS    005622                         G1        000100
                                                  G3        005617
                                                  DXCOM     000142
                                                  G2        000216
         DBPNT     016164                         G1        000100
                                                  G3        005617
                                                  DXCOM     000142
                                                  G2        000216
         FRN       016533                         G1        000100
                                                  G3        005617
                                                  DXCOM     000142
                                                  G2        000216
         IRN       016561                         G1        000100
                                                  G3        005617
                                                  DXCOM     000142
                                                  G2        000216
SYSLIB
         ACGOER    016607
         BACKSP    016621
         BUFFEI    016650
         BUFFEO    016771
         CLOCKF    017053
         DMPXX     017156
         ENDFIL    017720
         INPUTC    017734
         IOCHEK    020110
         LENGTH    020134
         LOCF      020154
         OUTPTC    020166
         PACKAGE   020324
         SETQ      020411
         SSWTCH    020632
         SYSTEM    020720
         XIT       021756
         ALNLOG    022075
         EXP       022164
         IBAIEX    022237
         RBAIEX    022270
         RBAREX    022321
         SORT      022400
         ABORT     022456
         BS4020    022527
         C4020     023307
         ENTR      023403
         GETBA     023437
         IOUTIL    023473
         KODER     024764
         KRAKER    026261
         LABRT     027322
         MEMORY    027430
         OUTPTS    027610
         REMARK    027701
         RETN      027734
         SKIPR     027764
         SHIFT     030036
         801       030053
         PSCALE    030117
         N203SR    030124

         UNSATISFIED                  REFERENCED                           
         EXTERNALS                    BY                                 LOCATION
         -------  -------             -------    -------   -------   -------   -------   -------   -------   -------
         SRCDX                        MCGPRS     006624
```

MCG TEST PROBLEM

SOURCE NO.	TIME CUTOFF	WT. CUTOFF 1	RUN TIME	D.P. CYCLE	DUMP CYCLE	DUMP NO.	CUTOFF CYCLE	WT. CUTOFF 2
7	1.0000E+02	1.0000E-03	4.9000E+00	25000	25000	-0	-0	1.0000E-04

NPS	X	Y	Z	IA	JA	U	V	W	TME	WT	DEL	ERG
1	1.8834E+00	-1.1784E+00	-1.9418E+00	1	1	7.8852E-01	6.0253E-01	1.2328E-01	0.	6.6667E-01	0.	7.5687E-01
2	7.9061E-01	-2.8099E+00	6.3319E-01	1	1	2.9424E-01	8.9063E-02	-9.5157E-01	0.	6.6667E-01	0.	9.9706E-01
3	-1.8176E+00	1.5956E+00	7.5875E-01	1	1	-7.4973E-01	5.6121E-01	-3.5064E-01	0.	6.6667E-01	0.	6.1370E-01
4	-1.5899E+00	3.0205E-01	4.9150E-01	1	1	9.0218E-01	3.8224E-01	1.9993E-01	0.	2.6667E-01	0.	1.3004E+01
5	9.8692E-01	6.5240E-01	2.5618E+00	1	1	3.0760E-01	6.8151E-01	6.6403E-01	0.	1.6667E-01	0.	4.5216E+00
6	1.0094E+00	-6.8089E-01	1.2487E+00	1	1	-3.4625E-01	5.4972E-01	7.6021E-01	0.	6.6667E-01	0.	5.7641E-01
7	1.5817E+00	1.5320E+00	1.0454E+00	1	1	5.8842E-01	1.7994E-01	7.8828E-01	0.	1.3333E-01	0.	5.3227E+00
8	8.7892E-01	-8.8799E-01	-1.9466E+00	1	1	5.8019E-01	-5.3230E-01	6.1647E-01	0.	2.0000E+00	0.	5.8851E-01
9	-4.8758E-02	-1.4527E+00	-1.8107E+00	1	1	-4.6680E-01	3.2436E-01	-8.2273E-01	0.	1.6667E-01	0.	4.6061E+00
10	-1.6290E+00	6.8720E-01	2.2839E+00	1	1	-4.2523E-02	4.0882E-01	-9.1162E-01	0.	1.0000E+00	0.	3.6253E-01
11	-1.8168E+00	-8.7101E-01	1.2774E+00	1	1	-2.1312E-01	-7.7967E-01	-5.8881E-01	0.	5.0000E-01	0.	2.9572E+00
12	1.2789E+00	-5.9198E-01	1.6113E+00	1	1	2.5608E-01	9.3071E-01	2.6116E-01	0.	6.6667E-01	0.	9.4169E-01
13	-1.9050E+00	3.5257E-01	1.2982E+00	1	1	-8.5814E-01	4.7129E-01	2.0369E-01	0.	1.0000E+00	0.	3.3627E-01
14	-5.6906E-01	-1.8986E+00	1.6113E+00	1	1	4.0615E-01	8.6279E-01	-3.0106E-01	0.	1.3333E-01	0.	7.1971E+00
15	1.4359E-01	2.3181E+00	-1.3006E+00	1	1	5.5104E-01	-2.9001E-01	7.8245E-01	0.	4.0000E-01	0.	5.4753E+00
16	2.8122E-01	-1.8006E+00	1.4064E+00	1	1	5.1306E-01	-4.6818E-01	7.1942E-01	0.	4.0000E-01	0.	8.6614E+00
17	1.3167E+00	2.5053E+00	-9.4498E-01	1	1	-8.0674E-01	4.4572E-01	3.8795E-01	0.	1.3333E-01	0.	7.6259E+00
18	-1.7895E+00	1.0723E+00	3.2450E-01	1	1	-1.7847E-01	3.4790E-01	9.2039E-01	0.	6.6667E-01	0.	7.8534E-01
19	9.3369E-01	5.8614E-01	8.6889E-01	1	1	-7.0619E-01	-6.0076E-01	-3.7467E-01	0.	5.0000E-01	0.	2.8264E+00
20	-4.4311E-01	6.5555E-01	2.0903E+00	1	1	5.6642E-01	3.2999E-01	7.5517E-01	0.	1.3333E-01	0.	6.4317E+00
21	5.6261E-01	-2.7617E-01	-2.0080E+00	1	1	7.1946E-01	6.8706E-01	1.0161E-01	0.	6.6667E-01	0.	7.0504E-01
22	1.8655E+00	1.5924E+00	6.2942E-01	1	1	2.1473E-01	-4.8953E-01	8.4513E-01	0.	3.0000E+00	0.	2.2138E-01
23	1.3925E+00	-9.4947E-01	-1.9876E+00	1	1	-4.6512E-01	6.6503E-01	-5.8429E-01	0.	6.6667E-01	0.	9.1464E-01
24	8.3328E-01	4.3827E-01	1.0312E+00	1	1	2.6656E-01	9.1716E-01	-2.9626E-01	0.	1.6667E-01	0.	2.1491E+00
25	-1.8862E-01	1.9109E+00	-1.2670E+00	1	1	-8.8971E-01	-4.4307E-01	1.1004E-01	0.	2.0000E+00	0.	5.1198E-01
26	-1.5025E-01	5.6974E-01	6.5121E-01	1	1	6.9655E-01	6.8546E-01	-2.1203E-01	0.	6.6667E-01	0.	5.5296E-01
27	1.0248E+00	-2.5649E+00	2.9570E-01	1	1	-7.6189E-01	6.4350E-01	-7.3714E-02	0.	1.6667E+00	0.	6.4567E-02
28	7.4240E-01	3.0756E-02	2.3358E+00	1	1	-7.2178E-01	-5.8659E-01	-3.6734E-01	0.	2.0000E+00	0.	7.0249E-01
29	-8.3918E-01	7.7705E-01	-9.1937E-01	1	1	3.3282E-02	6.3031E-01	-7.7563E-01	0.	6.6667E-01	0.	6.5480E-01
30	-1.7052E+00	-8.3155E-01	4.8474E-01	1	1	9.7486E-01	1.7086E-01	-1.4299E-01	0.	1.0000E+00	0.	1.0625E-01
31	-1.5052E+00	2.0610E+00	3.4549E-01	1	1	5.5236E-01	-5.8143E-01	5.9736E-01	0.	2.0000E+00	0.	9.4355E-01
32	5.3233E-01	-1.5705E+00	3.5310E-01	1	1	-5.0635E-02	-9.5567E-02	-9.9413E-01	0.	2.0000E+00	0.	5.5122E-01
33	1.0504E+00	-6.2248E-01	2.5924E+00	1	1	-4.8943E-01	7.5555E-01	4.3543E-01	0.	1.0000E+00	0.	3.4182E-01
34	9.6449E-01	-1.9494E-01	2.7427E+00	1	1	1.7474E-01	8.8773E-01	-4.2591E-01	0.	1.6667E-01	0.	1.2509E+00
35	-3.7365E-01	1.3200E+00	-1.9928E+00	1	1	6.7543E-01	2.6395E-01	6.8857E-01	0.	1.0000E+00	0.	3.1353E-01
36	6.1254E-01	-5.3557E-02	-2.7926E+00	1	1	-9.6888E-01	2.3505E-01	-7.7609E-02	0.	6.6667E-01	0.	8.9761E-01
37	-2.0957E+00	1.3958E-01	1.0718E+00	1	1	6.4676E-01	4.7923E-01	5.9334E-01	0.	6.6667E-01	0.	5.3418E-01
38	-1.8794E+00	9.2181E-01	-9.5096E-01	1	1	9.1006E-01	1.6180E-01	3.8160E-01	0.	1.6667E-01	0.	1.0363E+00
39	1.9181E+00	-9.0274E-02	-1.0936E-01	1	1	1.8984E-01	1.8167E-01	9.6486E-01	0.	6.6667E-01	0.	9.6230E-01
40	2.4012E+00	1.0240E+00	1.8979E-02	1	1	-5.3823E-01	2.7522E-01	7.9659E-01	0.	6.6667E-01	0.	8.4391E-01
41	7.3899E-01	2.0218E+00	-1.5797E+00	1	1	-7.5351E-01	9.6675E-02	-6.5029E-01	0.	1.0000E+00	0.	3.9029E-01
42	3.8772E-01	-1.9195E+00	-1.5532E+00	1	1	-1.5493E-01	1.5683E-02	-9.8780E-01	0.	6.6667E-01	0.	6.4604E-01
43	-1.5251E+00	5.2233E-01	5.1126E-01	1	1	-6.4712E-01	9.4135E-02	7.5655E-01	0.	1.6667E-01	0.	1.9578E+00
44	1.6763E-01	1.2843E-01	1.3653E+00	1	1	7.8093E-01	-4.9750E-01	-3.7768E-01	0.	3.0000E+00	0.	1.4861E-01
45	1.2854E+00	-4.0399E-01	2.0153E+00	1	1	8.7371E-01	-4.6380E-01	-1.4669E-01	0.	2.0000E+00	0.	8.6427E-01
46	7.2839E-01	6.6969E-01	2.1071E+00	1	1	-4.3991E-01	-8.7637E-01	1.9609E-01	0.	2.0000E+00	0.	5.9788E-01
47	2.5047E+00	-1.2434E-01	1.3765E+00	1	1	-6.4281E-01	8.6087E-02	-7.6117E-01	0.	1.6667E+00	0.	1.9952E+02
48	1.3688E+00	-6.3716E-01	1.6405E+00	1	1	6.8631E-01	-5.3775E-01	-4.8970E-01	0.	5.0000E-01	0.	3.9963E+00
49	-1.7992E+00	-4.2251E-01	1.9093E+00	1	1	-7.7616E-01	4.7190E-01	4.1818E-01	0.	6.6667E-01	0.	9.6833E-01
50	1.1096E+00	-8.0901E-01	-1.9184E+00	1	1	8.2028E-01	2.6719E-01	-5.0572E-01	0.	1.3333E-01	0.	5.7237E+00

MCG TEST PROBLEM

TIME= 4.671 MINUTES

NUMBER OF PHOTONS STARTED	TOTAL NUMBER OF COLLISIONS	RANDOM NUMBERS GENERATED	TOTAL WEIGHT STARTED	TOTAL ENERGY STARTED	COLLISIONS PER PHOTON STARTED	TRACKS PER PHOTON STARTED	PHOTONS PROCESSED PER MINUTE
15232	270746	1851954	1.5242E+04	1.4459E+04	1.7775E+01	6.2568E+00	3.2609E+03

TOTAL TRACKS STARTED	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO WEIGHT CUTOFF	LOSS TO ESCAPE	LOSS TO SPLITTING	TOTAL TRACKS LOST
95303	0	0	14816	21670	58817	95303

WEIGHT STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	WEIGHT LOST PER PHOTON	PAIR PRODUCTION PER PHOTON
1.0007E+00	0.	0.	3.2892E-01	6.8201E-0.	1.0109E+00	1.0015E-02

ENERGY STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	LOSS TO PAIR PRODUCTION	LOSS TO COMPTON	ENERGY LOST PER PHOTON
9.4927E-01	0.	0.	4.5810E-01	4.6079E-02	7.5579E-02	3.6976E-01	9.4952E-01

TOTAL CELL DEPOSITION DATA

CELL	NO. OF PHOTONS CAPTURED	RELATIVE ERROR	PHOTONS LOST TO E. C.	RELATIVE ERROR	PHOTONS CREATING A PAIR	RELATIVE ERROR
1	8.1522E-02	.07515	0.	0.00000	3.2826E-05	.99997
2	2.2121E-01	.02873	0.	0.00000	3.0001E-03	.09011
3	3.0329E-04	.11911	0.	0.00000	6.6745E-05	.29904
4	3.8187E-03	.06469	0.	0.00000	4.0923E-04	.14216
5	4.1135E-03	.08293	0.	0.00000	2.3853E-04	.34452
6	1.0464E-04	.06649	0.	0.00000	5.1427E-05	.24845
7	4.4541E-02	.02894	0.	0.00000	4.4203E-04	.09592
8	3.7848E-05	.08150	0.	0.00000	9.5741E-06	.39062
9	6.6745E-03	.04684	0.	0.00000	4.9783E-05	.21265
10	2.7522E-05	.07954	0.	0.00000	1.1762E-05	.26350
11	4.5063E-03	.05042	0.	0.00000	4.4039E-05	.20254
12	2.8438E-04	.06276	0.	0.00000	2.3935E-05	.16453
13	2.9468E-03	.04972	0.	0.00000	2.6670E-05	.20258
14	1.9177E-03	.04724	0.	0.00000	1.5933E-05	.22117
15	1.3922E-04	.29524	0.	0.00000	0.	0.00000
16	3.9648E-02	.05115	0.	0.00000	6.8930E-04	.23412
17	7.4677E-05	.17035	0.	0.00000	0.	0.00000
18	6.9669E-03	.12202	0.	0.00000	7.8779E-05	.74531
19	9.6583E-03	.09391	0.	0.00000	1.1160E-04	.50252
20	2.0554E-04	.17803	0.	0.00000	5.2521E-05	.70706
21	1.1877E-03	.07363	0.	0.00000	1.5756E-04	.52698
22	1.5082E-03	.04141	0.	0.00000	1.6741E-04	.13956
23	2.0537E-04	.08382	0.	0.00000	1.5319E-05	.41025
24	1.3118E-04	.07565	0.	0.00000	9.8477E-06	.43026
25	9.5131E-05	.08870	0.	0.00000	1.5592E-05	.37496
26	2.0029E-02	.07540	0.	0.00000	2.8209E-04	.34407
27	9.0121E-02	.03379	0.	0.00000	1.6403E-03	.15177
28	1.1179E-01	.02291	0.	0.00000	1.7879E-03	.06798
29	1.4275E-02	.04865	0.	0.00000	3.0622E-04	.17391
30	1.3966E-02	.03950	0.	0.00000	2.7832E-04	.13183
31	0.	0.00000	0.	0.00000	0.	0.00000
32	0.	0.00000	0.	0.00000	0.	0.00000

CELL	ENERGY LOST TO CAPTURE	RELATIVE ERROR	ENERGY LOST TO ENERGY CUTOFF	RELATIVE ERROR	ENERGY LOST TO PAIR PRODUCTION	RELATIVE ERROR	ENERGY LOST TO COMPTON	RELATIVE ERROR	TOTAL ENERGY DEPOSITED
1	4.3689E-04	.07865	0.	0.00000	8.2325E-05	.99997	4.3963E-03	.15966	4.9155E-03
2	1.0598E-02	.02500	0.	0.00000	2.2190E-02	.10595	1.0578E-01	.02738	1.3857E-01
3	1.4858E-05	.08762	0.	0.00000	3.9596E-04	.37726	8.7841E-03	.05674	9.1949E-03
4	2.0721E-04	.04578	0.	0.00000	3.2145E-03	.16079	3.4980E-02	.02808	3.8382E-02
5	2.2909E-04	.06546	0.	0.00000	1.2986E-03	.36066	4.1312E-02	.05329	4.2440E-02
6	5.1039E-06	.04896	0.	0.00000	4.2433E-04	.27651	7.9584E-03	.04048	8.3879E-03
7	2.7939E-03	.02532	0.	0.00000	3.3870E-03	.11234	1.7818E-02	.02757	2.3999E-02
8	1.7223E-06	.06305	0.	0.00000	5.0400E-05	.52863	1.9998E-03	.05997	2.0519E-03
9	3.9568E-04	.04202	0.	0.00000	3.2247E-04	.26287	1.8510E-03	.06240	2.5691E-03
10	1.1959E-06	.05949	0.	0.00000	9.9118E-05	.30708	1.2319E-03	.06087	1.3322E-03
11	2.6364E-04	.04532	0.	0.00000	3.3534E-04	.21881	1.2255E-03	.07806	1.8245E-03
12	1.1560E-05	.05026	0.	0.00000	1.8296E-04	.19477	2.5122E-03	.04520	2.7067E-03
13	1.6884E-04	.04478	0.	0.00000	2.2817E-04	.23491	8.2779E-04	.07849	1.2248E-03
14	1.0444E-04	.04341	0.	0.00000	1.1713E-04	.28156	5.0268E-04	.06835	7.2426E-04
15	8.3743E-06	.22727	0.	0.00000	0.	0.00000	9.1204E-04	.23854	9.2041E-04
16	2.4905E-03	.04643	0.	0.00000	5.1666E-03	.27279	1.5602E-02	.09110	2.3259E-02
17	4.6010E-06	.15346	0.	0.00000	0.	0.00000	9.1833E-04	.67083	9.2293E-04
18	4.4008E-04	.10718	0.	0.00000	8.0499E-04	.83582	3.1199E-03	.19197	4.3649E-03
19	6.9260E-04	.08573	0.	0.00000	6.1202E-04	.52578	4.3922E-03	.16176	5.6669E-03
20	1.2555E-05	.14099	0.	0.00000	3.1355E-04	.76760	3.4141E-03	.22877	3.7402E-03
21	7.5404E-05	.06241	0.	0.00000	1.4675E-03	.55960	1.3137E-02	.09301	1.4680E-02
22	9.2902E-05	.03269	0.	0.00000	1.3969E-03	.16180	1.7095E-02	.02758	1.8585E-02
23	1.2647E-05	.06389	0.	0.00000	5.4778E-05	.43355	2.2271E-03	.07823	2.2945E-03
24	8.0902E-06	.06193	0.	0.00000	8.5077E-05	.47527	1.2756E-03	.07110	1.3688E-03
25	5.7691E-06	.07468	0.	0.00000	1.2375E-04	.45343	1.1780E-03	.10718	1.3075E-03
26	2.2981E-03	.07494	0.	0.00000	1.8213E-03	.41876	6.6010E-03	.12897	1.0720E-02
27	9.9832E-03	.03363	0.	0.00000	1.2950E-02	.18098	2.9907E-02	.07208	5.2840E-02
28	1.1812E-02	.02172	0.	0.00000	1.3738E-02	.08013	2.9886E-02	.03307	5.5436E-02
29	1.5087E-03	.04781	0.	0.00000	2.4825E-03	.20737	4.3753E-03	.08605	8.3665E-03
30	1.4310E-03	.03859	0.	0.00000	2.2340E-03	.15985	4.5582E-03	.06400	8.2233E-03
31	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.
32	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.

NUMBER OF PHOTONS CROSSING SURFACE

TIME 0. 1.0000E+02

COSINE 1.0000E+00 8.0000E-01

	SURFACE 1			SURFACE 10	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	6.59248E-04	.99582	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	9.00676E-03	.20335	3.40383E-06 .59557	0. 0.00000	0. 0.00000
1.0000E+00	4.16958E-01	.01662	2.83541E-02 .06075	7.30967E-03 .03923	3.36233E-04 .07181
5.0000E+00	2.55887E-02	.02838	0. 0.00000	7.72283E-04 .08840	0. 0.00000
1.4000E+01	2.46586E-02	.03076	0. 0.00000	6.26696E-04 .11990	0. 0.00000
	SURFACE 11			SURFACE 14	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E+00	1.18778E-02	.04290	0. 0.00000	1.43455E-01 .02505	0. 0.00000
5.0000E+00	2.33315E-03	.06362	0. 0.00000	1.89052E-02 .03610	0. 0.00000
1.4000E+01	2.27043E-03	.07842	0. 0.00000	1.66841E-02 .04058	0. 0.00000

COSINE 8.0000E-01 6.0000E-01

	SURFACE 1			SURFACE 10	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	4.37712E-04	.70700	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	6.70838E-03	.26497	3.24215E-06 .46213	0. 0.00000	0. 0.00000
1.0000E+00	2.57052E-01	.02167	2.62112E-02 .06533	2.31611E-03 .04133	3.42202E-04 .07177
5.0000E+00	1.45636E-02	.03790	0. 0.00000	3.38513E-05 .12660	0. 0.00000
1.4000E+01	1.54062E-02	.04015	0. 0.00000	0. 0.00000	0. 0.00000
	SURFACE 11			SURFACE 14	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E+00	4.38217E-03	.07030	0. 0.00000	2.31599E-02 .05276	0. 0.00000
5.0000E+00	4.57348E-04	.13805	0. 0.00000	2.47624E-03 .08110	0. 0.00000
1.4000E+01	2.99806E-04	.20642	0. 0.00000	2.03955E-03 .09913	0. 0.00000

COSINE 6.0000E-01 4.0000E-01

	SURFACE 1			SURFACE 10	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	2.18838E-04	.99997	1.47249E-08 .99997	0. 0.00000	0. 0.00000
1.0000E-02	6.42234E-03	.26165	2.94011E-06 .50438	0. 0.00000	0. 0.00000
1.0000E+00	1.36099E-01	.03098	1.87816E-02 .07436	1.26625E-03 .04833	2.75049E-04 .07556
5.0000E+00	7.52801E-03	.05226	0. 0.00000	1.98310E-06 .37922	0. 0.00000
1.4000E+01	7.57178E-03	.05554	0. 0.00000	0. 0.00000	0. 0.00000
	SURFACE 11			SURFACE 14	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E+00	1.68032E-03	.08302	0. 0.00000	4.30755E-03 .13695	0. 0.00000
5.0000E+00	5.15016E-05	.39074	0. 0.00000	1.20241E-04 .31433	0. 0.00000
1.4000E+01	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000

COSINE 4.0000E-01 2.0000E-01

	SURFACE 1			SURFACE 10	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	2.87586E-03	.38043	3.11550E-07 .99997	0. 0.00000	0. 0.00000
1.0000E+00	5.91457E-02	.04659	1.28729E-02 .09584	5.83930E-04 .06723	2.33525E-04 .08484
5.0000E+00	2.56040E-03	.09209	0. 0.00000	0. 0.00000	0. 0.00000
1.4000E+01	2.70483E-03	.09723	0. 0.00000	0. 0.00000	0. 0.00000
	SURFACE 11			SURFACE 14	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E+00	9.23317E-04	.13678	0. 0.00000	2.44868E-04 .63292	0. 0.00000
5.0000E+00	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.4000E+01	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000

COSINE 2.0000E-01 0.

	SURFACE 1			SURFACE 10	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	8.76629E-04	.78938	1.27858E-06 .59272	0. 0.00000	0. 0.00000
1.0000E+00	1.18269E-02	.10349	4.28770E-03 .15300	1.63928E-04 .10023	1.07105E-04 .12071
5.0000E+00	4.33298E-04	.21197	0. 0.00000	0. 0.00000	0. 0.00000
1.4000E+01	3.93908E-04	.24431	0. 0.00000	0. 0.00000	0. 0.00000
	SURFACE 11			SURFACE 14	
ENERGY	- TO + REL. ERROR		+ TO - REL. ERROR	- TO + REL. ERROR	+ TO - REL. ERROR
5.0000E-03	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E-02	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.0000E+00	2.62914E-04	.24313	0. 0.00000	0. 0.00000	0. 0.00000
5.0000E+00	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000
1.4000E+01	0.	0.00000	0. 0.00000	0. 0.00000	0. 0.00000

NUMBER FLUX INTEGRATED OVER SURFACE

TIME 0. 1.0000E-02

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	7.13623E-02	.06881
5.0000E+00	3.14198E-03	.11031
1.4000E+01	2.75183E-03	.11993

TIME 1.0000E-01 1.0000E+00

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	3.53516E-02	.13097
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

PATH LENGTH/VOLUME

TIME 0. 1.0000E-02

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	6.54472E-07	.62693
5.0000E-01	1.94296E-06	.24094
1.0000E+00	2.30589E-06	.20131
5.0000E+00	3.67115E-07	.24633
1.4000E+01	6.84187E-07	.19826

TIME 1.0000E-02 1.0000E-01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	3.69732E-04	.06933
5.0000E-01	7.41841E-04	.03800
1.0000E+00	2.75035E-04	.05033
5.0000E+00	5.95909E-05	.05718
1.4000E+01	5.85952E-05	.06339

TIME 1.0000E-01 1.0000E+00

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	1.62643E-04	.08364
5.0000E-01	2.94410E-05	.14224
1.0000E+00	3.61612E-07	.63191
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	0.	0.00000
5.0000E-01	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

NUMBER FLUX AT DETECTOR

TIME 0. 1.0000E-02

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	1.64654E-05	.03184
5.0000E+00	3.37327E-06	.03660
1.4000E+01	3.07799E-06	.03312

TIME 1.0000E-01 1.0000E+00

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	1.41465E-05	.03793
5.0000E+00	1.63145E-07	.21329
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TAPE DUMP NO. 2 NPS= 15232

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17.04.37 $HNTR      JOB CARD READ WITH NO ERRORS
17.04.48 *LOS  01 CARDS      800208
17.04.50 $HNTR    READY.  JOB READY TO BE SCHEDULED.
17.09.19 $HNTR  00  CROS 1.02 72/12/06  BACH. 14              TAPE
         SY760073
17.29.20 $UNTR      .USER MONITOR  OF   11/02/72  INITIALIZED.
17.29.20 $UNTR      .JOB NAME=SCHRANDIDA;DATE =     72/12/06
17.29.20 *CCP   00  $JOB(NAME=SCHRANDT;CAT=05;CL=U;AC=V66;UA=94066C08QN
                    CO;PN=10;PL=30;TL=5M)
17.29.20 $UNTR      .FILE SET CCD      OPENED;BUFFER LENGTH =000011008;
17.29.20 $UNTR      .FILE SET INP      OPENED;BUFFER LENGTH =000010008;
17.29.20 *CCP       $. INITIATE AND RUN.
17.29.20 *CCP       $LABEL(STAGE)
17.29.20 *CCP   1   $CREATE(FS=CODETP;CL=U;PRENT=XX008216)
17.29.20 *CCP   2   $OPEN(FS=DUMMY;SCT=20000)
17.29.20 $UNTR      .FILE SET DUMMY    OPENED;BUFFER LENGTH =000032100;
17.29.21 *CCP   3   $COPY(I=CODETP;O=DUMMY)
17.29.21 $UNTR      .FILE SET CODETP   OPENED;BUFFER LENGTH =000032100;
17.29.21 $HNTR      ROLLOUT STARTED
17.29.21 $HNTR      ROLLOUT DONE
17.41.27 *LOS   05  XX008216 IS ON UNIT 2  FILE CODETP       800  BIN
17.56.01 $HNTR       ROLLIN STARTED
17.56.02 $HNTR       ROLLIN DONE
17.56.03 *CCP   4   $IF(FALSE=READY)
17.56.03 *CCP       $LABEL(READY)
17.56.03 *CCP   5   $AFSREL(FS=DUMMY)
17.56.03 $UNTR      .FILE SET DUMMY    CLOSED;BUFFER LENGTH =000032100;
17.56.03            .FILE SET STATISTICS
17.56.03            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
17.56.03             000000000 000000161 000000000 000000000 000000011
17.56.03            .      LWA=0000151306;DEVICE=03
17.56.03 *CCP   6   $REWIND(CODETP)
17.56.04 *CCP   7   $RUN(C=SX;U=RUNTP)
17.56.04 $UNTR      .FILE SET RUNTP    OPENED;BUFFER LENGTH =000032100;
17.56.04 $UNTR      .FILE SET OUT      OPENED;BUFFER LENGTH =000032100;
17.56.04 $RUN       .FIELD LENGTH IS =  051076
17.56.04 $RUN       .RUN=LCH69            CTIME 000.259 SEC.
17.56.04 *CCP   8   $COPYF(I=CODETP;O=RUNTP)
17.56.05 *CCP   9   $SETQ(KEY=KKTB)
17.56.05 *CCP  10   $SETQ.
17.56.05 *CCP  11   $LDGO(I=CODETP)
17.56.08  INCGPRS   .END
17.56.08 $UNTR      .FILE SET IMAGE    OPENED;BUFFER LENGTH =000064100;
17.56.08 $UNTR      .FILE SET IMAGE    CLOSED;BUFFER LENGTH =000064100;
17.56.08            .FILE SET STATISTICS
17.56.08            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
17.56.08             000000000 000040003 000000001 000000000 000000004
17.56.08            .      LWA=0000147515;DEVICE=03
17.56.08 *CCP  12   $IF(FALSE=RUN)
17.56.08 *CCP       $LABEL(RUN)
17.56.08 *CCP  13   $AFSREL(FS=CODETP)
17.56.08 $UNTR      .FILE SET CODETP   CLOSED;BUFFER LENGTH =000032100;
17.56.08            .FILE SET STATISTICS
17.56.08            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
17.56.08             000000331 000000000 000000001 000000014 000000006
17.56.08            .      LWA=0000151306;DEVICE=01
17.56.09 *CCP  14   $SETQ(KEY=KKTB)
17.56.09 *CCP  15   $SETQ.
17.56.09 *CCP  16   $LDGO(I=RUNTP)
18.27.38  HCGPRS    .END
18.27.38 $UNTR      .FILE SET IMAGE    OPENED;BUFFER LENGTH =000064100;
18.27.38 $UNTR      .FILE SET IMAGE    CLOSED;BUFFER LENGTH =000064100;
18.27.38            .FILE SET STATISTICS
18.27.38            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.27.39             000000000 000000003 000000001 000000001 000000004
18.27.39            .      LWA=0000147515;DEVICE=03
18.27.39 *LCP  17   $IF(FALSE=TAPE)
18.27.39 *CCP       $LABEL(TAPE)
18.27.39 *CCP  18   $AFSREL(FS=RUNTP;DISP=TAPE)
18.27.39 $UNTR      .FILE SET RUNTP    CLOSED;BUFFER LENGTH =000032100;
18.27.39            .FILE SET STATISTICS
18.27.39            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.27.39             000000025 000000026 000000003 000000005 000000012
18.27.39            .      LWA=0000152555;DEVICE=03
18.27.39 $CCP       .EOF OR EOI ON CC FILE.  FSET=CCD
18.27.39 $UNTR      .FILE SET CCD      CLOSED;BUFFER LENGTH =000011008;
18.27.39            .FILE SET STATISTICS
18.27.39            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.27.39             000000071 000000037 000000034 000000000 000000000
18.27.39            .      LWA=0000000000;DEVICE=00
18.27.39 $UNTR      .FILE SET INP      CLOSED;BUFFER LENGTH =000010100;
18.27.39            .FILE SET STATISTICS
18.27.39            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.27.39             000000223 000000223 000000001 000000000 000000008
18.27.39            .      LWA=0000000000;DEVICE=00
18.27.39 $UNTR      .FILE SET OUT      CLOSED;BUFFER LENGTH =000032100;
18.27.39            .FILE SET STATISTICS
18.27.39            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.27.39             000000000 000001456 000000000 000000000 000000002
18.27.39            .      LWA=0000021664;DEVICE=03
18.27.39 $UNTR  99  .JOB TERMINATION.
                    .ELAPSED  CP TIME =  00288.25747
                    .ESTIMATED JOB COST $0036.03
18.28.57 $OUTPUT    FS=OUT     DSP=PRT        9141 WORDS       13 PAGES
18.31.11 *LOS   06  XX003024 IS ON UNIT 3  FILE RUNTP        800  BIN
18.31.16 $OUTPUT    FS=RUNTP   DSP=TAPE       54638 WORDS

FILE COMPLETE   SCHRANDIDA 1
```

CORE MAP ********** DATE= 72/12/08 **** TIME= 20.26.31 ********** NORMAL LOAD **********

	FWA	LWA	BLNK COM	LENGTH
CODE	000100	130373	030243	100131
LOADER	143602	158071		
TABLES	143601	140067		

FILE	PROGRAM	ADDRESS	NAMED COMMON	ADDRESS	LCM BLOCK	ADDRESS
RUNTP						
	SOURCE	005453	01	000100		
			DXCOM	000142		
			02	000216		
	MCGPRS	005622	01	000100		
			03	005617		
			DXCOM	000142		
			02	000216		
	DBPNT	016164	01	000100		
			03	005617		
			DXCOM	000142		
			02	000216		
	FRN	016533	01	000100		
			03	005617		
			DXCOM	000142		
			02	000216		
	IRN	016561	01	000100		
			03	005617		
			DXCOM	000142		
			02	000216		
SYSLIB						
	ACGOER	016607	RBAREX	022321		
	BACKSP	016621	SORT	022400		
	BUFFEI	016650	ABORT	022456		
	BUFFEO	016771	BS4020	022527		
	CLOCKF	017053	C4020	023307		
	DMPXX	017156	ENTR	023403		
	ENDFIL	017720	GETBA	023437		
	INPUTC	017734	IOUTIL	023473		
	IOCHEK	020110	KODER	024764		
	LENGTH	020134	KRAKER	026261		
	LOCF	020154	LABRT	027322		
	OUTPTC	020166	MEMORY	027430		
	PACKAGE	020324	OUTPTS	027610		
	SETB	020411	REMARK	027701		
	SSWTCH	020632	RETN	027734		
	SYSTEM	020720	SKIPR	027764		
	XIT	021756	SHIFT	030036		
	ALNLOG	022075	BOI	030053		
	EXP	022164	PSCALE	030117		
	IRAIEX	022237	N2035R	030124		
	RRAIEX	022270				

UNSATISFIED EXTERNALS		REFERENCED BY		AT LOCATION					
SRCDX		MCGPRS	006624						

MCG TEST PROBLEM

SOURCE NO.	TIME CUTOFF	WT. CUTOFF 1	RUN TIME	D.P. CYCLE	DUMP CYCLE	DUMP NO.	CUTOFF CYCLE	WT. CUTOFF 2
7	1.0000E+02	1.0000E-03	4.9000E+00	0000	50000	-0	-0	1.0000E-04

TIME= 9.178 MINUTES

NUMBER OF PHOTONS STARTED	TOTAL NUMBER OF COLLISIONS	RANDOM NUMBERS GENERATED	TOTAL WEIGHT STARTED	TOTAL ENERGY STARTED	COLLISIONS PER PHOTON STARTED	TRACKS PER PHOTON STARTED	PHOTONS PROCESSED PER MINUTE	
30100	543978	3710883	3.0165E+04	2.8040E+04	1.8072E+01	6.3290E+00	3.2097E+03	
TOTAL TRACKS STARTED	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO WEIGHT CUTOFF	LOSS TO ESCAPE	LOSS TO SPLITTING	TOTAL TRACKS LOST		
190504	0	6	29762	42723	118019	190504		
WEIGHT STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF		LOSS TO ESCAPE	LOSS TO CAPTURE	WEIGHT LOST PER PHOTON		PAIR PRODUCTION PER PHOTON
1.0022E+00	0.	0.		3.2723E-01	6.8512E-01	1.0124E+00		9.3670E-03
ENERGY STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF		LOSS TO ESCAPE	LOSS TO CAPTURE	LOSS TO PAIR PRODUCTION	LOSS TO COMPTON	ENERGY LOST PER PHOTON
9.3157E-01	0.	0.		4.4510E-01	4.6489E-02	6.9519E-02	3.6607E-01	9.2718E-01

TOTAL CELL DEPOSITION DATA

CELL	NO. OF PHOTONS CAPTURED	RELATIVE ERROR	PHOTONS LOST TO E. C.	RELATIVE ERROR	PHOTONS CREATING A PAIR	RELATIVE ERROR
1	7.8183E-02	.05366	0.	0.00000	2.1041E-05	.81704
2	2.2189E-01	.02055	0.	0.00000	2.5757E-03	.06946
3	2.8466E-04	.07844	0.	0.00000	7.6412E-05	.20564
4	3.8581E-03	.04000	0.	0.00000	4.0919E-04	.09983
5	3.9917E-03	.05428	0.	0.00000	3.9646E-04	.21014
6	1.0429E-04	.04376	0.	0.00000	4.8173E-05	.18000
7	4.6101E-02	.02003	0.	0.00000	5.0330E-04	.06404
8	3.8055E-05	.05156	0.	0.00000	1.1351E-05	.25978
9	6.7975E-03	.03187	0.	0.00000	5.8829E-05	.13387
10	2.8444E-05	.05220	0.	0.00000	1.0244E-05	.20262
11	4.5461E-03	.03527	0.	0.00000	4.0834E-05	.15915
12	2.9120E-04	.04158	0.	0.00000	2.5055E-05	.11182
13	3.0126E-03	.03606	0.	0.00000	2.6784E-05	.14695
14	2.0223E-03	.03231	0.	0.00000	1.5641E-05	.14486
15	1.6314E-04	.15233	0.	0.00000	0.	0.00000
16	3.6722E-02	.03548	0.	0.00000	5.2378E-04	.18450
17	6.4943E-05	.15092	0.	0.00000	0.	0.00000
18	6.7529E-03	.08250	0.	0.00000	7.9731E-05	.52702
19	1.1120E-02	.06267	0.	0.00000	1.1295E-04	.39236
20	2.2071E-04	.11248	0.	0.00000	2.6578E-05	.70708
21	1.1916E-03	.07268	0.	0.00000	1.7276E-04	.32994
22	1.5921E-03	.03125	0.	0.00000	2.0570E-04	.09292
23	2.1881E-04	.05449	0.	0.00000	1.7719E-05	.28805
24	1.4552E-04	.05306	0.	0.00000	1.4258E-05	.23515
25	9.0885E-05	.06044	0.	0.00000	1.5781E-05	.26045
26	2.0615E-02	.05354	0.	0.00000	3.0538E-04	.23906
27	9.1620E-02	.02417	0.	0.00000	1.3680E-03	.11498
28	1.1305E-01	.01628	0.	0.00000	1.7426E-03	.04748
29	1.5467E-02	.03408	0.	0.00000	2.4793E-04	.12919
30	1.4945E-02	.02819	0.	0.00000	3.1489E-04	.09144
31	0.	0.00000	0.	0.00000	0.	0.00000
32	0.	0.00000	0.	0.00000	0.	0.00000

CELL	ENERGY LOST TO CAPTURE	RELATIVE ERROR	ENERGY LOST TO ENERGY CUTOFF	RELATIVE ERROR	ENERGY LOST TO PAIR PRODUCTION	RELATIVE ERROR	ENERGY LOST TO COMPTON	RELATIVE ERROR	TOTAL ENERGY DEPOSITED
1	4.2208E-04	.05686	0.	0.00000	6.5809E-05	.73169	4.7357E-03	.10552	5.2236E-03
2	1.0616E-02	.01771	0.	0.00000	1.8657E-02	.08208	1.0549E-01	.01935	1.3497E-01
3	1.4331E-05	.05880	0.	0.00000	5.8060E-04	.24369	9.0162E-03	.03930	9.6112E-03
4	2.1204E-04	.02987	0.	0.00000	3.1944E-03	.11463	3.4943E-02	.01984	3.8349E-02
5	2.2464E-04	.04305	0.	0.00000	2.7433E-03	.25993	3.9725E-02	.03676	4.2693E-02
6	5.1738E-06	.03260	0.	0.00000	3.7013E-04	.20577	8.1212E-03	.02757	8.4965E-03
7	2.8905E-03	.01769	0.	0.00000	3.9728E-03	.07589	1.7692E-02	.01958	2.4555E-02
8	1.7740E-06	.04036	0.	0.00000	6.6915E-05	.33980	2.0854E-03	.03861	2.1541E-03
9	4.0679E-04	.02869	0.	0.00000	4.2738E-04	.16198	2.0170E-03	.04527	2.8512E-03
10	1.2618E-06	.03929	0.	0.00000	8.3043E-05	.23643	1.2501E-03	.04109	1.3344E-03
11	2.6778E-04	.03192	0.	0.00000	3.1820E-04	.18209	1.2510E-03	.05536	1.8370E-03
12	1.1949E-05	.03379	0.	0.00000	1.8774E-04	.13523	2.5207E-03	.03206	2.7204E-03
13	1.7283E-04	.03293	0.	0.00000	2.1832E-04	.17757	8.7429E-04	.05765	1.2654E-03
14	1.0958E-04	.02991	0.	0.00000	1.1002E-04	.18706	5.0618E-04	.04989	7.2578E-04
15	9.8412E-06	.12054	0.	0.00000	0.	0.00000	1.5300E-03	.25256	1.5399E-03
16	2.3636E-03	.03215	0.	0.00000	3.8886E-03	.21063	1.5295E-02	.05922	2.1547E-02
17	3.9638E-06	.13077	0.	0.00000	0.	0.00000	7.3275E-04	.43925	7.3671E-04
18	4.3623E-04	.07267	0.	0.00000	8.2566E-04	.57931	2.7975E-03	.12303	4.0594E-03
19	7.4526E-04	.05793	0.	0.00000	7.3522E-04	.46095	4.8733E-03	.11355	6.3538E-03
20	1.4195E-05	.09103	0.	0.00000	1.5867E-04	.70762	3.2290E-03	.13988	3.4018E-03
21	7.5153E-05	.05320	0.	0.00000	1.4879E-03	.37905	1.3484E-02	.06490	1.5047E-02
22	9.7362E-05	.02365	0.	0.00000	1.6565E-03	.10521	1.7187E-02	.02026	1.8961E-02
23	1.3461E-05	.04315	0.	0.00000	9.8396E-05	.36408	2.3105E-03	.05499	2.4223E-03
24	8.7663E-06	.04289	0.	0.00000	1.0464E-04	.27328	1.3509E-03	.05052	1.4643E-03
25	5.5294E-06	.04984	0.	0.00000	1.2901E-04	.29927	1.2022E-03	.06820	1.3388E-03
26	2.2970E-03	.05281	0.	0.00000	1.8435E-03	.28797	6.7110E-03	.09631	1.0852E-02
27	9.9816E-03	.02419	0.	0.00000	1.0163E-02	.13621	2.6050E-02	.04896	4.6195E-02
28	1.1920E-02	.01559	0.	0.00000	1.3004E-02	.05565	3.0174E-02	.02334	5.5098E-02
29	1.6104E-03	.03312	0.	0.00000	1.9485E-03	.15517	4.4189E-03	.06153	7.9777E-03
30	1.5502E-03	.02755	0.	0.00000	2.4796E-03	.10956	4.2915E-03	.04468	8.3214E-03
31	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.
32	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.

NUMBER OF PHOTONS CROSSING SURFACE

TIME 0. 1.0000E+02

COSINE 1.0000E+00 8.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	4.44356E-04	.78808	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	1.01770E-02	.14102	3.96398E-06	.44402	0.	0.00000	0.	0.00000
1.0000E+00	4.13039E-01	.01178	2.64865E-02	.04491	7.27895E-03	.02762	3.44461E-04	.04985
5.0000E+00	2.52348E-02	.02031	0.	0.00000	7.59681E-04	.06270	0.	0.00000
1.4000E+01	2.39380E-02	.02192	0.	0.00000	6.01329E-04	.08670	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	1.21601E-02	.03073	0.	0.00000	1.41524E-01	.01771	0.	0.00000
5.0000E+00	2.31345E-03	.04527	0.	0.00000	1.85479E-02	.02594	0.	0.00000
1.4000E+01	2.10381E-03	.05529	0.	0.00000	1.63763E-02	.02891	0.	0.00000

COSINE 8.0000E-01 6.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	3.32498E-04	.57685	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	7.34345E-03	.18029	3.23957E-06	.36957	0.	0.00000	0.	0.00000
1.0000E+00	2.59763E-01	.01549	2.54493E-02	.04770	2.37388E-03	.02916	3.38284E-04	.05092
5.0000E+00	1.42669E-02	.02740	0.	0.00000	3.12497E-05	.09437	0.	0.00000
1.4000E+01	1.46489E-02	.02852	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	4.80514E-03	.05014	0.	0.00000	2.47377E-02	.03742	0.	0.00000
5.0000E+00	5.35661E-04	.10091	0.	0.00000	2.38669E-03	.05806	0.	0.00000
1.4000E+01	3.33328E-04	.13738	0.	0.00000	1.90032E-03	.06855	0.	0.00000

COSINE 6.0000E-01 4.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	5.53710E-04	.66330	7.45146E-09	.99998	0.	0.00000	0.	0.00000
1.0000E-02	4.93303E-03	.20075	1.49250E-06	.50285	0.	0.00000	0.	0.00000
1.0000E+00	1.40744E-01	.02174	1.77135E-02	.05290	1.30903E-03	.03398	2.84206E-04	.05422
5.0000E+00	7.31340E-03	.03798	0.	0.00000	2.66471E-06	.25870	0.	0.00000
1.4000E+01	7.67663E-03	.03918	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	1.80318E-03	.05927	0.	0.00000	4.32093E-03	.08878	0.	0.00000
5.0000E+00	7.21865E-05	.26763	0.	0.00000	1.02905E-04	.24634	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000

COSINE 4.0000E-01 2.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	2.23821E-03	.32818	1.70251E-07	.92897	0.	0.00000	0.	0.00000
1.0000E+00	6.07369E-02	.03338	1.29940E-02	.06746	6.16135E-04	.04398	2.39784E-04	.05900
5.0000E+00	2.74640E-03	.06386	3.65432E-05	.75269	1.38427E-07	.99998	0.	0.00000
1.4000E+01	2.55592E-03	.06827	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	8.50837E-04	.09367	0.	0.00000	3.04798E-04	.42215	0.	0.00000
5.0000E+00	5.51576E-06	.99998	0.	0.00000	0.	0.00000	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000

COSINE 2.0000E-01 0.

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	1.10742E-04	.99998	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	4.45192E-04	.78661	6.47021E-07	.59275	0.	0.00000	0.	0.00000
1.0000E+00	1.14033E-02	.07299	4.78145E-03	.10457	1.90695E-04	.07209	1.05521E-04	.09210
5.0000E+00	4.35216E-04	.15019	0.	0.00000	0.	0.00000	0.	0.00000
1.4000E+01	3.85382E-04	.17155	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	2.18563E-04	.16192	0.	0.00000	0.	0.00000	0.	0.00000
5.0000E+00	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000

NUMBER FLUX INTEGRATED OVER SURFACE

TIME 0. 1.0000E-02

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	7.15477E-02	.04836
5.0000E+00	3.34688E-03	.07444
1.4000E+01	2.79994E-03	.08408

TIME 1.0000E-01 1.0000E+00

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	3.79357E-02	.08376
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

PATH LENGTH/VOLUME

TIME 0. 1.0000E-02

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	6.27306E-07	.47126
5.0000E-01	2.45558E-06	.16268
1.0000E+00	2.93519E-06	.12496
5.0000E+00	4.74810E-07	.15388
1.4000E+01	4.06218E-07	.14615

TIME 1.0000E-02 1.0000E-01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	1.91645E-04	.04758
5.0000E-01	7.55486E-04	.02704
1.0000E+00	2.73593E-04	.03600
5.0000E+00	5.93950E-05	.04068
1.4000E+01	5.78128E-05	.04498

TIME 1.0000E-01 1.0000E+00

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	1.58796E-04	.06097
5.0000E-01	3.00687E-05	.10717
1.0000E+00	9.54413E-07	.51550
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	0.	0.00000
5.0000E-01	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

NUMBER FLUX AT DETECTOR

TIME 0. 1.0000E-02

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	1.69688E-05	.02373
5.0000E+00	3.27198E-06	.02565
1.4000E+01	3.03619E-06	.02687

TIME 1.0000E-01 1.0000E+00

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	1.38177E-05	.02606
5.0000E+00	1.37695E-07	.14637
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TAPE DUMP NO. 3 NPS= 30100

```
20.25.51 $BMTR      JOB CARD READ WITH NO ERRORS
20.25.51 *LOS   01 CARDS          000030B
20.25.53 $BMTR      READ.  JOB READY TO BE SCHEDULED.
20.25.55 $BMTR  00  CROS 1.82 72/12/06  MACH. 14              TAPE
         SY760073
20.25.56 $UMTR      .USER MONITOR  OF    11/02/72  INITIALIZED.
20.25.56 $UMTR      .JOB NAME=SCMRAND1VI.DATE =      72/12/08
20.25.56 *CCP   00  $JOB(NAME=SCMRANDT,CAT=05,CL=U,AC=V06,UA=9406C050M
                    CG,PR=10,PL=40,TL=5M)
20.25.56 $UMTR      .FILE SET CCD      OPENED.BUFFER LENGTH =00001100.
20.25.56 $UMTR      .FILE SET INP      OPENED.BUFFER LENGTH =00010100.
20.25.56 *CCP       $. CONTINUE RUN--MCG TEST PROBLEM.
20.25.56 *CCP       $LABEL(STAGE)
20.25.56 *CCP   1   $CREATE(FS=RUNTP,CL=U,SCT=2000,PREMT=XX003024)
20.25.57 *CCP   2   $OPEN(FS=DUMMY,SCT=2000)
20.25.57 $UMTR      .FILE SET DUMMY    OPENED.BUFFER LENGTH =00032100.
20.25.57 *CCP   3   $COPY(I=RUNTP,O=DUMMY)       TO VERIFY POINTER WORD
                    $
20.25.57 $UMTR      .FILE SET RUNTP    OPENED.BUFFER LENGTH =00032100.
20.25.57 $BMTR      ROLLOUT STARTED
20.25.58 $BMTR      ROLLOUT DONE
20.26.07 *LOS   05  XX003024 IS ON UNIT 0  FILE RUNTP        800  BIN
20.26.26 $BMTR       ROLLIN STARTED
20.26.27 $BMTR       ROLLIN DONE
20.26.28 *CCP   4   $IF(FALSE=READY)
20.26.28 *CCP       $LABEL(READY)      SUCCESSFUL STAGING
20.26.28 *CCP   5   $AFSREL(FS=DUMMY)
20.26.28 $UMTR      .FILE SET DUMMY    CLOSED.BUFFER LENGTH =00032100.
20.26.28            .FILE SET STATISTICS
20.26.28            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.26.28             000000000 000000101 000000000 000000006 000000011
20.26.28            .      LWA=0000152711.DEVICE=03
20.26.29 *CCP   6   $REWIND(RUNTP)
20.26.29 *CCP   7   $SETQ(KEY=KKTP)
20.26.29 *CCP   8   $SETQ.
20.26.29 *CCP   9   $LDGO(I=RUNTP)
20.26.31 $UMTR      .FILE SET OUT      OPENED.BUFFER LENGTH =00032100.
20.26.34 $BMTR      ROLLOUT STARTED
20.26.35 $BMTR      ROLLOUT DONE
20.27.18 $BMTR       ROLLIN STARTED
20.27.19 $BMTR       ROLLIN DONE
20.28.10 $BMTR      ROLLOUT STARTED
20.28.11 $BMTR      ROLLOUT DONE
20.29.21 $BMTR       ROLLIN STARTED
20.29.22 $BMTR       ROLLIN DONE
20.31.07 $BMTR      ROLLOUT STARTED
20.31.08 $BMTR      ROLLOUT DONE
20.31.43 $BMTR       ROLLIN STARTED
20.31.44 $BMTR       ROLLIN DONE
20.32.42 $BMTR      ROLLOUT STARTED
20.32.43 $BMTR      ROLLOUT DONE
20.32.47 $BMTR       ROLLIN STARTED
20.32.48 $BMTR       ROLLIN DONE
20.33.53  MCGPRS    .END
20.33.53 $UMTR      .FILE SET IMAGE    OPENED.BUFFER LENGTH =00064100.
20.33.53 $UMTR      .FILE SET IMAGE    CLOSED.BUFFER LENGTH =00064100.
20.33.53            .FILE SET STATISTICS
20.33.53            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.33.53             000000000 000000003 000000001 000000000 000000004
20.33.53            .      LWA=0000130676.DEVICE=03
20.33.54 *CCP  10   $IF(FALSE=TAPE)
20.33.54 *CCP       $LABEL(TAPE)
20.33.54 *CCP  11   $AFSREL(FS=RUNTP,ADISP=STAPE,POSMT=XX003024)
20.33.54 $UMTR      .FILE SET RUNTP    CLOSED.BUFFER LENGTH =00032100.
20.33.54            .FILE SET STATISTICS
20.33.54            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.33.54             000000210 000000002 000000003 000000020 000000003
20.33.54            .      LWA=0000210131.DEVICE=03
20.33.54 $CCP       .EOF OR EOI ON CC FILE.  FSET=CCD
20.33.54 $UMTR      .FILE SET CCD      CLOSED.BUFFER LENGTH =00001100.
20.33.54            .FILE SET STATISTICS
20.33.54            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.33.54             000000046 000000025 000000023 000000000 000000000
20.33.54            .      LWA=0000000000.DEVICE=00
20.33.54 $UMTR      .FILE SET INP      CLOSED.BUFFER LENGTH =00010100.
20.33.54            .FILE SET STATISTICS
20.33.54            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.33.54             000000001 000000001 000000001 000000000 000000000
20.33.54            .      LWA=0000000000.DEVICE=00
20.33.54 $UMTR      .FILE SET OUT      CLOSED.BUFFER LENGTH =00032100.
20.33.54            .FILE SET STATISTICS
20.33.54            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.33.54             000000000 000000554 000000000 000000000 000000001
20.33.54            .      LWA=0000010463.DEVICE=01
20.33.54 $UMTR  99  .JOB TERMINATION.
                    .ELAPSED  CP TIME = 00288.44490
                    .ESTIMATED JOB COST $0036.05
20.34.24 *LOS   06  XX003024 IS ON UNIT 0  FILE RUNTP        800  BIN
20.34.26 *LOS   03    RCOVERED WPE UNIT 0  FILE RUNTP
20.34.34 $OUTPUT    FS=OUT     DSP=PRT        4404 WORDS        6 PAGES
20.34.37 $OUTPUT    FS=RUNTP   DSP=TAPE      69722 WORDS

 FILE COMPLETE   SCMRAND1VI 2
```

TABLE V

SAMPLE RUN - MCP

```
      SUBROUTINE SOURCE
1       COMMON MXA,MXJ,MXS,MXF,MXFM,MXLC,LC3,IF0,MXA7,IL1,NSR,I11,I12,J11,
     A J12,K11,K12,I11,LL1,IKL1,I21,I22,J21,J22,II2,I41,I42,I51,I52,J51,
     B J52,I15,NDETX,LCO,LCP,J41,J42,II4,SRC(8),SPB(24),SWM(24),SEG(24),
     C IDY(5),JD(8),NIF(7),LDF(6),NCL(120),F10(120),ML1(120),ML2(120),LC
     D A(121),LJA(480),LCAJ(480),LAJ(960),KST(120),LSC(121),SCF(360),LCB
     E (960),LFD(6),LPR(6),IJP(60),QA(120),IFP(60),P(200),CDETX(25,3),R0
     F (25),FR0(25),VOL(120),LME(800),FRC(800),NDC,
     G NST,KRN,NRN,TWS,
     H TES,NPS,NTR,NCT,TM0,ETM(6),NTM(6),WTM(6),ECR(18000)
1       COMMON/G1/SIG,ULS,PL,OPL,PMF,DEG,CSJA,CSA,IAP,NE,NCP,KDB,
     A X,Y,Z,U,V,W,ERG,WT,TME,VL,DEL,IA,JA,NPS,USQ,VSQ,WSQ,I4F,
     B I1F,I2F,I5F,I6F
1       COMMON/G5/JQ(2),TP(25),JSF(120),SG1(120),SG2(120),TCR(13),
     A PCR(52),BNK(22,100)
1       COMMON/G3/I519,F241,F248
1       COMMON/G4/VIC(21),WCO(55),VCO(55)
1       COMMON/DXCOM/IDETX,CSDX,DDETX,DXFAC,AMFP,PBL5AV,13),LV2,LV3,
     A LV4,PSC,UOLD,VOLD,WOLD
C     UNIFORMLY DISTRIBUTED IN VOLUME IN SPECIFIED SPHERICAL CELL.
C     STARTING DIRECTION ISOTROPIC, BUT BIASED IN POSITIVE V-DIRECTION.
C     ENERGY DISTRIBUTION.
C       S7 CARD REQUIRED IN PROBLEM DECK.
C       SRC(1)=CELL NUMBER.
C       SRC(2)=RADIUS OF CELL IN CM.
C       SRC(3)=FRACTION OF NEUTRONS WHOSE STARTING DIRECTION HAS
C              POSITIVE V.
C
C       DISTANCE FROM ORIGIN SAMPLED FROM THE INTERVAL .0,SRC(2))
C       DISTRIBUTED ACCORDING TO THE DISTANCE CUBED.
1       R=SRC(2)*(FRN(KRN))**.3333333333
C       SAMPLE UNIFORMLY FROM POINTS INSIDE THE UNIT CIRCLE.
10    10 TP(1)=2.*FRN(KRN)-1.
15      TP(2)=2.*FRN(KRN)-1.
22      TP(3)=TP(1)**2+TP(2)**2
24      IF(TP(3).GT.1.) GO TO 10
C       TP(3) DISTRIBUTED UNIFORMLY ON THE INTERVAL (0,1).  TP(4) IS
C       THE COSINE OF THE POLAR ANGLE OF THE STARTING POINT.
30      TP(4)=2.*TP(3)-1.
31      TP(5)=R*SQRT(1.-TP(4)**2)/TP(3))
37      X=R*TP(4)
40      Y=TP(1)*TP(5)
41      Z=TP(2)*TP(5)
43      IF(FRN(KRN).GT.SRC(3)) GO TO 30
C       SET V POSITIVE SRC(3) OF THE TIME.
51      V=ABS(V)
52      WT=0.5/SRC(3)
54    15 IA=SRC(1)
55      JA=1
56      TME=0
57      DEL=0
60      R=FRN(KRN)
63      DO 20 I=2,6
64      IF (R .LT. SPB(I)) GO TO 25
67    20 CONTINUE
72    25 ENG=SEG(I-1)+(SEG(I)-SEG(I-1))*(R-SPB(I-1))/
       1 (SPB(I)-SPB(I-1))
100     WT=WT*SWM(I)
102     RETURN
C       SET V NEGATIVE 1-SRC(3) OF THE TIME.
103   30 V=-ABS(V)
105     WT=0.5/(1.-SRC(3))
110     GO TO 15
111     END
```

```
SUBPROGRAM LENGTH = SOURCE
   144

STATEMENT ASSIGNMENTS
STMT NO=  LOCATION      STMT NO=  LOCATION      STMT NO=  LOCATION      STMT NO=  LOCATION
10     =     11         15     =     55         25     =     72         30     =    104

BLOCK NAMES AND LENGTHS
       =   57747         01     =     42         02     =   5134         03     =      3
04     =     203         DXCOM  =     31

VARIABLE ASSIGNMENTS
NAME    =  LOCATION     NAME    =  LOCATION     NAME    =  LOCATION     NAME    =  LOCATION
BNK     =R    704C03    CDETX   =R  11106C01   DEL     =R     26C02    ECR     =R  14627C01
ERG     =R     22C02    ETM     =R  14605C01   FIO     =R    410C01    FRC     =R  13133C01
FRO     =R  11252C01    I       =I    142      IA      =I     27C02    ID      =I    173C01
IDY     =I    166C01    IFP     =I  10502C01   IJP     =I  10216C01    JA      =I     30C02
JQ      =I      0C03    JSF     =I     33C03   KRK     =I  14575C01    KST     =I   5151C01
LAJ     =I   3251C01    LCA     =I   1160C01   LCAJ    =I   2311C01    LCB     =I   6302C01
LDF     =I    212C01    LFD     =I  10202C01   LJA     =I   1351C01    LME     =I  11473C01
LPR     =I  10210C01    LSC     =I   5341C01   MLI     =I    600C01    ML2     =I    770C01
NCL     =I    220C01    NIF     =I    203C01   NTM     =I  14613C01    P       =R  10576C01
PBLSAV  =R      5C06    PCR     =R    620C03   QA      =R  10312C01    R       =R     143
RO      =R  11221C01    SCF     =R   5532C01   SEG     =R    136C01    SG1     =R    223C03
SG2     =R    413C03    SPB     =R     56C01   SRC     =R     46C01    SWM     =R    106C01
TCR     =R    603C03    TWE     =R     24C02   TP      =R      2C03    V       =R     20C02
VCO     =R    114C05    VIC     =R      0C05   VOL     =R  11303C01    WCO     =R     25C05
WT      =R     23C02    WTM     =R  14621C01   X       =R     14C02    Y       =R     15C02
Z       =R     16C02

EXTERNAL ASSIGNMENTS
FRN                      RBAREX                  SQRT

START OF  =     CONSTANTS       TEMPORARIES       INDIRECTS  =     UNUSED COMPILER SPACE
                  113               117               141               77100
```

```
CORE MAP ************** DATE= 72/12/07**** TIME= 18.25.42************** NORMAL LOAD **********************************************

                 FWA      LWA          BLNK COM  LENGTH
                 ------   ------       --------  ------
        CODE     000100   076066       016120    057747
        LOADER   143602   150071
        TABLES   143601   141761

FILE    PROGRAM  ADDRESS                NAMED COMMON  ADDRESS        LCM BLOCK  ADDRESS
------  -------  -------                ------------  -------        ---------  -------
CODETP
        IMCPPRS  002154                 C1            000100
SYSLIB
        ACGOER   006734
        BUFFEI   006746
        BUFFEO   007067
        ENDFIL   007151
        INPUTC   007165
        INPUTS   007341
        IOCHEK   007427
        LENGTH   007453
        LOCF     007473
        OUTPTC   007505
        OUTPTS   007643
        REWINN   007734
        SYSTEM   007767
        IBAIEX   011025
        BS4020   011056
        C4020    011636
        GETBA    011732
        IOUTIL   011766
        KODER    013257
        KRAKER   014554
        MEMORY   015615
        SKIPR    015775
        BOI      016047
        PSCALE   016113

        UNSATISFIED EXTERNALS   REFERENCED BY   AT LOCATION
        ---------- ----------   -------------   -----------
```

```
                                                    MCP TEST PROBLEM
  1   45 .00926   -1,2
  2   43 .0603    1,1 -2,4,5,3
  3   44 .123    2,2 -4,4 -3,6
  4   46 .1173    2,2 4,3 15,5 -3,6
  5   46 .1173    2,2 -15,4 -3,15
  6   41 .0463    3,4,3 -5,7 -7,8
  7   43 .0603    5,6 15,16 -6,22 -7,9
  8   41 .0463   -5,9 7,6 -8,10
  9   43 .0603    5,8 7,7 -6,23 -8,11
 10   41 .0463   -5,11 8,8 -9,12
 11   43 .0603    5,10 8,9 -6,24 -9,13
 12   44 .123    -5,13 9,10 -10,14
 13   43 .0603    5,12,14 9,11 -6,25 -11,32
 14   43 .0603   -5,13 10,12 -11,32
 15   45 .00926    3,5 16,17 -5,16
 16   43 .0603    5,15 16,18 -6,21 -15,7
 17   45 .00926   -5,18 17,19 -16,15
 18   43 .0603    5,17,19 18,32 -6,20 -16,16
 19   43 .0603   -5,18 18,32 -17,17
 20   46 .1173    6,18 18,32 -12,26 -16,21
 21   46 .1173    6,16 16,20 -12,27 -15,22
 22   46 .1173    6,7 15,21 -12,28 -7,23
 23   46 .1173    6,9 7,22 -12,29 -8,24
 24   46 .1173    6,11 8,23 -12,30 -9,25
 25   46 .1173    6,13 9,24 -12,30 -11,32
 26   42 .0847   12,20 18,32 -13,31 -16,27
 27   42 .0847   12,21 16,26 -13,31 -15,28
 28   42 .0847   12,22 15,27 -13,31 -7,29
 29   42 .0847   12,23 7,28 -13,31 -8,30
 30   42 .0847   12,24,25 8,29 -13,31 -11,32
 31   0    13,26,27,28,29,30 18,32 -14,32 -11,32
 32   0    14,31 -18,19,18,20,26,31 11,14,13,25,30,31

  1   SO 3.0
  2   SO 5.0
  3   SO 10.0
  4   KY 0 .3333333333
  5   CY 10.
  6   CY 11.
  7   PY 15.
  8   PY 20.
  9   PY 25.
 10   PY 30.
 11   PY 31.
 12   CY 14.
 13   CY 15.
 14   CY 26.
 15   PY 0
 16   PY -12.
 17   PY -16.
    18  PY  -18.

I0   1. 1. 2. 2. 1. 4. 4. 8. 8. 16. 8. 32. 16. 32. 1. 6R 4. 4. 8. 8.
     1. 1. 2. 2. 4. 1. 0
S7   1 3.0 .75
   F1  1   10  11  14
   E1  .005  .01  1.  5.  14.
I1   100.
C1   .8 .6 .4 .2 0
F2   17


   E2  .005  .01  1.  5.  14.
   T2  .01  .1  1.  10.
F4   3
E4   .1 .5 1.0 5.0 14.0
   T4  .01  .1  1.  10.
P4   245.52
F5   0 10. 25. 0
   E5  .005  .01  1.  5.  14.
   T5  .01  .1  1.  10.
   U0  0.  .02  .08  .2  .3  .2  .15  .05
   V0  0.  .1  .2  .3  .3  .05  .03  .02
   W0  .001  .01  .1  .5  1.  5.  10.  14.
  M41 3  1.
  M42  26  1.
  M43  13  1.
  M44  4  1.
  M45  1  25  6  25
  M46  1  2.  6  1.
```

NO. CELLS= 32

PROGRAM NAME	CELLS PROBLEM NAME	TALLY FORMULA
1	1	
2	2	
3	3	4
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	
11	11	
12	12	
13	13	
14	14	
15	15	
16	16	
17	17	
18	18	
19	19	
20	20	
21	21	
22	22	
23	23	
24	24	
25	25	
26	26	
27	27	
28	28	
29	29	
30	30	
31	31	
32	32	

NO. SURFACES= 10

PROGRAM NAME	SURFACES PROBLEM NAME	TALLY FORMULA
1	1	1
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	1
11	11	1
12	12	
13	13	
14	14	1
15	15	
16	16	
17	17	2
18	18	

CELL	AMB. SURF.	MATERIAL	DENSITY	10
1		45	9.2[illegible]0E-03	1.0000E+00
2		43	6.0300E-02	1.0000E+00
3		44	1.2[illegible]0E-01	2.0000E+00
4		46	1.1730E-01	2.0000E+00
5		46	1.1730E-01	1.0000E+00
6		41	4.6300E-02	4.0000E+00
7		43	6.0300E-02	4.0000E+00
8		41	4.6300E-02	8.0000E+00
9		43	6.0300E-02	8.0000E+00
10		41	4.6300E-02	1.6000E+01
11		43	6.0300E-02	8.0000E+00
12		44	1.2[illegible]00E-01	3.2000E+01
13		43	6.0300E-02	1.6000E+01
14		43	6.0[illegible]00E-02	3.2000E+01
15		45	9.2600E-03	1.0000E+00
16		43	6.0[illegible]00E-02	1.0000E+00
17		45	9.2600E-03	1.0000E+00
18		43	6.0[illegible]00E-02	1.0000E+00
19		43	6.0300E-02	1.0000E+00
20		46	1.1730E-01	1.0000E+00
21		46	1.1730E-01	1.0000E+00
22		46	1.1730E-01	4.0000E+00
23		46	1.1730E-01	4.0000E+00
24		46	1.1730E-01	8.0000E+00
25		46	1.1730E-01	8.0000E+00
26		42	8.4700E-02	1.0000E+00
27		42	8.4700E-02	1.0000E+00
28		42	8.4700E-02	2.0000E+00
29		42	8.4700E-02	2.0000E+00
30		42	8.4700E-02	4.0000E+00
31		0	0.	1.0000E+00
32		0	0.	0.

FORMULA 1 -- NEUTRONS CROSSING SURFACE

SURFACE	1 10	11 14			
ENERGY	5.0000E-03	1.0000E-02	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E+02				
COSINE	8.0000E-01	9.0000E-01	4.0000E-01	2.0000E-01	0.

FORMULA 2 -- FLUX INTEGRATED OVER SURFACE

SURFACE	17				
ENERGY	5.0000E-03	1.0000E-02	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E-02	1.0000E-01	1.0000E+00	1.0000E+01	

FORMULA 4 -- PATH LENGTH/VOLUME

CELL	3				
ENERGY	1.0000E-01	5.0000E-01	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E-02	1.0000E-01	1.0000E+00	1.0000E+01	
VOLUME	2.4552E+02				

FORMULA 5 -- FLUX AT DETECTOR

DETECTOR	1	X 0.	Y 1.0000E+01	Z 2.5000E+01	NEIGHBORHOOD 0.
CELL	ALL				
ENERGY	5.0000E-03	1.0000E-02	1.0000E+00	5.0000E+00	1.4000E+01
TIME	1.0000E-02	1.0000E-01	1.0000E+00	1.0000E+01	

SOURCE= 7

SRC(1)	SRC(2)	SRC(3)
1.0000E+00	3.0000E+00	7.5000E-01

N	ENERGY	CUM. PROB.	WT. MULT.
1	1.0000E-03	0.	0.
2	1.0000E-02	2.0000E-02	5.0000E+00
3	1.0000E-01	1.0000E-01	2.5000E+00
4	5.0000E-01	3.0000E-01	1.5000E+00
5	1.0000E+00	6.0000E-01	1.0000E+00
6	5.0000E+00	8.0000E-01	2.5000E-01
7	1.0000E+01	9.5000E-01	2.0000E-01
8	1.4000E+01	1.0000E+00	4.0000E-01

MATERIAL DATA

MAT. NO.	ELEM. NO.	FRACTION
41	3	1.00000
42	26	1.00000
43	13	1.00000
44	4	1.00000
45	1	.50000
	6	.50000
46	1	.66667
	6	.33333

INITIATION COMPLETED

```
CORE MAP ********** DATE- 72/12/07**** TIME- 18.25.46********** NORMAL LOAD **********
```

	FWA	LWA	BLNK COM	LENGTH
CODE	000100	110757	031011	057747
LOADER	143602	150071		
TABLES	143601	140017		

FILE	PROGRAM	ADDRESS	NAMED COMMON	ADDRESS	LCM BLOCK	ADDRESS
RUNTP						
	SOURCE	005535	01	000100		
			02	000142		
			03	005276		
			04	005301		
			DXCOM	005504		
	MCPPR5	005701	01	000100		
			02	000142		
			03	005276		
			04	005301		
			DXCOM	005504		
	UBPNT	016730	01	000100		
			02	000142		
			03	005276		
			04	005301		
			DXCOM	005504		
	FRN	017301	01	000100		
			02	000142		
			03	005276		
			04	005301		
			DXCOM	005504		
	IRN	017327	01	000100		
			02	000142		
			03	005276		
			04	005301		
			DXCOM	005504		
SYSLIB						
	ACGOER	017355				
	BACKSP	017367				
	BUFFEI	017416				
	BUFFEO	017537				
	CLOCKF	017621				
	DMPXX	017724				
	ENDFIL	020466				
	INPUTC	020502				
	IOCHEK	020656				
	LENGTH	020702				
	LOCF	020722				
	OUTPTC	020734				
	PACKAGE	021072				
	SETQ	021157				
	SSWTCH	021400				
	SYSTEM	021466				
	XIT	022524				
	ALNLOG	022643				
	EXP	022732				
	IBAIEX	023005				
	RBAIEX	023036				
	RBAREX	023067				
	SQRT	023146				
	ABORT	023224				
	BS4020	023275				
	C4020	024055				
	ENTR	024151				
	GETBA	024205				
	IOUTIL	024241				
	KODER	025532				
	KRAKER	027027				
	LABRT	030070				
	MEMORY	030176				
	OUTPTS	030356				
	REMARK	030447				
	RETN	030502				
	SKIPR	030532				
	SHIFT	030604				
	BOI	030621				
	PSCALE	030665				
	N2035R	030672				

UNSATISFIED EXTERNALS		REFERENCED BY			AT LOCATION				
SRCDX		MCPPR5	006677						

MCP TEST PROBLEM

SOURCE NO.	TIME CUTOFF	ENERGY CUTOFF	RUN TIME	O.P. CYCLE	DUMP CYCLE	DUMP NO.	CUTOFF CYCLE
7	1.0000E+02	1.0000E-03	4.9000E+00	25000	25000	=0	=0

NPS	X	Y	Z	IA	JA	U	V	W	TME	WT	DEL	ERG
1	1.8634E+00	-1.1784E+00	-1.9418E+00	1	1	7.8852E-01	6.0453E-01	1.2328E-01	0.	6.6667E-01	0.	7.5687E-01
2	-7.6927E-01	9.4340E-01	-1.0674E+00	1	1	8.5543E-01	-3.2219E-01	-4.0551E-01	0.	3.0000E+00	0.	3.8554E-01
3	-2.4464E+00	-4.0441E-01	-4.9125E-01	1	1	7.7575E-01	2.9254E-01	-5.5913E-01	0.	1.6667E-01	0.	2.5128E+00
4	-7.5052E-01	2.6368E+00	2.9899E-01	1	1	-9.8079E-01	-2.6476E-02	1.9324E-01	0.	8.0000E-01	0.	1.0061E+01
5	1.5596E+00	9.0693E-01	-4.7437E-01	1	1	7.3281E-01	4.7166E-01	4.9044E-01	0.	6.6667E-01	0.	9.0868E+01
6	8.8854E-01	1.1039E-01	-1.8744E+00	1	1	-6.0454E-01	3.3734E-01	7.2162E-01	0.	1.0000E+00	0.	4.6181E-01
7	2.5917E+00	-5.4249E-01	4.3255E-01	1	1	-2.9061E-01	4.6562E-01	-8.3591E-01	0.	1.6667E-01	0.	4.1620E+00
8	-8.7200E-01	6.2016E-01	2.1681E+00	1	1	-2.2042E-01	-5.4173E-02	9.7390E-01	0.	4.0000E-01	0.	5.1946E+00
9	-2.0645E+00	1.3224E+00	-5.6974E-01	1	1	6.5875E-01	6.6167E-01	3.5812E-01	0.	1.6667E-01	0.	2.6810E+00
10	1.0045E+00	1.3225E+00	4.1324E-01	1	1	-8.3340E-01	3.6956E-02	5.5144E-01	0.	1.3333E-01	0.	7.2481E+00
11	-7.9293E-02	3.6146E-01	2.9623E+00	1	1	-1.5551E-01	-2.8660E-02	9.8742E-01	0.	5.0000E+00	0.	3.1242E-02
12	-9.6391E-01	-6.9394E-01	2.2224E-01	1	1	7.7150E-01	6.3385E-01	5.4942E-02	0.	1.0000E+00	0.	2.8091E+01
13	-6.6898E-01	2.9487E-03	-7.1511E-01	1	1	-5.7973E-01	-1.3928E-01	8.0282E-01	0.	3.0000E+00	0.	1.8212E-01
14	-2.3188E+00	-4.5438E-01	-1.5132E+00	1	1	-6.1893E-01	-7.8544E-01	-3.2886E-03	0.	5.0000E-01	0.	2.4521E+00
15	1.3775E+00	2.3000E+00	-2.4732E-01	1	1	-2.6839E-01	2.5913E-01	9.2780E-01	0.	1.6667E+00	0.	3.0584E-02
16	1.3847E-01	2.3330E+00	-3.8756E-01	1	1	-2.5318E-01	8.1735E-02	-9.6396E-01	0.	6.6667E-01	0.	6.1986E-01
17	1.9894E+00	-2.0589E+00	-8.8648E-01	1	1	2.0860E-01	-7.3541E-01	-6.4472E-01	0.	3.0000E+00	0.	1.9222E-01
18	5.7099E-01	-5.9941E-01	-7.1424E-01	1	1	6.3296E-01	4.0073E-01	-6.6240E-01	0.	6.6667E-01	0.	7.6630E-01
19	-1.5302E+00	-2.2200E+00	4.5534E-01	1	1	9.4572E-01	3.2389E-01	2.6606E-02	0.	6.6667E-01	0.	8.0117E-01
20	1.7716E+00	-1.5236E+00	1.3888E+00	1	1	-5.9958E-01	-6.3481E-01	4.8736E-01	0.	3.0000E+00	0.	1.9734E-01
21	-1.0808E+00	-7.1116E-01	-1.1190E-01	1	1	8.9975E-01	3.5960E-01	2.4728E-01	0.	6.6667E-01	0.	6.2104E-01
22	-8.2244E-01	4.9091E-01	-7.9707E-01	1	1	-9.9231E-01	1.1765E-01	3.8517E-02	0.	1.3333E-01	0.	5.8952E+00
23	6.5988E-01	8.5280E-01	-1.8288E-01	1	1	-7.6712E-01	2.2883E-01	-5.9930E-01	0.	6.6667E-01	0.	5.4739E-01
24	4.5570E-01	1.4091E+00	-5.9566E-01	1	1	-3.9194E-01	1.4904E-01	9.1090E-01	0.	1.0000E+00	0.	3.3358E-01
25	4.4906E-01	1.3921E+00	1.1531E+00	1	1	1.2420E-01	-8.6567E-01	-4.8496E-01	0.	5.0000E+00	0.	1.2880E-02
26	2.8902E+00	6.2510E-01	4.6220E-01	1	1	6.1286E-01	7.9018E-01	-3.8154E-03	0.	6.6667E-01	0.	7.8886E-01
27	-5.6748E-01	6.6624E-02	-2.3618E+00	1	1	-2.8628E-01	-8.8806E-01	3.5970E-01	0.	4.0000E-01	0.	8.4639E+00
28	2.0345E+00	-8.0678E-01	-1.1377E+00	1	1	-1.9296E-01	4.1077E-02	-9.8035E-01	0.	1.6667E+00	0.	7.6937E-02
29	1.6317E+00	-4.8622E-01	2.0900E+00	1	1	2.6737E-01	9.6248E-01	4.6260E-02	0.	1.6667E-01	0.	2.2300E+00
30	1.3357E+00	2.3638E-01	-1.9277E-01	1	1	1.7439E-02	1.3122E-02	9.9976E-01	0.	1.0000E+00	0.	1.5420E-01
31	8.9330E-01	-8.7418E-01	5.8956E-01	1	1	-3.4255E-01	6.4344E-01	6.8458E-01	0.	1.0000E+00	0.	3.9580E-01
32	-1.1163E+00	2.3696E+00	7.7764E-01	1	1	-1.2829E-01	7.6786E-01	6.2764E-01	0.	1.6667E-01	0.	1.3541E+00
33	2.5938E+00	-8.6808E-01	-1.4908E-02	1	1	1.7859E-01	-2.8988E-01	9.4025E-01	0.	2.0000E+00	0.	5.5342E-01
34	2.3214E-02	-2.2209E-01	3.5839E-01	1	1	4.6249E-01	4.6780E-01	-7.5317E-01	0.	1.6667E+00	0.	6.9213E-02
35	6.5634E-01	1.9474E+00	-1.7164E+00	1	1	1.1932E-01	-7.5493E-01	-6.4486E-01	0.	4.0000E-01	0.	7.8823E+00
36	8.1224E-01	2.6601E+00	8.8752E-01	1	1	-8.8208E-01	2.0539E-01	4.2397E-01	0.	1.6667E-01	0.	2.5452E+00
37	-8.4098E-01	1.7157E-01	-2.3035E+00	1	1	-9.3820E-01	9.2612E-02	-3.3348E-01	0.	1.6667E-01	0.	4.2433E+00
38	3.5784E-01	5.1613E-01	1.3592E+00	1	1	-4.1469E-01	8.1499E-01	-4.0474E-01	0.	1.6667E-01	0.	4.5873E+00
39	1.6519E+00	2.1294E+00	3.4949E-01	1	1	-7.5653E-01	2.6252E-01	-5.9895E-01	0.	1.6667E-01	0.	2.0123E+00
40	-2.3624E+00	-1.5042E-01	9.4255E-01	1	1	-6.9761E-02	9.2774E-01	-3.6664E-01	0.	1.0000E+00	0.	4.2103E-01
41	-9.9382E-02	5.5475E-01	-2.6669E+00	1	1	-8.7580E-01	4.8268E-01	1.4833E-03	0.	6.6667E-01	0.	7.0687E-01
42	1.3828E+00	1.1500E+00	2.2912E+00	1	1	-6.6437E-01	-6.2985E-01	4.0237E-01	0.	5.0000E-01	0.	4.3982E+00
43	-2.3392E-01	-2.2430E-01	-5.5501E-01	1	1	-3.2351E-01	2.0279E-01	9.2424E-01	0.	1.3333E-01	0.	6.9181E+00
44	-2.4562E+00	1.0749E+00	-3.1791E-01	1	1	5.6814E-01	1.6978E-01	-8.0523E-01	0.	6.6667E-01	0.	5.1485E-01
45	-4.5430E-01	-9.8526E-02	-5.9728E-02	1	1	-3.4586E-01	9.1088E-01	2.2514E-01	0.	6.6667E-01	0.	7.4685E-01
46	-4.4030E-01	-1.9660E-01	5.2124E-01	1	1	1.6513E-01	-1.2814E-01	-9.7791E-01	0.	2.0000E+00	0.	7.1822E-01
47	8.5038E-01	2.3612E+00	1.3213E+00	1	1	-1.2435E-01	6.0094E-01	-7.8956E-01	0.	2.6667E-01	0.	1.1466E+01
48	-6.2690E-01	2.2637E+00	6.2585E-01	1	1	-8.6021E-01	2.6343E-01	4.3663E-01	0.	1.0000E+00	0.	1.5056E-01
49	-7.8057E-01	-2.5449E+00	-5.0268E-01	1	1	-1.4857E-01	4.5491E-01	-8.7806E-01	0.	6.6667E-01	0.	5.0623E-01
50	-2.0422E+00	1.4796E+00	5.9978E-01	1	1	5.2481E-01	3.7261E-02	-8.5040E-01	0.	6.6667E-01	0.	7.0003E-01

MCP TEST PROBLEM

TIME= 4.005 MINUTES

NUMBER OF PHOTONS STARTED	TOTAL NUMBER OF COLLISIONS	RANDOM NUMBERS GENERATED	TOTAL WEIGHT STARTED	TOTAL ENERGY STARTED	COLLISIONS PER PHOTON STARTED	TRACKS PER PHOTON STARTED	PHOTONS PROCESSED PER MINUTE
16414	17840	1837675	1.6503E+04	1.5567E+04	1.0896E+01	5.5690E+00	3.5642E+03

TOTAL TRACKS STARTED	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	LOSS TO SPLITTING	TOTAL TRACKS LOST	
91410	0	0	22460	16752	52198	91410	

WEIGHT STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	WEIGHT LOST PER PHOTON		PAIR PRODUCTION PER PHOTON
1.0054E+00	0.	0.	3.3986E-01	6.8308E-01	1.0229E+00		9.4479E-03

ENERGY STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	LOSS TO PAIR PRODUCTION	LOSS TO COMPTON	ENERGY LOST PER PHOTON
9.4841E-01	0.	0.	4.4966E-01	4.6119E-02	7.1904E-02	3.7334E-01	9.4101E-01

TOTAL CELL DEPOSITION DATA

CELL	NO. OF PHOTONS CAPTURED	RELATIVE ERROR	PHOTONS LOST TO E. C.	RELATIVE ERROR	PHOTONS CREATING A PAIR	RELATIVE ERROR
1	8.0013E-02	.07114	0.	0.00000	2.0308E-05	.70706
2	2.2259E-01	.02913	0.	0.00000	3.0259E-03	.09037
3	2.8431E-04	.39682	0.	0.00000	7.6155E-05	.29049
4	4.4799E-03	.11637	0.	0.00000	3.1883E-04	.14594
5	4.7155E-03	.18524	0.	0.00000	5.3613E-04	.24194
6	8.8847E-05	.42467	0.	0.00000	3.1985E-05	.30232
7	4.3994E-02	.03631	0.	0.00000	4.1580E-04	.08924
8	3.3000E-05	.42475	0.	0.00000	1.0408E-05	.37222
9	6.9026E-03	.05491	0.	0.00000	5.0262E-05	.17331
10	3.5539E-05	.34307	0.	0.00000	1.1169E-05	.25398
11	4.6403E-03	.06325	0.	0.00000	3.5285E-05	.22952
12	3.0233E-04	.12058	0.	0.00000	2.4687E-05	.14450
13	2.8366E-03	.05932	0.	0.00000	3.7950E-05	.19971
14	1.9202E-03	.05366	0.	0.00000	1.9546E-05	.16383
15	0.	0.00000	0.	0.00000	2.4369E-05	.99997
16	3.3668E-02	.06420	0.	0.00000	4.6302E-04	.28804
17	1.0154E-04	.72107	0.	0.00000	0.	0.00000
18	8.1577E-03	.13494	0.	0.00000	2.4369E-05	.99997
19	1.1777E-02	.11415	0.	0.00000	1.0357E-04	.50253
20	2.4776E-04	.54637	0.	0.00000	1.2794E-04	.52375
21	1.1799E-03	.32748	0.	0.00000	1.2997E-04	.49994
22	1.6262E-03	.11332	0.	0.00000	1.9699E-04	.12655
23	1.3200E-04	.34176	0.	0.00000	1.6246E-05	.43294
24	1.4038E-04	.23902	0.	0.00000	1.7262E-05	.28957
25	4.3154E-05	.44792	0.	0.00000	1.5992E-05	.31537
26	1.9660E-02	.08060	0.	0.00000	3.5945E-04	.30072
27	9.9220E-02	.03605	0.	0.00000	1.1941E-03	.17663
28	1.0416E-01	.02473	0.	0.00000	1.5688E-03	.06460
29	1.4863E-02	.05279	0.	0.00000	2.3862E-04	.16945
30	1.5262E-02	.04260	0.	0.00000	3.5285E-04	.10369
31	0.	0.00000	0.	0.00000	0.	0.00000
32	0.	0.00000	0.	0.00000	0.	0.00000

CELL	ENERGY LOST TO CAPTURE	RELATIVE ERROR	ENERGY LOST TO ENERGY CUTOFF	RELATIVE ERROR	ENERGY LOST TO PAIR PRODUCTION	RELATIVE ERROR	ENERGY LOST TO COMPTON	RELATIVE ERROR	TOTAL ENERGY DEPOSITED
1	3.8119E-04	.07971	0.	0.00000	4.8341E-05	.74803	4.6267E-03	.12217	5.0543E-03
2	1.0817E-02	.03111	0.	0.00000	2.3862E-02	.10816	1.0715E-01	.02858	1.4183E-01
3	1.1826E-05	.38612	0.	0.00000	6.1208E-04	.34638	8.4404E-03	.05102	9.0643E-03
4	2.2843E-04	.12327	0.	0.00000	2.5830E-03	.16619	3.4432E-02	.02729	3.7244E-02
5	2.7657E-04	.19232	0.	0.00000	3.9758E-03	.28195	4.2664E-02	.04948	4.6897E-02
6	3.1791E-06	.45401	0.	0.00000	2.3263E-04	.37502	9.0944E-03	.03611	9.3302E-03
7	2.7148E-03	.03287	0.	0.00000	3.1793E-03	.10606	1.7718E-02	.02609	2.3612E-02
8	1.4423E-06	.43227	0.	0.00000	8.4134E-05	.41207	2.1630E-03	.05414	2.2491E-03
9	4.1602E-04	.05403	0.	0.00000	3.3654E-04	.20217	2.2123E-03	.05846	2.9649E-03
10	1.5718E-06	.37612	0.	0.00000	8.5101E-05	.30012	1.4157E-03	.05557	1.5025E-03
11	2.6494E-04	.06001	0.	0.00000	2.9552E-04	.26054	1.3173E-03	.07146	1.8777E-03
12	1.3002E-05	.11319	0.	0.00000	1.9804E-04	.16542	3.0131E-03	.04475	3.2242E-03
13	1.6138E-04	.05742	0.	0.00000	3.2594E-04	.23358	9.3093E-04	.07772	1.4183E-03
14	1.0544E-04	.05326	0.	0.00000	1.5272E-04	.18517	6.7912E-04	.06969	9.3728E-04
15	0.	0.00000	0.	0.00000	1.9294E-04	.99997	1.1144E-03	.16979	1.3073E-03
16	2.1096E-03	.06810	0.	0.00000	3.4418E-03	.36632	1.6858E-02	.08429	2.2410E-02
17	5.9928E-06	.81269	0.	0.00000	0.	0.00000	3.8357E-04	.37941	3.8957E-04
18	5.1776E-04	.13798	0.	0.00000	1.0750E-04	.99997	2.6145E-03	.22730	3.2397E-03
19	7.9832E-04	.11834	0.	0.00000	5.5681E-04	.51243	6.9717E-03	.13967	8.3268E-03
20	1.2175E-05	.53274	0.	0.00000	8.2338E-04	.62091	3.4269E-03	.17297	4.2624E-03
21	6.3843E-05	.33577	0.	0.00000	1.1715E-03	.58472	1.3371E-02	.07453	1.4606E-02
22	9.6192E-05	.12078	0.	0.00000	1.4221E-03	.15624	1.6684E-02	.02481	1.8202E-02
23	6.1711E-06	.32812	0.	0.00000	1.4592E-04	.47910	2.4446E-03	.06859	2.5967E-03
24	9.2218E-06	.23931	0.	0.00000	1.0726E-04	.34428	1.5708E-03	.07032	1.6871E-03
25	2.2160E-06	.43702	0.	0.00000	1.2885E-04	.37847	1.1970E-03	.10620	1.3281E-03
26	2.1383E-03	.09011	0.	0.00000	2.0786E-03	.36484	6.7942E-03	.15707	1.1011E-02
27	1.0615E-02	.04026	0.	0.00000	9.8624E-03	.21577	2.6302E-02	.07737	4.6780E-02
28	1.1169E-02	.02501	0.	0.00000	1.1921E-02	.07502	2.8480E-02	.02925	5.1571E-02
29	1.5938E-03	.05302	0.	0.00000	1.6043E-03	.22462	4.7693E-03	.08217	7.9674E-03
30	1.5842E-03	.04420	0.	0.00000	2.3681E-03	.12655	4.5188E-03	.06043	8.4712E-03
31	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.
32	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.

NUMBER OF PHOTONS CROSSING SURFACE

TIME 0. 1.0000E+02

COSINE 1.0000E+00 8.0000E-01

SURFACE 1

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	1.01539E-03	.66328	0.	0.00000
1.0000E-02	7.51391E-03	.22109	0.	0.00000
1.0000E+00	4.23776E-01	.01613	2.91588E-02	.07066
5.0000E+00	2.38922E-02	.02814	0.	0.00000
1.4000E+01	2.43207E-02	.02952	0.	0.00000

SURFACE 10

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
7.72638E-03	.04014	3.48597E-04	.07882
8.17899E-04	.08357	0.	0.00000
9.02177E-04	.10530	0.	0.00000

SURFACE 11

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000
1.0000E+00	1.28570E-02	.04296	0.	0.00000
5.0000E+00	2.47159E-03	.06087	0.	0.00000
1.4000E+01	2.56209E-03	.06364	0.	0.00000

SURFACE 14

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
1.63928E-01	.02478	0.	0.00000
1.76821E-02	.03533	0.	0.00000
1.55802E-02	.04020	0.	0.00000

COSINE 8.0000E-01 6.0000E-01

SURFACE 1

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	1.82771E-03	.57730	8.12315E-04	.79053
1.0000E-02	6.09236E-03	.24482	0.	0.00000
1.0000E+00	2.59362E-01	.02156	2.81000E-02	.06818
5.0000E+00	1.49527E-02	.03604	0.	0.00000
1.4000E+01	1.49628E-02	.03829	0.	0.00000

SURFACE 10

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
2.42698E-03	.04066	3.91307E-04	.08013
3.42061E-05	.13287	0.	0.00000
0.	0.00000	0.	0.00000

SURFACE 11

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000
1.0000E+00	5.11663E-03	.07338	0.	0.00000
5.0000E+00	8.10949E-04	.12786	0.	0.00000
1.4000E+01	4.31542E-04	.20521	0.	0.00000

SURFACE 14

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
2.72796E-02	.05057	0.	0.00000
2.33337E-03	.08202	0.	0.00000
2.25823E-03	.09024	0.	0.00000

COSINE 6.0000E-01 4.0000E-01

SURFACE 1

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000
1.0000E-02	6.09236E-03	.24482	0.	0.00000
1.0000E+00	1.40244E-01	.03015	1.87746E-02	.08237
5.0000E+00	7.36566E-03	.05167	0.	0.00000
1.4000E+01	7.76573E-03	.05365	0.	0.00000

SURFACE 10

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
1.44173E-03	.05089	3.40030E-04	.08085
5.26735E-06	.31844	0.	0.00000
0.	0.00000	0.	0.00000

SURFACE 11

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000
1.0000E+00	2.06233E-03	.08634	0.	0.00000
5.0000E+00	1.05030E-04	.30483	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000

SURFACE 14

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
4.19764E-03	.11768	0.	0.00000
1.27940E-04	.29728	0.	0.00000
0.	0.00000	0.	0.00000

COSINE 4.0000E-01 2.0000E-01

SURFACE 1

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	2.03079E-04	.99997	2.03079E-04	.99997
1.0000E-02	2.64002E-03	.42822	0.	0.00000
1.0000E+00	6.02697E-02	.04605	1.30539E-02	.09732
5.0000E+00	2.38414E-03	.09246	0.	0.00000
1.4000E+01	2.45319E-03	.09262	0.	0.00000

SURFACE 10

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
6.91356E-04	.06432	3.86966E-04	.08720
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000

SURFACE 11

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000
1.0000E+00	7.01129E-04	.09516	0.	0.00000
5.0000E+00	1.24386E-05	.73039	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000

SURFACE 14

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
3.63511E-04	.45382	0.	0.00000
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000

COSINE 2.0000E-01 0.

SURFACE 1

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	6.09236E-04	.57730	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000
1.0000E+00	1.20466E-02	.10072	4.97949E-03	.15212
5.0000E+00	3.55388E-04	.21932	0.	0.00000
1.4000E+01	3.81788E-04	.22803	0.	0.00000

SURFACE 10

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
1.96098E-04	.10373	1.43488E-04	.12292
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000

SURFACE 11

ENERGY	- TO -	REL. ERROR	- TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000
1.0000E+00	3.83248E-04	.27697	0.	0.00000
5.0000E+00	0.	0.00000	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000

SURFACE 14

- TO -	REL. ERROR	- TO -	REL. ERROR
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000
0.	0.00000	0.	0.00000

NUMBER FLUX INTEGRATED OVER SURFACE

TIME 0. 1.0000E-02

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	7.72276E-02	.07031
5.0000E+00	4.32173E-03	.06710
1.4000E+01	2.74300E-03	.11593

TIME 1.0000E-01 1.0000E+00

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	3.72053E-02	.10142
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

PATH LENGTH/VOLUME

TIME 0. 1.0000E-02

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	7.50098E-07	.57706
5.0000E-01	3.43105E-06	.20956
1.0000E+00	2.43378E-06	.18010
5.0000E+00	6.38992E-07	.17916
1.4000E+01	7.15237E-07	.19121

TIME 1.0000E-02 1.0000E-01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	4.12029E-04	.06899
5.0000E-01	7.15813E-04	.03874
1.0000E+00	2.83715E-04	.04827
5.0000E+00	6.00373E-05	.05492
1.4000E+01	6.21578E-05	.05909

TIME 1.0000E-01 1.0000E+00

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	1.42780E-04	.09497
5.0000E-01	3.67072E-05	.15782
1.0000E+00	8.69763E-08	.99997
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	0.	0.00000
5.0000E-01	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

NUMBER FLUX AT DETECTOR

TIME 0. 1.0000E-02

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	1.46701E-29	.99997
1.0000E+00	1.60796E-05	.03019
5.0000E+00	3.28125E-06	.03420
1.4000E+01	3.12916E-06	.03027

TIME 1.0000E-01 1.0000E+00

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	4.23541E-10	.80352
1.0000E+00	1.28952E-05	.03838
5.0000E+00	1.84510E-07	.18699
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TAPE DUMP NO. 2 NPS= 16414

```
17.56.41 $BMTR      JOB CARD READ WITH NO ERRORS
17.56.48 .LOS   01 CARDS          000263R
17.56.49 $BMTR      READ.  JOB READY TO BE SCHEDULED.
17.56.50 $BMTR  00  CROS 1.82 72/12/06  MACH. 14              TAPE
         SY760073
17.56.51 $UMTR      .USER MONITOR  OF   11/02/72  INITIALIZED.
17.56.51 $UMTR      .JOB NAME=SCHRAND1BR,DATE =     72/12/07
17.56.51 *CCP   00  $JOB(NAME=SCHRANDT,CAT=05,CL=U,AC=V06,UA=9406C050M
         CP,PR=10,PL=40,TL=5M)
17.56.51 $UMTR      .FILE SET CCD      OPENED,BUFFER LENGTH =00001100.
17.56.51 $UMTR      .FILE SET INP      OPENED,BUFFER LENGTH =00010100.
17.56.51 *CCP       $. INITIATE AND RUN MCP TEST PROBLEM.
17.56.51 *CCP       $LABEL(STAGE)
17.56.51 *CCP   1   $CREATE(FS=CODETP,CL=U,PRENT=XX009301)
17.56.52 *CCP   2   $OPEN(FS=DUMMY,SCT=2000)
17.56.52 $UMTR      .FILE SET DUMMY    OPENED,BUFFER LENGTH =00032100.
17.56.52 *CCP   3   $COPY(I=CODETP,O=DUMMY)
17.56.52 $UMTR      .FILE SET CODETP   OPENED,BUFFER LENGTH =00032100.
17.56.52 $BMTR      ROLLOUT STARTED
17.56.53 $BMTR      ROLLOUT DONE
18.11.46 *LOS   05  XX009301 IS ON UNIT 2  FILE CODETP       800  BIN
18.25.34 $BMTR       ROLLIN STARTED
18.25.35 $BMTR       ROLLIN DONE
18.25.38 *CCP   4   $IF(FALSE=READY)
18.25.38 *CCP       $LABEL(READY)
18.25.38 *CCP   5   $AFSREL(FS=DUMMY)
18.25.38 $UMTR      .FILE SET DUMMY    CLOSED,BUFFER LENGTH =00032100.
18.25.38            .FILE SET STATISTICS
18.25.38            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.25.38             000000000 000000320 000000000 000000000 000000010
18.25.38            .     LWA=0000256555,DEVICE=01
18.25.38 *CCP   6   $REWIND(CODETP)
18.25.39 *CCP   7   $RUN(C=SX,B=RUNTP)
18.25.39 $UMTR      .FILE SET RUNTP    OPENED,BUFFER LENGTH =00032100.
18.25.39 $UMTR      .FILE SET OUT      OPENED,BUFFER LENGTH =00032100.
18.25.39 $RUN       .FIELD LENGTH IS =  050776
18.25.39 $RUN       .RUN-LCM69           CTIME 000.259 SEC.
18.25.40 *CCP   8   $COPYFI(I=CODETP,O=RUNTP)
18.25.40 *CCP   9   $SETQ(KEY=KKTP)
18.25.40 *CCP  10   $SETQ.
18.25.40 *CCP  11   $LDGO(I=CODETP)
18.25.43  MCPPR5    .END
18.25.43 $UMTR      .FILE SET IMAGE    OPENED,BUFFER LENGTH =00064100.
18.25.43 $UMTR      .FILE SET IMAGE    CLOSED,BUFFER LENGTH =00064100.
18.25.43            .FILE SET STATISTICS
18.25.43            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.25.43             000000000 000000003 000000001 000000000 000000003
18.25.43            .     LWA=0000076344,DEVICE=01
18.25.44 *CCP  12   $IF(FALSE=RUN)
18.25.44 *CCP       $LABEL(RUN)
18.25.44 *CCP  13   $AFSREL(FS=CODETP)
18.25.44 $UMTR      .FILE SET CODETP   CLOSED,BUFFER LENGTH =00032100.
18.25.44            .FILE SET STATISTICS
18.25.44            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
18.25.44             000000404 000000000 000000001 000000020 000000000
18.25.44            .     LWA=0000256555,DEVICE=01
18.25.44 *CCP  14   $SETQ(KEY=KKTP)
18.25.44 *CCP  15   $SETQ.
18.25.44 *CCP  16   $LDGO(I=RUNTP)
19.00.58  MCPPR5    .END
19.00.58 $UMTR      .FILE SET IMAGE    OPENED,BUFFER LENGTH =00064100.
19.00.59 $UMTR      .FILE SET IMAGE    CLOSED,BUFFER LENGTH =00064100.
19.00.59            .FILE SET STATISTICS
19.00.59            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
19.00.59             000000000 000000003 000000001 000000001 000000003
19.00.59            .     LWA=0000111257,DEVICE=01
19.00.59 *CCP  17   $IF(FALSE=TAPE)
19.00.59 *CCP       $LABEL(TAPE)
19.00.59 *CCP  18   $AFSREL(FS=RUNTP,ADISP=TAPE)
19.01.00 $UMTR      .FILE SET RUNTP    CLOSED,BUFFER LENGTH =00032100.
19.01.00            .FILE SET STATISTICS
19.01.00            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
19.01.00             000000025 000000027 000000003 000000004 000000011
19.01.00            .     LWA=0000141032,DEVICE=01
19.01.00 $CCP       .EOF OR EOI ON CC FILE.  FSET=CCD
19.01.00 $UMTR      .FILE SET CCD      CLOSED,BUFFER LENGTH =00001100.
19.01.00            .FILE SET STATISTICS
19.01.00            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
19.01.00             000000071 000000037 000000034 000000000 000000000
19.01.00            .     LWA=0000000000,DEVICE=00
19.01.00 $UMTR      .FILE SET INP      CLOSED,BUFFER LENGTH =00010100.
19.01.00            .FILE SET STATISTICS
19.01.00            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
19.01.00             000000222 000000222 000000001 000000000 000000000
19.01.00            .     LWA=0000000000,DEVICE=00
19.01.00 $UMTR      .FILE SET OUT      CLOSED,BUFFER LENGTH =00032100.
19.01.00            .FILE SET STATISTICS
19.01.00            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
19.01.00             000000000 000001463 000000000 000000000 000000002
19.01.00            .     LWA=0000021702,DEVICE=03
19.01.00 $UMTR  99  .JOB TERMINATION.
                    .ELAPSED  CP TIME = 00288.19619
                    .ESTIMATED JOB COST $0036.02
19.02.00 *LOS   06  XX008199 IS ON UNIT 1  FILE RUNTP       800  BIN
19.02.13 $OUTPUT    FS=RUNTP    DSP=TAPE       49691 WORDS
19.02.17 $OUTPUT    FS=OUT      DSP=PRT         9155 WORDS       13 PAGES


FILE COMPLETE   SCHRAND1BR 1
```

```
CORE MAP ************** DATE-  72/12/08**** TIME-  20.28.15*********** NORMAL LOAD ********************************************
                      FWA      LWA                          BLNK COM  LENGTH
                    -------  -------                        -------  -------
          CODE      000100   110757                         031011   057747
          LOADER    143602   150071
          TABLES    143601   140017

                                                            NAMED                         LCM
FILE      PROGRAM   ADDRESS                                 COMMON   ADDRESS              BLOCK    ADDRESS
-------   -------   -------                                 -------  -------              -------  -------
RUNTP
          SOURCE    005535                                  G1       000100
                                                            G2       000142
                                                            G3       005276
                                                            G4       005301
                                                            DXCOM    005504
          MCPPR5    005701                                  G1       000100
                                                            G2       000142
                                                            G3       005276
                                                            G4       005301
                                                            DXCOM    005504
          DRPNT     016730                                  G1       000100
                                                            G2       000142
                                                            G3       005276
                                                            G4       005301
                                                            DXCOM    005504
          FRN       017301                                  G1       000100
                                                            G2       000142
                                                            G3       005276
                                                            G4       005301
                                                            DXCOM    005504
          IRN       017327                                  G1       000100
                                                            G2       000142
                                                            G3       005276
                                                            G4       005301
                                                            DXCOM    005504
SYSLIB
          ACGOER    017355             RBAREX    023067
          BACKSP    017367             SQRT      023146
          BUFFEI    017416             ABORT     023224
          BUFFEO    017537             BS4020    023275
          CLOCKF    017621             C4020     024055
          DMPXX     017724             ENTR      024151
          ENDFIL    020466             GETBA     024205
          INPUTC    020502             IOUTIL    024241
          IOCHEK    020656             KODER     025532
          LENGTH    020702             KRAKER    027027
          LOCF      020722             LAHRT     030070
          OUTPTC    020734             MEMORY    030176
          PACKAGE   021072             OUTPTS    030356
          SETQ      021157             REMARK    030447
          SSWTCH    021400             RETN      030502
          SYSTEM    021466             SKIPR     030532
          XIT       022524             SHIFT     030604
          ALNLOG    022643             BOI       030621
          EXP       022732             PSCALE    030665
          IRAIEX    023005             N203SR    030672
          RBAIEX    023036

        UNSATISFIED                    REFERENCED                          AT
        EXTERNALS                      BY                               LOCATION
        -------  -------               -------         -------  -------  -------  -------  -------  -------  -------
        SRCDX                          MCPPR5          006677
```

MCP TEST PROBLEM

SOURCE NO.	TIME CUTOFF	ENERGY CUTOFF	RUN TIME	O.P. CYCLE	DUMP CYCLE	DUMP NO.	CUTOFF CYCLE
7	1.0000E+02	1.0000E-03	4.9000E+00	50000	50000	-0	-0

TIME= 9.[illegible]50 MINUTES

NUMBER OF PHOTONS STARTED	TOTAL NUMBER OF COLLISIONS	RANDOM NUMBERS GENERATED	TOTAL WEIGHT STARTED	TOTAL ENERGY STARTED	COLLISIONS PER PHOTON STARTED	TRACKS PER PHOTON STARTED	PHOTONS PROCESSED PER MINUTE
33217	365325	3740703	3.3418E+04	3.1508E+04	1.0998E+01	5.5468E+00	3.5526E+03

TOTAL TRACKS STARTED	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	LOSS TO SPLITTING	TOTAL TRACKS LOST
184248	0	0	44545	34312	105391	184248

WEIGHT STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	WEIGHT LOST PER PHOTON		PAIR PRODUCTION PER PHOTON
1.0061E+00	0.	0.	3.3946E-01	6.8302E-01	1.0225E+00		9.8588E-03

ENERGY STARTED PER PHOTON	LOSS TO ENERGY CUTOFF	LOSS TO TIME CUTOFF	LOSS TO ESCAPE	LOSS TO CAPTURE	LOSS TO PAIR PRODUCTION	LOSS TO COMPTON	ENERGY LOST PER PHOTON
9.4855E-01	0.	0.	4.5585E-01	4.6006E-02	7.4350E-02	3.6930E-01	9.4551E-01

TOTAL CELL DEPOSITION DATA

CELL	NO. OF PHOTONS CAPTURED	RELATIVE ERROR	PHOTONS LOST TO E. C.	RELATIVE ERROR	PHOTONS CREATING A PAIR	RELATIVE ERROR
1	7.6768E-02	.05057	0.	0.00000	3.1109E-05	.42179
2	2.2495E-01	.02053	0.	0.00000	3.0296E-03	.06380
3	2.7596E-04	.28191	0.	0.00000	6.6231E-05	.20433
4	4.6708E-03	.08040	0.	0.00000	3.5725E-04	.09361
5	5.1249E-03	.12949	0.	0.00000	4.6462E-04	.18507
6	1.2067E-04	.28184	0.	0.00000	4.1645E-05	.18244
7	4.3895E-02	.02496	0.	0.00000	4.3703E-04	.06098
8	5.3060E-05	.29841	0.	0.00000	1.0160E-05	.26386
9	6.7887E-03	.03958	0.	0.00000	4.5659E-05	.13797
10	3.6879E-05	.23812	0.	0.00000	8.7179E-06	.20124
11	4.6451E-03	.04496	0.	0.00000	3.3994E-05	.17272
12	3.5245E-04	.07627	0.	0.00000	2.4021E-05	.10434
13	2.9434E-03	.04047	0.	0.00000	3.3241E-05	.14187
14	1.9798E-03	.03854	0.	0.00000	1.6244E-05	.11828
15	5.0175E-05	.72109	0.	0.00000	6.0210E-05	.59997
16	3.6005E-02	.04418	0.	0.00000	4.1846E-04	.20812
17	7.0245E-05	.58899	0.	0.00000	1.2042E-05	.99998
18	7.8675E-03	.09833	0.	0.00000	4.8168E-05	.49997
19	1.1145E-02	.08334	0.	0.00000	1.1741E-04	.33526
20	2.5489E-04	.38142	0.	0.00000	6.3221E-05	.52378
21	1.4149E-03	.22039	0.	0.00000	1.2443E-04	.36349
22	1.8326E-03	.08026	0.	0.00000	1.9644E-04	.09076
23	2.0898E-04	.21607	0.	0.00000	2.5840E-05	.22617
24	1.7687E-04	.14956	0.	0.00000	1.5931E-05	.20389
25	8.6928E-05	.22858	0.	0.00000	1.7185E-05	.21009
26	2.1357E-02	.05463	0.	0.00000	4.5760E-04	.19904
27	9.4627E-02	.02573	0.	0.00000	1.4109E-03	.11048
28	1.0535E-01	.01761	0.	0.00000	1.6904E-03	.04594
29	1.4988E-02	.03663	0.	0.00000	2.7797E-04	.11239
30	1.4986E-02	.02928	0.	0.00000	3.2313E-04	.07869
31	0.	0.00000	0.	0.00000	0.	0.00000
32	0.	0.00000	0.	0.00000	0.	0.00000

CELL	ENERGY LOST TO CAPTURE	RELATIVE ERROR	ENERGY LOST TO ENERGY CUTOFF	RELATIVE ERROR	ENERGY LOST TO PAIR PRODUCTION	RELATIVE ERROR	ENERGY LOST TO COMPTON	RELATIVE ERROR	TOTAL ENERGY DEPOSITED
1	3.9056E-04	.05606	0.	0.00000	1.7411E-04	.53510	4.3414E-03	.00718	4.9263E-03
2	1.0844E-02	.02168	0.	0.00000	2.3009E-02	.07641	1.0577E-01	.01963	1.3962E-01
3	1.2038E-05	.27761	0.	0.00000	4.5015E-04	.25187	8.5612E-03	.03687	9.0234E-03
4	2.4910E-04	.08470	0.	0.00000	2.7599E-03	.10731	3.4544E-02	.01889	3.7553E-02
5	3.1337E-04	.13989	0.	0.00000	3.4716E-03	.21542	4.1410E-02	.03416	4.5395E-02
6	5.0749E-06	.28477	0.	0.00000	3.0727E-04	.21871	8.5153E-03	.02486	8.8274E-03
7	2.7872E-03	.02318	0.	0.00000	3.3457E-03	.07208	1.7954E-02	.01877	2.4009E-02
8	2.2045E-06	.30060	0.	0.00000	8.5105E-05	.29241	2.0908E-03	.03837	2.1781F-03
9	3.9928E-04	.03781	0.	0.00000	3.4874E-04	.16561	2.0486E-03	.04053	2.8167E-03
10	1.4509E-06	.24923	0.	0.00000	6.0432E-05	.24067	1.3093E-03	.03758	1.3712E-03
11	2.6343E-04	.04258	0.	0.00000	2.8527E-04	.20209	1.2814E-03	.05265	1.8302E-03
12	1.5047E-05	.07617	0.	0.00000	1.9248E-04	.12333	2.8934E-03	.03144	3.1010E-03
13	1.6726E-04	.03936	0.	0.00000	2.8248E-04	.16474	8.8056E-04	.05380	1.3303E-03
14	1.0881E-04	.03779	0.	0.00000	1.2108E-04	.13637	6.1183E-04	.04863	8.4172E-04
15	3.2040E-06	.81392	0.	0.00000	6.8465E-04	.62459	1.0857E-03	.12165	1.7756E-03
16	2.2427E-03	.04682	0.	0.00000	3.1048E-03	.25654	1.6113E-02	.05609	2.1461E-02
17	3.7538E-06	.67499	0.	0.00000	9.3817E-05	.99998	3.5758E-04	.24928	4.5516E-04
18	5.1866E-04	.10077	0.	0.00000	2.9871E-04	.51042	2.9645E-03	.14786	3.7819E-03
19	7.4769E-04	.08757	0.	0.00000	6.3654E-04	.34447	6.0214E-03	.09744	7.4059E-03
20	1.5865E-05	.44236	0.	0.00000	4.0687E-04	.62093	3.8755E-03	.12116	4.2982E-03
21	7.1014E-05	.22462	0.	0.00000	1.0771E-03	.43568	1.5237E-02	.05787	1.6385E-02
22	1.1117E-04	.08691	0.	0.00000	1.5407E-03	.10679	1.7063E-02	.01918	1.8715E-02
23	9.4301E-06	.21384	0.	0.00000	1.7092E-04	.27034	2.3884E-03	.04705	2.5688E-03
24	1.0398E-05	.15556	0.	0.00000	9.9358E-05	.24476	1.4807E-03	.04800	1.5904E-03
25	4.8465E-06	.23351	0.	0.00000	1.2531E-04	.24697	1.2103E-03	.06726	1.3405E-03
26	2.3960E-03	.06352	0.	0.00000	3.6959E-03	.23316	6.8759E-03	.10149	1.2968E-02
27	1.0026E-02	.02860	0.	0.00000	1.0145E-02	.13570	2.4326E-02	.05130	4.4497E-02
28	1.1199E-02	.01768	0.	0.00000	1.3117E-02	.05444	2.8826E-02	.02112	5.3142E-02
29	1.6040E-03	.03716	0.	0.00000	1.9548E-03	.14236	4.5506E-03	.05612	8.1094E-03
30	1.5639E-03	.03037	0.	0.00000	2.3024E-03	.09629	4.4761E-03	.04258	8.3424E-03
31	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.
32	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000	0.

NUMBER OF PHOTONS CROSSING SURFACE

TIME 0. 1.0000E+02

COSINE 1.0000E+00 8.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	1.40490E-03	.44028	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	9.43292E-03	.14654	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	4.23907E-01	.01136	3.02245E-02	.04797	7.56402E-03	.02750	3.50881E-04	.05542
5.0000E+00	2.36114E-02	.01987	0.	0.00000	7.72822E-04	.05956	0.	0.00000
1.4000E+01	2.43329E-02	.02084	0.	0.00000	8.11959E-04	.07519	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	1.29006E-02	.03034	0.	0.00000	1.45012E-01	.01734	0.	0.00000
5.0000E+00	2.34054E-03	.04260	0.	0.00000	1.81233E-02	.02475	0.	0.00000
1.4000E+01	2.38834E-03	.04789	0.	0.00000	1.65257E-02	.02772	0.	0.00000

COSINE 8.0000E-01 6.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	1.00350E-03	.52912	4.01401E-04	.79055	0.	0.00000	0.	0.00000
1.0000E-02	6.22171E-03	.16907	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	2.63121E-01	.01504	2.79465E-02	.04882	2.42531E-03	.02812	3.60916E-04	.05361
5.0000E+00	1.42778E-02	.02570	0.	0.00000	2.99483E-05	.09333	0.	0.00000
1.4000E+01	1.48799E-02	.02703	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	5.09553E-03	.04839	0.	0.00000	2.56375E-02	.03676	0.	0.00000
5.0000E+00	5.60174E-04	.09655	0.	0.00000	2.44453E-03	.05600	0.	0.00000
1.4000E+01	4.09931E-04	.15349	0.	0.00000	2.13545E-03	.06412	0.	0.00000

COSINE 6.0000E-01 4.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	4.01401E-04	.79055	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	4.61611E-03	.19678	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	1.41453E-01	.02090	1.89200E-02	.05727	1.40196E-03	.03428	3.33351E-04	.05825
5.0000E+00	7.56841E-03	.03615	0.	0.00000	6.08373E-06	.19238	0.	0.00000
1.4000E+01	7.62260E-03	.03819	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	2.16057E-03	.06828	0.	0.00000	4.35319E-03	.08296	0.	0.00000
5.0000E+00	8.89040E-05	.21919	0.	0.00000	1.12392E-04	.21936	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000	8.02802E-06	.99998	0.	0.00000

COSINE 4.0000E-01 2.0000E-01

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	2.00700E-04	.70709	1.00350E-04	.99998	0.	0.00000	0.	0.00000
1.0000E-02	2.91016E-03	.27795	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	5.93782E-02	.03230	1.28930E-02	.06847	6.57608E-04	.04310	2.92666E-04	.06029
5.0000E+00	2.68638E-03	.06305	0.	0.00000	0.	0.00000	0.	0.00000
1.4000E+01	2.60509E-03	.06398	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	8.92803E-04	.12274	0.	0.00000	3.59254E-04	.34026	0.	0.00000
5.0000E+00	8.52977E-06	.55452	0.	0.00000	0.	0.00000	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000

COSINE 2.0000E-01 0.

	SURFACE 1				SURFACE 10			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	3.01051E-04	.57732	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	3.01051E-04	.99998	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	1.17912E-02	.07240	5.05765E-03	.10776	1.95557E-04	.07506	1.02999E-04	.08846
5.0000E+00	3.89359E-04	.15484	8.02802E-06	.99998	0.	0.00000	0.	0.00000
1.4000E+01	4.53583E-04	.15445	0.	0.00000	0.	0.00000	0.	0.00000
	SURFACE 11				SURFACE 14			
ENERGY	- TO +	REL. ERROR	+ TO -	REL. ERROR	- TO +	REL. ERROR	+ TO -	REL. ERROR
5.0000E-03	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E-02	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.0000E+00	3.09675E-04	.18353	0.	0.00000	0.	0.00000	0.	0.00000
5.0000E+00	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000
1.4000E+01	0.	0.00000	0.	0.00000	0.	0.00000	0.	0.00000

NUMBER FLUX INTEGRATED OVER SURFACE

TIME 0. 1.0000E-02

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	8.00788E-02	.05450
5.0000E+00	3.57769E-03	.06721
1.4000E+01	2.79901E-03	.08264

TIME 1.0000E-01 1.0000E+00

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	3.41178E-02	.07053
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	SURFACE 17	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

PATH LENGTH/VOLUME

TIME 0. 1.0000E-02

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	4.17716E-07	.51739
5.0000E-01	3.12166E-06	.14615
1.0000E+00	2.66085E-06	.12528
5.0000E+00	6.03493E-07	.12646
1.4000E+01	6.41106E-07	.14639

TIME 1.0000E-02 1.0000E-01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	4.08842E-04	.04696
5.0000E-01	7.41274E-04	.02636
1.0000E+00	2.79005E-04	.03420
5.0000E+00	5.89645E-05	.03888
1.4000E+01	5.95074E-05	.04222

TIME 1.0000E-01 1.0000E+00

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	1.78923E-04	.06573
5.0000E-01	3.86588E-05	.10721
1.0000E+00	1.89136E-07	.59416
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	CELL 3	RELATIVE ERROR
1.0000E-01	0.	0.00000
5.0000E-01	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

NUMBER FLUX AT DETECTOR

TIME 0. 1.0000E-02

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TIME 1.0000E-02 1.0000E-01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	9.71985E-30	.9999A
1.0000E+00	1.67103E-05	.02255
5.0000E+00	3.30998E-06	.02554
1.4000E+01	3.12255E-06	.02215

TIME 1.0000E-01 1.0000E+00

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	2.14581E-10	.78412
1.0000E+00	1.35727E-05	.03892
5.0000E+00	1.69817E-07	.3768A
1.4000E+01	0.	0.00000

TIME 1.0000E+00 1.0000E+01

ENERGY	DETECTOR 1	RELATIVE ERROR
5.0000E-03	0.	0.00000
1.0000E-02	0.	0.00000
1.0000E+00	0.	0.00000
5.0000E+00	0.	0.00000
1.4000E+01	0.	0.00000

TAPE DUMP NO. 3 NPS= 33217

```
20.25.56 $BMTR      JOB CARD READ WITH NO ERRORS
20.25.59 *LOS    01 CARDS          000030B
20.26.01 $RMTR      READ.  JOB READY TO BE SCHEDULED.
20.26.02 $RMTR   00  CROS 1.82 72/12/06  MACH. 14              TAPE
         SY760073
20.26.03 $UMTR      .USER MONITOR  OF   11/02/72  INITIALIZED.
20.26.03 $UMTR      .JOB NAME=SCHRAND1VJ.DATE =      72/12/08
20.26.03 *CCP    00 $JOB(NAME=SCHRANDT.CAT=05.CL=U.AC=V06.UA=9406C050M
         CP.PR=10.PL=40.TL=5M)
20.26.03 $UMTR      .FILE SET CCD      OPENED.BUFFER LENGTH =00001100.
20.26.03 $UMTR      .FILE SET INP      OPENED.BUFFER LENGTH =00010100.
20.26.03 *CCP       $. CONTINUE RUN--MCP TEST PROBLEM.
20.26.03 *CCP       $LABEL(STAGE)
20.26.03 *CCP    1  $CREATE(FS=RUNTP.CL=U.SCT=2000.PREMT=XX008199)
20.26.04 $BMTR 01  DISK ERROR CHN=2.3  DISK=A     FS=SYSLIB  REQ=READ
         $BMTR 01  ERRN=0002 TRKN=0005 SCTN=0004 MDGN=0000  VRA=0001
         $BMTR 01  PPNO=0003 SHTR=0005 SHSE=0004 SHME=0000 SPAR=0000
         $BMTR 01  ST1R=0502 SPAR=0000 ST1P=0502 ST2P=2000 SPAR=0000
20.26.04 *CCP    2  $OPEN(FS=DUMMY.SCT=2000)
20.26.04 $UMTR      .FILE SET DUMMY    OPENED.BUFFER LENGTH =LJ032100.
20.26.04 *CCP    3  $COPY(I=RUNTP.O=DUMMY)       TO VERIFY POINTER WORD
                    S
20.26.04 $UMTR      .FILE SET RUNTP    OPENED.BUFFER LENGTH =00032100.
20.26.04 $RMTR      ROLLOUT STARTED
20.26.05 $RMTR      ROLLOUT DONE
20.26.13 *LOS    05 XX008199 IS ON UNIT 1  FILE RUNTP        800  BIN
20.28.11 $RMTR       ROLLIN STARTED
20.28.12 $RMTR       ROLLIN DONE
20.28.13 *CCP    4  $IF(FALSE=READY)
20.28.13 *CCP       $LABEL(READY)      SUCCESSFUL STAGING
20.28.13 *CCP    5  $AFSREL(FS=DUMMY)
20.28.13 $UMTR      .FILE SET DUMMY    CLOSED.BUFFER LENGTH =00032100.
20.28.13            .FILE SET STATISTICS
20.28.13            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.28.13             000000000 000000150 000000000 000000000 000000010
20.28.13            .      LWA=0000141155.DEVICE=03
20.28.13 *CCP    6  $REWIND(RUNTP)
20.28.13 *CCP    7  $SETO(KEY=KKTP)
20.28.13 *CCP    8  $SETD.
20.28.13 *CCP    9  $LDGO(I=RUNTP)
20.28.15 $UMTR      .FILE SET OUT      OPENED.BUFFER LENGTH =00032100.
20.29.10 $BMTR      ROLLOUT STARTED
20.29.11 $RMTR      ROLLOUT DONE
20.35.30 $BMTR       ROLLIN STARTED
20.35.31 $BMTR       ROLLIN DONE
20.39.21  MCPPR5    .END
20.39.21 $UMTR      .FILE SET IMAGE    OPENED.BUFFER LENGTH =LJ064100.
20.39.21 $UMTR      .FILE SET IMAGE    CLOSED.BUFFER LENGTH =00064100.
20.39.21            .FILE SET STATISTICS
20.39.21            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.39.21             000000000 000000003 000000001 000000000 000000003
20.39.21            .      LWA=0000111257.DEVICE=01
20.39.21 *CCP   10  $IF(FALSE=TAPE)
20.39.21 *CCP       $LABEL(TAPE)
20.39.21 *CCP   11  $AFSREL(FS=RUNTP.ADISP=STAPE.POSMT=XX008199)
20.39.21 $UMTR      .FILE SET RUNTP    CLOSED.BUFFER LENGTH =00032100.
20.39.21            .FILE SET STATISTICS
20.39.21            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.39.21             000000177 000000002 000000003 000000016 000000009
20.39.21            .      LWA=0000204251.DEVICE=01
20.39.22 $CCP       .EOF OR EOI ON CC FILE.  FSET=CCD
20.39.22 $UMTR      .FILE SET CCD      CLOSED.BUFFER LENGTH =LJ001100.
20.39.22            .FILE SET STATISTICS
20.39.22            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.39.22             000000046 000000025 000000023 000000000 000000000
20.39.22            .      LWA=0000000000.DEVICE=00
20.39.22 $UMTR      .FILE SET INP      CLOSED.BUFFER LENGTH =00010100.
20.39.22            .FILE SET STATISTICS
20.39.22            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.39.22             000000001 000000001 000000001 000000000 000000000
20.39.22            .      LWA=0000000000.DEVICE=00
20.39.22 $UMTR      .FILE SET OUT      CLOSED.BUFFER LENGTH =00032100.
20.39.22            .FILE SET STATISTICS
20.39.22            . READS      WRITES  POSITIONS  DISK RDS  DISK WRS
20.39.22             000000000 000000560 000000000 000000000 000000001
20.39.22            .      LWA=0000010600.DEVICE=03
20.39.22 $UMTR   99 .JOB TERMINATION.
                    .ELAPSED  CP TIME = 00288.27910         .
                    .ESTIMATED JOB COST $0036.03
20.39.30 *LOS    06 XX008199 IS ON UNIT 1  FILE RUNTP        800  BIN
20.39.40 $OUTPUT   FS=RUNTP   DSP=TAPE      67754 WORDS
20.40.00 $OUTPUT   FS=OUT     DSP=PRT        4481 WORDS        6 PAGES

FILE COMPLETE    SCHRAND1VJ 2
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ALT:533(260)