Radiation Physics Note 45

Test Spectra for Testing Neutron Spectrum Unfolding Programs

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Introduction

The purpose of this Note is to provide a procedure for creating artificial input data corresponding to test spectra of any desired shape or complexity. These input data can then be used to test the accuracy, resolution, convergence and other characteristics of neutron spectrum unfolding codes.

The results of a few tests using the SWIFT Monte Carlo unfolding program (Ref. 1) are included as examples in this report. SWIFT selects the four best spectra from the many "histories" based on a worst case ball comparison and computes the average of these spectra.

Spectrum Unfolding

Various unfolding methods are based on solving the homogeneous Friedholm equation which, in discrete form, is

$$C_r = \sum_{i=1}^{n} N(E_i) R_r(E_i) \Delta E_i \qquad r=1,m \qquad (1)$$

taken over m detectors and n energy increments.

C_r = response of detector r

ΔE_i = ith energy increment

$R_r(E_i)$ = response matrix element corresponding to detector r and energy group i

$N(E_i)$ = differential neutron fluence (dN/dE_i) for the ith energy group.

Equation 1 can be rewritten as

$$C_r = \sum_{i=1}^{n} \left[N(E_i) \Delta E_i \right] R_r(E_i) \qquad (2)$$

where the quantity in brackets represents the number of neutrons (actually, n/cm^2) having energies in the range ΔE_i.

In practice the C_r are measured, $R_r(E_i)$ are calculated, and a spectrum $N(E_i)\Delta E_i$ vs E_i is obtained by unfolding. $N(E_i)$ and dose-related quantities are calculated from the unfolded spectrum. It is useful for test purposes to create test data C_r that, when properly unfolded, will yield test spectra having certain desired characteristics.

Test Spectra

Single-group test spectra are the simplest test spectra for which detector responses can be calculated. The responses C_r of the r detectors for a unit single-group spectrum in energy group i=k are (from Eq. 2).

$$C_r = \left[1\right] R_r(E_k) \qquad r=1,m \qquad (3)$$

Such single-group responses C_r are listed in the r=1,8 columns and i=1,31 rows of Tables 1 through 4. The four tables contain values of four different response functions (Refs. 2 and 3) corresponding to various detector size and polyethylene sphere density combinations.

Complex multiple-groups test spectra can be constructed by summing selected single-group elements in chosen proportions.

Examples

Several examples of multiple-group test spectra have been constructed and unfolded using SWIFT. Tables and graphs of the output are included in this report. Estimates of the rate of convergence with respect to number of histories are discussed in Ref. 1. The number of Monte Carlo histories used in this analysis was 3.15×10^6. All examples were constructed using the C_r values of Table 1.

Example 1: Peaks in Groups 23 and 25

$$C_r = \left[1\right] R_r(E_{23}) + \left[1\right] R_r(E_{25}) \quad (4)$$

Input detector counts for this spectrum were constructed by summing corresponding elements in rows 23 and 25 for each of the m=8 columns of Table 1. The input counts and counts recalculated following unfolding are listed in Tables 5A and 5B together with the results $\%N(E_i)\Delta E_i$, $N(E_i)$ and other quantities of interest. In this case all four individual (and hence the average) spectra show peaks in the correct groups in proper proportion.

The spectrum is listed in columns 10 and 11 of Table 5A and plotted in Figure 1A in such a way that visual intergation is possible. The area under the curve for each energy bin is proportional to the neutron fluence within that bin. The figure shows the spectrum contains peaks in groups 23 and 25 in proper proportion.

It is clear from the results of this test that SWIFT unfolded the spectrum correctly.

Example 2: Peaks in Groups 1 and 12

$$C_r = \left[0.7\right] R_r(E_1) + \left[0.3\right] R_r(E_{12}) \quad (5)$$

This spectrum was constructed by adding 0.7 times the elements of row 1 to 0.3 times the elements of row 12 for each column r of Table 1. The SWIFT output is shown in Tables 6A and 6B and Figure 2. SWIFT unfolded this spectrum with only partial success. The respective areas under the peaks in group 1 and the combination of groups 12 and 13 of Fig. 2A are approximately in the proper proportion. Inspection of columns 3, 5, 7 and 9 of Table 6B shows that 3 of the 4 individual spectra are correct but the fourth deviates from the expected spectrum. One could expect that SWIFT would eventially find a suitable fourth spectrum if more histories were run.

Example 3: Peaks in Groups 23, 25 and 27

$$C_r = \left[1\right] R_r(E_{23}) + \left[1\right] R_r(E_{25}) + \left[1\right] R_r(E_{27}) \qquad (6)$$

This example is an extension of Example 1 with a third group added. The SWIFT output is found in Tables 7A and 7B and Figure 3. It is expected that one third of the fluence would be found in each of the three groups. However, columns 5 of Table 7A and columns 3, 5, 7, 9 of Table 7B show that SWIFT has failed to produce the proper spectrum. Three of the four individual spectra properly placed about one third of the fluence in group 23 but group 25 incorrectly contains the rest of the fluence. It is possible that spectra containing 3 or more peaks could be resolved by SWIFT if enough histories were taken (See Ref. 1). However, the cost in CPU time to give this a true test is prohibitive.

Example 4: Peaks in Groups 1, 2, 3, and 4

$$C_r = \left[1\right] R_r(E_1 + \left[1\right] R_r(E_2) + \left[1\right] R_r(E_3) + \left[1\right] R_r(E_4) \quad (7)$$

This test is constructed by adding the first four elements in each column of Table 1. The SWIFT results are shown in Tables 8A and 8B and Figure 4. The %N(E)DE values in the tables show that one fourth of the fluence is in group 1 but the remaining fluence is in group 3. Figure 4A shows this graphically as histogram areas. The error bars in the figure are small and would mislead one into thinking that a correct solution had been obtained if the test spectrum were not known.

The results of Examples 3 and 4 show that complex spectra unfolded by SWIFT may likely be in error, especially if too few histories are included in the analysis.

Example 5: Equal Fluence in All 31 Groups

$$C_r = \sum_{i=1}^{31} \left[1\right] R_r(E_i) \quad (8)$$

The m=8 detector input data are the sums of the n=31 elements in each of the 8 columns of Table 1. The SWIFT results are listed in Tables 9A and 9B and shown in Figure 5. SWIFT yields the fluence in group 1 with a small error and the remaining flux is spread (apparently) randomly among the remaining thirty groups. These results are not inconsistent with what one might expect.

However, the large error bars would indicate that the spectrum is not sufficiently resolved.

It should be noted that in Examples 2, 4, 5 and other tests not shown, the part of the spectrum contained in group 1 appears correct and has a small error even if the rest of the spectrum is incorrect or uncertain.

Comments

Single- and double-group spectra can usually be unfolded by SWIFT with good resolution provided a sufficient number of histories are run (Ref. 1). However, more complex test spectra and actual measured spectra probably can not be unfolded in precise detail by SWIFT, at least using reasonable amounts of computer time.

This is not to say that SWIFT is not useful in spectral analysis. On the contrary, to put the problem in proper perspective we must focus on what information is usually sought when unfolding codes are used. An important goal with spectrum measurements is to obtain information about dose, dose equivalent, and quality factors.

For four of the five examples described in this Note (see Table 10) dose, dose equivalent and quality factor values from SWIFT are within a few percent of the expected values calculated from the original test spectra. This is, indeed, encouraging. However, the discrepancy in Example 3 illustrates the effect errors in the unfolded spectrum can have on dose-related quantities.

The moral here, if a moral is to be drawn, is that future emphasis should go toward understanding errors and limitations in dose-related quantities obtained with unfolding codes.

Summary

Input data for single-group test spectra are listed in the tables. Five examples are shown to illustrate the method of constructing multiple-group test spectra from the single-group input data. Such multiple-group spectra can be used to test the characteristics of spectrum unfolding programs.

The Monte Carlo program SWIFT was used to unfold the spectra in the five examples. Some of the successes and limitations of SWIFT are pointed out.

Acknowledgment: Appreciation is expressed to Alex Elwyn for reading a draft of this Note and for offering valuable suggestions.

References

1. O'Brien, K. and Sanna, R. 1981, "Neutron Spectrum Unfolding Using the Monte Carlo Method," Nucl. Instr. and Meth. 214, p. 547-549.

2. Sanna, R., 1973, "Thirty One Group Response Matrices for the Multisphere Neutron Spectrometer Over the Energy Range Thermal to 400 MeV," USAEC, HASL-267.

3. Couch, J., 1984, "Response Matrices for Polyethylene Bonner Spheres of Density 0.92 g/cm^3," Fermilab Radiation Physics Note 43.

Tables

Figures

Table 1

THESE DETECTOR INPUT VALUES WILL YIELD SINGLE GROUP TEST SPECTRA WHEN UNFOLDED WITH SWIFT

4X4 MM DETECTOR .95 DENSITY

GRP	ENERGY	BARE	2 INCH	3 INCH	5 INCH	8 INCH	10 INCH	12 INCH	18 INCH
1	6.4340E-08	1.6854E-01	1.2852E-01	9.7515E-02	4.7543E-02	1.2653E-02	4.8054E-03	1.7332E-03	4.2525E-05
2	5.3160E-07	1.1327E-01	2.6279E-01	2.1168E-01	1.0261E-01	2.6903E-02	1.0161E-02	3.6564E-03	9.2207E-05
3	9.9320E-07	9.4778E-02	2.8930E-01	2.5294E-01	1.2606E-01	3.2995E-02	1.2442E-02	4.4758E-03	1.1514E-04
4	2.1020E-06	7.4135E-02	2.9784E-01	2.8439E-01	1.4762E-01	3.8738E-02	1.4594E-02	5.2508E-03	1.3778E-04
5	4.4510E-06	5.6322E-02	2.9081E-01	3.0303E-01	1.6529E-01	4.3653E-02	1.6441E-02	5.9170E-03	1.5819E-04
6	9.4230E-06	4.1793E-02	2.7498E-01	3.1239E-01	1.8023E-01	4.8075E-02	1.8107E-02	6.5193E-03	1.7746E-04
7	1.9950E-05	3.0286E-02	2.5451E-01	3.1486E-01	1.9308E-01	5.2201E-02	1.9669E-02	7.0849E-03	1.9626E-04
8	4.2230E-05	2.1592E-02	2.3206E-01	3.1219E-01	2.0421E-01	5.6152E-02	2.1176E-02	7.6313E-03	2.1502E-04
9	8.9410E-05	1.5240E-02	2.0928E-01	3.0564E-01	2.1382E-01	6.0000E-02	2.2657E-02	8.1696E-03	2.3401E-04
10	1.8930E-04	1.0811E-02	1.8717E-01	2.9629E-01	2.2211E-01	6.3817E-02	2.4144E-02	8.7115E-03	2.5357E-04
11	4.0410E-04	7.6454E-03	1.6634E-01	2.8493E-01	2.2916E-01	6.7632E-02	2.5652E-02	9.2632E-03	2.7387E-04
12	8.5540E-04	5.2735E-03	1.4707E-01	2.7216E-01	2.3497E-01	7.1450E-02	2.7190E-02	9.8278E-03	2.9500E-04
13	1.7960E-03	3.6579E-03	1.2949E-01	2.5862E-01	2.3989E-01	7.5388E-02	2.8809E-02	1.0425E-02	3.1762E-04
14	3.8020E-03	2.5755E-03	1.1357E-01	2.4477E-01	2.4427E-01	7.9611E-02	3.0582E-02	1.1083E-02	3.4271E-04
15	8.0480E-03	1.9348E-03	9.9158E-02	2.3095E-01	2.4873E-01	8.4475E-02	3.2668E-02	1.1862E-02	3.7243E-04
16	1.7040E-02	1.4500E-03	8.5947E-02	2.1740E-01	2.5440E-01	9.0743E-02	3.5413E-02	1.2893E-02	4.1165E-04
17	3.6070E-02	1.1018E-03	7.3447E-02	2.0392E-01	2.6292E-01	9.9956E-02	3.9555E-02	1.4468E-02	4.7145E-04
18	7.6350E-02	8.6945E-04	6.0893E-02	1.8931E-01	2.7627E-01	1.1537E-01	4.6842E-02	1.7308E-02	5.8120E-04
19	1.5760E-01	1.1751E-03	4.8106E-02	1.7119E-01	2.9329E-01	1.4143E-01	6.0500E-02	2.2973E-02	8.1618E-04
20	3.1760E-01	1.8542E-03	3.5256E-02	1.4577E-01	3.0607E-01	1.8344E-01	8.7274E-02	3.5767E-02	1.4869E-03
21	6.3950E-01	4.4492E-04	2.2515E-02	1.1167E-01	2.9930E-01	2.3996E-01	1.3148E-01	6.5539E-02	4.2358E-03
22	1.2870E+00	2.7026E-04	1.3117E-02	7.8327E-02	2.7672E-01	3.1410E-01	2.2464E-01	1.3709E-01	1.9273E-02
23	2.5930E+00	1.7899E-04	6.3270E-03	4.3506E-02	1.9417E-01	2.9716E-01	2.5929E-01	1.9443E-01	5.3320E-02
24	5.2210E+00	1.0212E-04	2.8111E-03	2.1791E-02	1.2033E-01	2.4234E-01	2.5271E-01	2.2732E-01	1.1088E-01
25	1.0510E+01	5.0065E-05	1.1240E-03	9.5620E-03	6.2602E-02	1.5676E-01	1.8753E-01	1.9337E-01	1.4300E-01
26	1.9620E+01	4.5946E-05	5.6625E-04	4.6141E-03	3.0087E-02	7.7386E-02	9.5157E-02	1.0138E-01	8.4305E-02
27	3.3950E+01	3.0015E-05	3.3619E-04	2.7406E-03	1.8369E-02	4.9672E-02	6.3345E-02	7.0151E-02	6.6262E-02
28	5.8730E+01	1.8732E-05	2.2399E-04	1.8495E-03	1.2700E-02	3.5823E-02	4.7160E-02	5.4066E-02	5.7515E-02
29	1.0160E+02	1.2187E-05	1.7340E-04	1.4579E-03	1.0216E-02	2.9912E-02	4.0501E-02	4.7852E-02	5.6262E-02
30	1.7580E+02	7.9545E-06	1.4230E-04	1.2418E-03	9.0718E-03	2.7837E-02	3.8754E-02	4.7023E-02	5.9752E-02
31	3.0410E+02	4.6976E-06	1.2274E-04	1.0990E-03	8.1887E-03	2.5791E-02	3.6530E-02	4.5101E-02	6.0432E-02

Table 2

THESE DETECTOR INPUT VALUES WILL YIELD SINGLE GROUP TEST SPECTRA WHEN UNFOLDED WITH SWIFT

4X4 MM DETECTOR .92 DENSITY

GRP	ENERGY	BARE	2 INCH	3 INCH	5 INCH	8 INCH	10 INCH	12 INCH	18 INCH
1	6.4340E-08	1.6854E-01	9.9090E-02	5.1270E-02	1.0377E-02	5.5630E-04	6.5012E-05	6.8313E-06	2.2557E-09
2	5.3160E-07	1.1327E-01	5.2357E-01	3.0660E-01	6.1178E-02	3.1665E-03	3.6523E-04	3.8109E-05	1.3197E-08
3	9.9320E-07	9.4778E-02	6.6942E-01	4.6328E-01	9.8294E-02	5.0691E-03	5.8251E-04	6.0682E-05	2.1777E-08
4	2.1020E-06	7.4135E-02	7.3823E-01	6.0961E-01	1.4136E-01	7.3372E-03	8.4146E-04	8.7607E-05	3.2588E-08
5	4.4510E-06	5.6322E-02	7.2203E-01	7.0974E-01	1.8327E-01	9.6606E-03	1.1073E-03	1.1528E-04	4.4366E-08
6	9.4230E-06	4.1793E-02	6.5534E-01	7.6636E-01	2.2348E-01	1.2063E-02	1.3830E-03	1.4403E-04	5.7281E-08
7	1.9950E-05	3.0286E-02	5.6487E-01	7.8579E-01	2.6163E-01	1.4578E-02	1.6734E-03	1.7435E-04	7.1588E-08
8	4.2230E-05	2.1592E-02	4.6866E-01	7.7556E-01	2.9737E-01	1.7239E-02	1.9833E-03	2.0678E-04	8.7571E-08
9	8.9410E-05	1.5240E-02	3.7761E-01	7.4293E-01	3.3018E-01	2.0070E-02	2.3172E-03	2.4180E-04	1.0553E-07
10	1.8930E-04	1.0811E-02	2.9733E-01	6.9514E-01	3.5990E-01	2.3117E-02	2.6821E-03	2.8021E-04	1.2592E-07
11	4.0410E-04	7.6454E-03	2.2986E-01	6.3784E-01	3.8621E-01	2.6401E-02	3.0832E-03	3.2262E-04	1.4916E-07
12	8.5540E-04	5.2735E-03	1.7495E-01	5.7555E-01	4.0698E-01	2.9926E-02	3.5244E-03	3.6953E-04	1.7564E-07
13	1.7960E-03	3.6579E-03	1.3147E-01	5.1262E-01	4.2760E-01	3.3818E-02	4.0246E-03	4.2309E-04	2.0663E-07
14	3.8020E-03	2.5755E-03	9.7623E-02	4.5188E-01	4.4486E-01	3.8280E-02	4.6155E-03	4.8688E-04	2.4431E-07
15	8.0480E-03	1.9348E-03	7.1597E-02	3.9509E-01	4.6263E-01	4.3799E-02	5.3687E-03	5.6898E-04	2.9360E-07
16	1.7040E-02	1.4500E-03	5.1536E-02	3.4310E-01	4.8583E-01	5.1519E-02	6.4576E-03	6.8890E-04	3.6661E-07
17	3.6070E-02	1.1018E-03	3.5826E-02	2.9501E-01	5.2195E-01	6.4141E-02	8.3157E-03	8.9737E-04	4.9591E-07
18	7.6350E-02	8.6945E-04	2.3179E-02	2.4692E-01	5.8124E-01	8.8697E-02	1.2228E-02	1.3530E-03	7.9167E-07
19	1.5760E-01	1.1751E-03	1.3535E-02	1.9392E-01	6.5991E-01	1.4014E-01	2.1839E-02	2.5803E-03	1.6930E-06
20	3.1760E-01	1.8542E-03	6.9128E-03	1.3276E-01	7.1592E-01	2.4950E-01	4.9638E-02	7.0045E-03	6.4637E-06
21	6.3950E-01	4.4492E-04	2.4220E-03	7.0352E-02	6.6279E-01	4.4659E-01	1.2768E-01	2.6844E-02	6.5490E-05
22	1.2870E+00	2.7026E-04	6.9842E-04	3.0311E-02	5.3435E-01	7.8921E-01	3.9209E-01	1.3507E-01	1.8226E-03
23	2.5930E+00	1.7899E-04	1.3382E-04	7.6891E-03	2.2879E-01	6.6255E-01	5.1327E-01	2.7961E-01	1.6567E-02
24	5.2210E+00	1.0212E-04	2.1442E-05	1.5434E-03	7.3684E-02	3.9575E-01	4.5673E-01	3.7318E-01	7.9455E-02
25	1.0510E+01	5.0065E-05	2.7026E-06	2.2943E-04	1.5950E-02	1.3984E-01	2.1953E-01	2.4336E-01	1.3098E-01
26	1.9620E+01	4.5946E-05	5.2988E-07	4.2686E-05	2.9454E-03	2.7334E-02	4.5554E-02	5.4244E-02	3.7798E-02
27	3.3950E+01	3.0015E-05	1.5505E-07	1.2791E-05	9.4012E-04	9.7500E-03	1.7616E-02	2.2852E-02	2.1108E-02
28	5.8730E+01	1.8732E-05	6.4188E-08	5.2075E-06	4.0068E-04	4.5568E-03	8.8296E-03	1.2361E-02	1.4833E-02
29	1.0160E+02	1.2187E-05	4.2484E-08	3.0975E-06	2.4285E-04	2.9897E-03	6.1614E-03	9.2173E-03	1.3794E-02
30	1.7590E+02	7.9545E-06	3.8552E-08	2.2912E-06	1.8557E-04	2.5213E-03	5.5259E-03	8.7708E-03	1.5604E-02
31	3.0410E+02	4.6976E-06	4.7584E-08	1.9873E-06	1.4947E-04	2.1192E-03	4.8164E-03	7.9379E-03	1.5875E-02

Table 3

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GRP	ENERGY	BARE	2 INCH	3 INCH	5 INCH	8 INCH	10 INCH	12 INCH	18 INCH
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2	5.3160E-07	6.0763E-01	9.1903E-01	7.1837E-01	3.4491E-01	9.0270E-02	3.4030E-02	1.2334E-02	4.1419E-04
3	9.9320E-07	5.4393E-01	1.0248E+00	8.6126E-01	4.2383E-01	1.1071E-01	4.1671E-02	1.5087E-02	5.1052E-04
4	2.1020E-06	4.5725E-01	1.0699E+00	9.7249E-01	4.9656E-01	1.2998E-01	4.8884E-02	1.7688E-02	6.0329E-04
5	4.4510E-06	3.8739E-01	1.0590E+00	1.0411E+00	5.5632E-01	1.4648E-01	5.5072E-02	1.9920E-02	6.8469E-04
6	9.4230E-06	2.8685E-01	1.0143E+00	1.0786E+00	6.0709E-01	1.6132E-01	6.0657E-02	2.1936E-02	7.5964E-04
7	1.9950E-05	2.1603E-01	9.4994E-01	1.0926E+00	6.5103E-01	1.7517E-01	6.5893E-02	2.3827E-02	8.3118E-04
8	4.2230E-05	1.5878E-01	8.7535E-01	1.0885E+00	6.8938E-01	1.8845E-01	7.0944E-02	2.5653E-02	9.0127E-04
9	8.9410E-05	1.1463E-01	7.9678E-01	1.0706E+00	7.2275E-01	2.0139E-01	7.5909E-02	2.7451E-02	9.7113E-04
10	1.8930E-04	8.2564E-02	7.1846E-01	1.0424E+00	7.5183E-01	2.1423E-01	8.0897E-02	2.9260E-02	1.0422E-03
11	4.0410E-04	5.8971E-02	6.4301E-01	1.0065E+00	7.7682E-01	2.2709E-01	8.5959E-02	3.1102E-02	1.1151E-03
12	8.5540E-04	4.1096E-02	5.7195E-01	9.6496E-01	7.9777E-01	2.3996E-01	9.1119E-02	3.2988E-02	1.1902E-03
13	1.7960E-03	2.8730E-02	5.0620E-01	9.2008E-01	8.1576E-01	2.5326E-01	9.6553E-02	3.4982E-02	1.2702E-03
14	3.8020E-03	2.0310E-02	4.4594E-01	8.7350E-01	8.3198E-01	2.6754E-01	1.0251E-01	3.7180E-02	1.3585E-03
15	8.0480E-03	1.5303E-02	3.9089E-01	8.2658E-01	8.4863E-01	2.8401E-01	1.0952E-01	3.9782E-02	1.4630E-03
16	1.7040E-02	1.1498E-02	3.4006E-01	7.8024E-01	8.6961E-01	3.0526E-01	1.1875E-01	4.3232E-02	1.6013E-03
17	3.6070E-02	8.7511E-03	2.9165E-01	7.3388E-01	9.0069E-01	3.3652E-01	1.3268E-01	4.8502E-02	1.8123E-03
18	7.6350E-02	6.9113E-03	2.4274E-01	6.8326E-01	9.4898E-01	3.8894E-01	1.5722E-01	5.8017E-02	2.1983E-03
19	1.5760E-01	9.3027E-03	1.9307E-01	6.1980E-01	1.0107E+00	4.7788E-01	2.0335E-01	7.7027E-02	3.0143E-03
20	3.1760E-01	1.4685E-02	1.4402E-01	5.3013E-01	1.0587E+00	6.2211E-01	2.9421E-01	1.2013E-01	5.3011E-03
21	6.3950E-01	3.5567E-03	9.2192E-02	4.0714E-01	1.0387E+00	8.1749E-01	4.6113E-01	2.2104E-01	1.4569E-03
22	1.2870E+00	2.1546E-03	5.4062E-02	2.8617E-01	9.6275E-01	1.0746E+00	7.6472E-01	4.6493E-01	6.5336E-03
23	2.5930E+00	1.4310E-03	2.6362E-02	1.5930E-01	6.7653E-01	1.0193E+00	8.8557E-01	6.6190E-01	1.8064E-01
24	5.2210E+00	8.1679E-04	1.1865E-02	7.9972E-02	4.1967E-01	8.3256E-01	8.6483E-01	7.7570E-01	3.7619E-01
25	1.0510E+01	4.0010E-04	4.8064E-03	3.5168E-02	2.1846E-01	5.3903E-01	6.4242E-01	6.6063E-01	4.8565E-01
26	1.9620E+01	3.6683E-04	2.4879E-03	1.7041E-02	1.0505E-01	2.6613E-01	3.2605E-01	3.4647E-01	2.8640E-01
27	3.3950E+01	2.4014E-04	1.4920E-03	1.0141E-02	6.4161E-02	1.7085E-01	2.1710E-01	2.3979E-01	2.2516E-01
28	5.8730E+01	1.5034E-04	9.9289E-04	6.8447E-03	4.4364E-02	1.2323E-01	1.6165E-01	1.8484E-01	1.9548E-01
29	1.0160E+02	9.7882E-05	7.6236E-04	5.3868E-03	3.5679E-02	1.0290E-01	1.3883E-01	1.6360E-01	1.9124E-01
30	1.7580E+02	6.3898E-05	6.1803E-04	4.5805E-03	3.1676E-02	9.5759E-02	1.3284E-01	1.6078E-01	2.0311E-01
31	3.0410E+02	3.7765E-05	5.2507E-04	4.0441E-03	2.8583E-02	8.7714E-02	1.2521E-01	1.5420E-01	2.0542E-01

Table 4

THESE DETECTOR INPUT VALUES WILL YIELD SINGLE GROUP TEST SPECTRA WHEN UNFOLDED WITH SWIFT

8X8 MM DETECTOR .92 DENSITY

GRP	ENERGY	BARE	2 INCH	3 INCH	5 INCH	8 INCH	10 INCH	12 INCH	18 INCH
1	6.4340E-08	7.2254E-01	4.5662E-01	3.4398E-01	1.7239E-01	4.8578E-02	1.9179E-02	7.3048E-03	3.1118E-04
2	5.3160E-07	6.0763E-01	9.3960E-01	7.4821E-01	3.7254E-01	1.0339E-01	4.0592E-02	1.5394E-02	6.5718E-04
3	9.9320E-07	5.4393E-01	1.0421E+00	8.9438E-01	4.5771E-01	1.2683E-01	4.9719E-02	1.8829E-02	8.0661E-04
4	2.1020E-06	4.5725E-01	1.0822E+00	1.0063E+00	5.3588E-01	1.4893E-01	5.8336E-02	2.2073E-02	9.4933E-04
5	4.4510E-06	3.8739E-01	1.0660E+00	1.0731E+00	5.9970E-01	1.6784E-01	6.5725E-02	2.4855E-02	1.0733E-03
6	9.4230E-06	2.8695E-01	1.0161E+00	1.1071E+00	6.5345E-01	1.8482E-01	7.2392E-02	2.7366E-02	1.1864E-03
7	1.9950E-05	2.1603E-01	9.4705E-01	1.1167E+00	6.9942E-01	2.0066E-01	7.8645E-02	2.9720E-02	1.2935E-03
8	4.2230E-05	1.5878E-01	8.6847E-01	1.1077E+00	7.3906E-01	2.1581E-01	8.4670E-02	3.1994E-02	1.3976E-03
9	8.9410E-05	1.1463E-01	7.8665E-01	1.0845E+00	7.7292E-01	2.3053E-01	9.0590E-02	3.4231E-02	1.5009E-03
10	1.8930E-04	8.2564E-02	7.0584E-01	1.0512E+00	8.0182E-01	2.4509E-01	9.6534E-02	3.6481E-02	1.6054E-03
11	4.0410E-04	5.8971E-02	6.2859E-01	1.0104E+00	8.2615E-01	2.5962E-01	1.0256E-01	3.8771E-02	1.7121E-03
12	8.5540E-04	4.1096E-02	5.5631E-01	9.6424E-01	8.4441E-01	2.7410E-01	1.0869E-01	4.1115E-02	1.8217E-03
13	1.7960E-03	2.8730E-02	4.8986E-01	9.1513E-01	8.6204E-01	2.8899E-01	1.1514E-01	4.3592E-02	1.9382E-03
14	3.8020E-03	2.0310E-02	4.2930E-01	8.6475E-01	8.7617E-01	3.0490E-01	1.2219E-01	4.6322E-02	2.0666E-03
15	8.0480E-03	1.5303E-02	3.7430E-01	8.1436E-01	8.9033E-01	3.2317E-01	1.3048E-01	4.9551E-02	2.2185E-03
16	1.7040E-02	1.1498E-02	3.2393E-01	7.6468E-01	9.0847E-01	3.4665E-01	1.4136E-01	5.3829E-02	2.4198E-03
17	3.6070E-02	8.7511E-03	2.7591E-01	7.1492E-01	9.3603E-01	3.8103E-01	1.5773E-01	6.0359E-02	2.7273E-03
18	7.6350E-02	6.9113E-03	2.2790E-01	6.6063E-01	9.7919E-01	4.3821E-01	1.8639E-01	7.2107E-02	3.2890E-03
19	1.5760E-01	9.3027E-03	1.7987E-01	5.9374E-01	1.0326E+00	5.3358E-01	2.3951E-01	9.5346E-02	4.4693E-03
20	3.1760E-01	1.4685E-02	1.3354E-01	5.0245E-01	1.0673E+00	6.8354E-01	3.4119E-01	1.4672E-01	7.7110E-03
21	6.3950E-01	3.5567E-03	8.4498E-02	3.8088E-01	1.0301E+00	8.7696E-01	5.1976E-01	2.6152E-01	2.0139E-03
22	1.2870E+00	2.1546E-03	4.9099E-02	2.6402E-01	9.3682E-01	1.1192E+00	8.2922E-01	5.2391E-01	8.2437E-03
23	2.5930E+00	1.4310E-03	2.3838E-02	1.4538E-01	6.4776E-01	1.0353E+00	9.2925E-01	7.1543E-01	2.1179E-01
24	5.2210E+00	8.1679E-04	1.0705E-02	7.2302E-02	3.9596E-01	8.2690E-01	8.8177E-01	8.0886E-01	4.1531E-01
25	1.0510E+01	4.0010E-04	4.3332E-03	3.1567E-02	2.0372E-01	5.2617E-01	6.4103E-01	6.7101E-01	5.1433E-01
26	1.9620E+01	3.6683E-04	2.2432E-03	1.5304E-02	9.7900E-02	2.5901E-01	3.2381E-01	3.4963E-01	2.9963E-01
27	3.3950E+01	2.4014E-04	1.3433E-03	9.0969E-03	5.9654E-02	1.6556E-01	2.1435E-01	2.4017E-01	2.3253E-01
28	5.8730E+01	1.5034E-04	8.9662E-04	6.1380E-03	4.1174E-02	1.1898E-01	1.5879E-01	1.8390E-01	1.9943E-01
29	1.0160E+02	9.7882E-05	6.9564E-04	4.8379E-03	3.3067E-02	9.9029E-02	1.3577E-01	1.6183E-01	1.9315E-01
30	1.7580E+02	6.3898E-05	5.7448E-04	4.1504E-03	2.9298E-02	9.1841E-02	1.2937E-01	1.5826E-01	2.0364E-01
31	3.0410E+02	3.7765E-05	4.9927E-04	3.6749E-03	2.6436E-02	8.4926E-02	1.2163E-01	1.5130E-01	2.0492E-01

Table 5A: Example 1

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
R314495
TEST 6

GRP	E(MEV)	N(E)	% STD. DEV.	PERCENT N(E)*DE	DE	INT RAD	INT REM	INT FLUX	E*N(E)	ERROR
1	6.434E-08	4.595E-01	193.823	.00	4.0400E-07	.00	.00	.00	1.1479E-07	2.2250E-07
2	5.316E-07	4.104E-08	133.474	.00	2.6860E-07	.00	.00	.00	5.0756E-14	6.7746E-14
3	9.932E-07	1.075E-02	200.000	.00	7.6240E-07	.00	.00	.00	2.5157E-08	5.0314E-08
4	2.102E-06	1.301E-08	197.984	.00	1.6140E-06	.00	.00	.00	6.4452E-14	1.2889E-13
5	4.451E-06	1.318E-06	199.996	.00	3.4170E-06	.00	.00	.00	1.3826E-11	2.7652E-11
6	9.423E-06	6.434E-05	155.324	.00	7.2340E-06	.00	.00	.00	1.4290E-09	2.2195E-09
7	1.995E-05	8.322E-06	182.325	.00	1.5310E-05	.00	.00	.00	3.9121E-10	7.1328E-10
8	4.223E-05	2.854E-01	199.979	.00	3.2420E-05	.00	.00	.00	2.8405E-05	5.6804E-05
9	8.941E-05	1.204E-06	124.211	.00	6.8660E-05	.00	.00	.00	2.5374E-10	3.1517E-10
10	1.893E-04	1.707E-03	199.998	.00	1.4530E-04	.00	.00	.00	7.6139E-07	1.5228E-06
11	4.041E-04	3.435E-03	123.285	.00	3.1750E-04	.00	.00	.00	3.2749E-06	4.0375E-06
12	8.554E-04	3.708E-08	199.999	.00	6.4110E-04	.00	.00	.00	7.4681E-11	1.4936E-10
13	1.796E-03	5.046E-16	199.395	.00	1.3790E-03	.00	.00	.00	2.1356E-18	4.2583E-18
14	3.802E-03	2.869E-07	193.931	.00	2.9180E-03	.00	.00	.00	2.5704E-09	4.9849E-09
15	8.048E-03	2.353E-06	200.000	.00	6.1790E-03	.00	.00	.00	4.4635E-08	8.9270E-08
16	1.704E-02	1.150E-10	164.422	.00	1.3080E-02	.00	.00	.00	4.6171E-12	7.5915E-12
17	3.607E-02	6.859E-07	199.982	.00	2.7680E-02	.00	.00	.00	5.8302E-08	1.1659E-07
18	7.635E-02	1.825E-06	199.991	.00	5.8630E-02	.00	.00	.00	3.2834E-07	6.5665E-07
19	1.576E-01	2.691E-05	200.000	.00	1.1260E-01	.00	.00	.00	9.9671E-06	1.9934E-05
20	3.176E-01	2.077E-13	171.031	.00	2.2710E-01	.00	.00	.00	1.5501E-13	2.6511E-13
21	6.395E-01	2.035E-11	199.999	.00	4.5640E-01	.00	.00	.00	3.0574E-11	6.1146E-11
22	1.287E+00	1.829E-11	187.493	.00	9.1980E-01	.00	.00	.00	5.5339E-11	1.0376E-10
23	2.593E+00	5.384E-01	1.390	49.83	1.8520E+00	.39	.44	.50	3.2804E+00	4.5601E-02
24	5.221E+00	9.536E-07	200.000	.00	3.7290E+00	.39	.44	.50	1.1698E-05	2.3397E-05
25	1.051E+01	1.336E-01	1.922	50.17	7.5120E+00	1.00	1.00	1.00	3.3014E+00	6.3460E-02
26	1.962E+01	1.796E-10	199.935	.00	1.0890E+01	1.00	1.00	1.00	8.2160E-09	1.6427E-08
27	3.395E+01	2.332E-11	199.403	.00	1.8840E+01	1.00	1.00	1.00	1.8461E-09	3.6812E-09
28	5.873E+01	3.141E-07	200.000	.00	3.2600E+01	1.00	1.00	1.00	4.3011E-05	8.6022E-05
29	1.016E+02	1.004E-11	200.000	.00	5.6350E+01	1.00	1.00	1.00	2.3779E-09	4.7557E-09
30	1.756E+02	1.764E-12	168.970	.00	9.7600E+01	1.00	1.00	1.00	7.2264E-10	1.2210E-09
31	3.041E+02	4.897E-17	199.995	.00	1.6880E+02	1.00	1.00	1.00	3.4719E-14	6.9436E-14

DETECTOR	INPUT COUNTS	RECALCULATED COUNTS	PERCENT DIFFERENCE
BARE	2.291E-04	2.290E-04	-2.836E-02
2 INCH	7.451E-03	7.440E-03	-1.449E-01
3 INCH	5.307E-02	5.299E-02	-1.524E-01
5 INCH	2.568E-01	2.565E-01	-1.152E-01
8 INCH	4.539E-01	4.537E-01	-4.923E-02
10 INCH	4.468E-01	4.468E-01	1.704E-04
12 INCH	3.878E-01	3.880E-01	5.266E-02
18 INCH	1.963E-01	1.967E-01	2.053E-01

TOTAL FLUENCE (FLUX) = 2.001E+00 N/CM**2   STD DEV = 2.376E-02
ABSORBED DOSE (RATE) = 1.086E-08RADS   ST DEV = 1.405E-10
DOSE EQUIVALENT (RATE)= 8.239E-06 REMS   ST DEV = 1.022E-09
AVERAGE ENERGY = .66E+01 MEV
QUALITY FACTOR = 7.5393

Table 5B: Example 1

THE OUTPUT ON THIS PAGE IS FOR THE FOUR INDIVIDUA SPECTRA

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
TEST 6

SAMPLE SPACE	INVERSE	INVERSE	INVERSE	INVERSE
ERROR ESTIMATOR	3.068E-03	4.017E-03	9.299E-03	1.527E-02
HISTORY NUMBER	265393	617791	1945999	2223729
TOTAL FLUENCE	1.998E+00	2.002E+00	1.996E+00	2.008E+00
ABSORBED DOSE	1.082E-08	1.087E-08	1.079E-08	1.095E-08
DOSE EQUIV.	8.220E-08	8.246E-08	8.200E-08	8.290E-08
QUALITY FACTOR	7.595E+00	7.587E+00	7.602E+00	7.573E+00

DETECTOR	INPUT CTS	RECALCULATED CTS....			
BARE	2.291E-04	2.060E-01	-2.573E-01	9.298E-01	-1.012E+00
2 INCH	7.451E-03	2.690E-01	-3.423E-01	8.242E-01	-1.357E+00
3 INCH	5.307E-02	2.354E-01	-3.078E-01	6.495E-01	-1.206E+00
5 INCH	2.568E-01	1.724E-01	-2.263E-01	4.632E-01	-8.802E-01
8 INCH	4.539E-01	7.151E-02	-9.536E-02	1.918E-01	-3.666E-01
10 INCH	4.468E-01	-1.797E-03	1.372E-03	-5.584E-03	6.690E-03
12 INCH	3.878E-01	-7.972E-02	1.040E-01	-2.158E-01	4.000E-01
18 INCH	1.963E-01	-3.071E-01	4.017E-01	-8.324E-01	1.527E+00

GRP	N(E)	% N(E)*DE						
1	4.29E-02	.00	4.36E-11	.00	1.79E+00	.00	1.38E-10	.00
2	6.91E-10	.00	1.16E-07	.00	1.64E-18	.00	4.73E-08	.00
3	4.30E-02	.00	5.49E-08	.00	1.37E-35	.00	2.38E-09	.00
4	3.56E-20	.00	3.08E-12	.00	5.20E-08	.00	2.83E-17	.00
5	6.89E-11	.00	1.02E-21	.00	6.51E-13	.00	5.27E-06	.00
6	6.40E-06	.00	2.12E-04	.00	1.98E-11	.00	3.89E-05	.00
7	3.10E-05	.00	2.26E-06	.00	4.78E-16	.00	1.36E-14	.00
8	1.26E-09	.00	9.13E-05	.00	1.14E+00	.00	4.20E-22	.00
9	1.81E-13	.00	1.73E-06	.00	3.08E-06	.00	5.78E-33	.00
10	4.89E-08	.00	1.16E-10	.00	6.83E-03	.00	4.63E-09	.00
11	8.69E-03	.00	6.02E-09	.00	5.05E-03	.00	1.46E-17	.00
12	2.74E-16	.00	4.74E-13	.00	1.48E-07	.00	7.27E-15	.00
13	2.07E-28	.00	4.52E-18	.00	2.01E-15	.00	6.19E-20	.00
14	5.75E-19	.00	2.63E-08	.00	1.12E-06	.00	9.22E-16	.00
15	9.41E-06	.00	1.91E-17	.00	5.72E-20	.00	2.13E-25	.00
16	4.96E-16	.00	3.85E-11	.00	2.39E-11	.00	3.98E-10	.00
17	1.67E-10	.00	2.74E-06	.00	1.60E-13	.00	1.74E-11	.00
18	7.53E-12	.00	4.15E-23	.00	7.30E-06	.00	2.28E-10	.00
19	3.31E-12	.00	1.08E-04	.00	9.98E-11	.00	2.42E-16	.00
20	9.45E-14	.00	7.36E-13	.00	1.17E-19	.00	2.41E-21	.00
21	1.69E-16	.00	8.14E-11	.00	4.88E-18	.00	1.09E-19	.00
22	1.22E-13	.00	2.55E-12	.00	7.60E-13	.00	6.97E-11	.00
23	5.42E-01	50.25	5.37E-01	49.67	5.46E-01	50.66	5.29E-01	48.75
24	3.81E-06	.00	2.35E-20	.00	1.91E-13	.00	7.13E-21	.00
25	1.32E-01	49.75	1.34E-01	50.33	1.31E-01	49.33	1.37E-01	51.25
26	7.18E-10	.00	2.43E-23	.00	6.54E-14	.00	1.09E-13	.00
27	5.32E-15	.00	9.31E-11	.00	2.04E-13	.00	9.13E-32	.00
28	1.26E-06	.00	5.57E-15	.00	1.21E-16	.00	8.47E-26	.00
29	4.02E-11	.00	2.26E-20	.00	1.09E-17	.00	7.35E-27	.00
30	6.19E-12	.00	5.23E-17	.00	8.63E-13	.00	5.19E-46	.00
31	2.81E-21	.00	1.96E-16	.00	5.09E-29	.00	7.87E-25	.00

Table 6A: Example 2

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
R314495
TEST 11

GRP	E(MEV)	N(E)	% STD. DEV.	PERCENT N(E)*DE	DE	INT RAD	INT REM	INT FLUX	E*N(E)	ERROR
1	6.434E-08	1.712E+06	3.364	69.53	4.0400E-07	.69	.67	.70	4.2784E-01	1.4391E-02
2	5.316E-07	2.155E+00	200.000	.00	2.6860E-07	.69	.67	.70	2.6652E-06	5.3304E-06
3	9.932E-07	4.145E+01	191.139	.00	7.6240E-07	.69	.67	.70	9.7021E-05	1.8544E-04
4	2.102E-06	5.722E+00	200.000	.00	1.6140E-06	.69	.67	.70	2.8356E-05	5.6711E-05
5	4.451E-06	3.710E+03	200.000	1.27	3.4170E-06	.71	.68	.71	3.8922E-02	7.7843E-02
6	9.423E-06	8.155E+01	199.995	.06	7.2340E-06	.71	.69	.71	1.8110E-03	3.6220E-03
7	1.995E-05	6.058E+02	200.000	.93	1.5310E-05	.72	.70	.72	2.8481E-02	5.6961E-02
8	4.223E-05	5.659E-05	189.105	.00	3.2420E-05	.72	.70	.72	5.6321E-09	1.0651E-08
9	8.941E-05	1.516E-05	199.884	.00	6.8660E-05	.72	.70	.72	3.1942E-09	6.3847E-09
10	1.893E-04	9.217E+00	200.000	.13	1.4530E-04	.72	.70	.72	4.1122E-03	8.2243E-03
11	4.041E-04	6.264E-06	199.971	.00	3.1750E-04	.72	.70	.72	5.9717E-09	1.1942E-08
12	8.554E-04	3.500E+02	66.771	22.55	6.4110E-04	.94	.92	.94	7.0488E-01	4.7066E-01
13	1.796E-03	3.736E+01	199.997	5.18	1.3790E-03	.99	.97	1.00	1.5813E-01	3.1626E-01
14	3.802E-03	4.571E-07	199.844	.00	2.9180E-03	.99	.97	1.00	4.0954E-09	8.1845E-09
15	8.048E-03	8.490E-14	181.597	.00	6.1790E-03	.99	.97	1.00	1.6104E-15	2.9244E-15
16	1.704E-02	6.533E-07	200.000	.00	1.3080E-02	.99	.97	1.00	2.6233E-08	5.2466E-08
17	3.607E-02	9.260E-03	200.000	.03	2.7680E-02	.99	.97	1.00	7.8710E-04	1.5742E-03
18	7.635E-02	1.237E-09	199.502	.00	5.8630E-02	.99	.97	1.00	2.2264E-10	4.4416E-10
19	1.576E-01	2.535E-02	200.000	.29	1.1260E-01	1.00	1.00	1.00	9.3916E-03	1.8783E-02
20	3.176E-01	1.126E-03	200.000	.03	2.2710E-01	1.00	1.00	1.00	8.4142E-04	1.6828E-03
21	6.395E-01	4.730E-10	200.000	.00	4.5640E-01	1.00	1.00	1.00	7.1079E-10	1.4216E-09
22	1.287E+00	1.287E-10	197.694	.00	9.1980E-01	1.00	1.00	1.00	3.8926E-10	7.6954E-10
23	2.593E+00	2.002E-15	159.540	.00	1.8520E+00	1.00	1.00	1.00	1.2195E-14	1.9456E-14
24	5.221E+00	4.042E-09	200.000	.00	3.7290E+00	1.00	1.00	1.00	4.9581E-08	9.9161E-08
25	1.051E+01	2.337E-07	120.953	.00	7.5120E+00	1.00	1.00	1.00	5.7724E-06	6.9818E-06
26	1.962E+01	1.354E-07	200.000	.00	1.0890E+01	1.00	1.00	1.00	6.1949E-06	1.2390E-05
27	3.395E+01	3.246E-17	200.000	.00	1.8840E+01	1.00	1.00	1.00	2.5691E-15	5.1381E-15
28	5.873E+01	3.516E-13	186.115	.00	3.2600E+01	1.00	1.00	1.00	4.8151E-11	8.9616E-11
29	1.016E+02	2.124E-15	200.000	.00	5.6350E+01	1.00	1.00	1.00	5.0301E-13	1.0060E-12
30	1.758E+02	4.705E-09	200.000	.00	9.7600E+01	1.00	1.00	1.00	1.9281E-06	3.8563E-06
31	3.041E+02	3.622E-17	177.768	.00	1.6880E+02	1.00	1.00	1.00	2.5680E-14	4.5652E-14

DETECTOR	INPUT COUNTS	RECALCULATED COUNTS	PERCENT DIFFERENCE
BARE	1.196E-01	1.190E-01	-4.601E-01
2 INCH	1.341E-01	1.352E-01	8.372E-01
3 INCH	1.499E-01	1.498E-01	-6.102E-02
5 INCH	1.038E-01	1.033E-01	-5.000E-01
8 INCH	3.029E-02	3.030E-02	2.558E-02
10 INCH	1.152E-02	1.155E-02	2.507E-01
12 INCH	4.162E-03	4.177E-03	3.640E-01
18 INCH	1.163E-04	1.195E-04	1.020E+00

TOTAL FLUENCE (FLUX) = 9.950E-01 N/CM**2   STD DEV = 1.861E-01
ABSORBED DOSE (RATE) = 5.262E-10RADS   ST DEV = 9.774E-11
DOSE EQUIVALENT (RATE)= 1.056E-09 REMS   ST DEV = 2.022E-10
AVERAGE ENERGY = .96E-03 MEV
QUALITY FACTOR = 2.0116

Table 6B: Example 2

THE OUTPUT ON THIS PAGE IS FOR THE FOUR INDIVIDUA SPECTRA

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
TEST 11

SAMPLE SPACE	INVERSE	INVERSE	INVERSE	INVERSE
ERROR ESTIMATOR	1.305E-02	1.574E-02	2.907E-02	3.676E-02
HISTORY NUMBER	1050922	1863714	2018837	3043216
TOTAL FLUENCE	9.968E-01	9.956E-01	1.009E+00	9.790E-01
ABSORBED DOSE	5.241E-10	5.236E-10	5.303E-10	5.267E-10
DOSE EQUIV.	1.029E-09	1.030E-09	1.041E-09	1.134E-09
QUALITY FACTOR	1.964E+00	1.966E+00	1.962E+00	2.154E+00

DETECTOR	INPUT CTS	RECALCULATED CTS....			
BARE	1.196E-01	-1.121E+00	-1.574E+00	2.907E+00	-2.216E+00
2 INCH	1.341E-01	-2.342E-01	-3.852E-01	6.419E-01	3.240E+00
3 INCH	1.499E-01	3.508E-01	4.608E-01	-9.609E-01	-1.875E-01
5 INCH	1.038E-01	7.111E-01	1.049E+00	-1.988E+00	-1.851E+00
8 INCH	3.029E-02	7.865E-01	1.223E+00	-2.208E+00	2.313E-01
10 INCH	1.152E-02	7.887E-01	1.236E+00	-2.213E+00	1.112E+00
12 INCH	4.162E-03	8.008E-01	1.243E+00	-2.215E+00	1.539E+00
18 INCH	1.183E-04	1.305E+00	1.429E+00	-2.527E+00	3.676E+00

GRP	N(E)	% N(E)*DE						
1	1.71E+06	69.42	1.71E+06	69.18	1.79E+06	71.55	1.65E+06	67.91
2	2.51E-09	.00	4.96E-20	.00	1.44E-22	.00	8.62E+00	.00
3	1.60E+02	.01	8.62E-08	.00	2.22E-24	.00	5.57E+00	.00
4	2.64E-09	.00	6.66E-18	.00	1.72E-16	.00	2.29E+01	.00
5	2.64E-04	.00	4.29E-06	.00	4.72E-23	.00	1.48E+04	5.18
6	4.13E-03	.00	2.56E-03	.00	4.93E-20	.00	3.26E+02	.24
7	1.74E-11	.00	1.18E-05	.00	3.84E-27	.00	2.42E+03	3.79
8	9.38E-06	.00	1.31E-09	.00	2.06E-19	.00	2.17E-04	.00
9	1.02E-12	.00	6.06E-05	.00	8.82E-45	.00	2.63E-08	.00
10	2.42E-17	.00	4.18E-20	.00	6.42E-26	.00	3.69E+01	.55
11	2.75E-09	.00	2.51E-05	.00	4.41E-23	.00	1.93E-17	.00
12	4.75E+02	30.57	4.77E+02	30.71	4.48E+02	28.45	3.04E-02	.00
13	1.50E-03	.00	1.78E-07	.00	1.33E-16	.00	1.49E+02	21.05
14	1.07E-09	.00	2.86E-12	.00	3.13E-19	.00	1.83E-06	.00
15	3.16E-13	.00	8.27E-15	.00	9.29E-20	.00	1.54E-14	.00
16	4.54E-13	.00	3.76E-19	.00	2.11E-39	.00	2.61E-06	.00
17	1.62E-16	.00	3.70E-02	.10	1.31E-08	.00	4.42E-26	.00
18	4.94E-09	.00	1.18E-14	.00	1.71E-25	.00	9.24E-12	.00
19	6.39E-21	.00	2.93E-20	.00	9.04E-32	.00	1.01E-01	1.17
20	6.58E-18	.00	3.61E-17	.00	4.08E-25	.00	4.51E-03	.10
21	5.10E-21	.00	3.80E-24	.00	4.66E-30	.00	1.89E-09	.00
22	5.10E-10	.00	4.28E-26	.00	1.10E-22	.00	4.46E-12	.00
23	1.02E-27	.00	6.73E-15	.00	1.12E-15	.00	1.56E-16	.00
24	1.90E-21	.00	1.01E-16	.00	1.48E-25	.00	1.62E-08	.00
25	3.64E-07	.00	9.34E-24	.00	2.89E-31	.00	5.70E-07	.00
26	2.71E-21	.00	7.05E-25	.00	6.38E-18	.00	5.42E-07	.00
27	3.02E-23	.00	8.75E-31	.00	1.08E-29	.00	1.30E-16	.00
28	3.74E-19	.00	1.33E-12	.00	1.00E-37	.00	7.47E-14	.00
29	8.49E-15	.00	3.89E-32	.00	1.43E-24	.00	3.16E-29	.00
30	1.89E-06	.00	3.68E-17	.00	1.82E-29	.00	6.39E-15	.00
31	1.23E-17	.00	1.56E-19	.00	6.29E-33	.00	1.32E-16	.00

Table 7A: Example 3

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
R314495
TEST 7

GRP	E(MEV)	N(E)	% STD. DEV.	PERCENT N(E)*DE	DE	INT RAD	INT REM	INT FLUX	E*N(E)	ERROR
1	6.434E-08	4.240E-02	187.375	.00	4.0400E-07	.00	.00	.00	1.0592E-08	1.9847E-08
2	5.316E-07	6.277E+00	200.000	.00	2.6860E-07	.00	.C0	.00	7.7638E-06	1.5528E-05
3	9.932E-07	7.714E-04	200.000	.00	7.6240E-07	.00	.00	.00	1.8056E-09	3.6111E-09
4	2.102E-06	1.285E-02	199.971	.00	1.6140E-06	.00	.00	.00	6.3685E-08	1.2735E-07
5	4.451E-06	1.997E+01	200.000	.00	3.4170E-06	.00	.00	.00	2.0950E-04	4.1901E-04
6	9.423E-06	1.348E-06	199.993	.00	7.2340E-06	.00	.00	.00	2.9946E-11	5.9889E-11
7	1.995E-05	4.462E-06	190.470	.00	1.5310E-05	.00	.00	.00	2.0976E-10	3.9953E-10
8	4.223E-05	2.563E+00	200.000	.00	3.2420E-05	.00	.00	.00	2.5703E-04	5.1407E-04
9	8.941E-05	9.587E-13	82.188	.00	6.8660E-05	.00	.00	.00	2.0201E-16	1.6603E-16
10	1.893E-04	8.080E-07	199.954	.00	1.4530E-04	.00	.00	.00	3.6050E-10	7.2083E-10
11	4.041E-04	3.612E-08	127.251	.00	3.1750E-04	.00	.00	.00	3.4436E-11	4.4508E-11
12	8.554E-04	6.795E-04	119.671	.00	6.4110E-04	.00	.00	.00	1.3685E-06	1.6377E-06
13	1.796E-03	4.534E-10	191.117	.00	1.3790E-03	.00	.00	.00	1.9188E-12	3.6671E-12
14	3.802E-03	1.667E-13	194.365	.00	2.9180E-03	.00	.00	.00	1.4941E-15	2.9040E-15
15	8.048E-03	2.819E-09	198.764	.00	6.1790E-03	.00	.00	.00	5.3477E-11	1.0629E-10
16	1.704E-02	1.117E-07	199.542	.00	1.3080E-02	.00	.00	.00	4.4841E-09	8.9476E-09
17	3.607E-02	4.061E-03	200.000	.00	2.7680E-02	.00	.00	.00	3.4522E-04	6.9044E-04
18	7.635E-02	3.925E-06	200.000	.00	5.8630E-02	.00	.00	.00	7.0638E-07	1.4128E-06
19	1.576E-01	4.474E-14	199.357	.00	1.1260E-01	.00	.00	.00	1.6573E-14	3.3039E-14
20	3.176E-01	5.901E-03	200.000	.05	2.2710E-01	.00	.00	.00	4.4039E-03	8.8079E-03
21	6.395E-01	1.934E-02	200.000	.35	4.5640E-01	.00	.00	.00	2.9063E-02	5.8125E-02
22	1.287E+00	2.069E-06	196.867	.00	9.1980E-01	.00	.00	.00	6.2600E-06	1.2324E-05
23	2.593E+00	5.071E-01	9.458	36.99	1.8520E+00	.26	.31	.37	3.0892E+00	2.9217E-01
24	5.221E+00	8.826E-10	200.000	.00	3.7290E+00	.26	.31	.37	1.0827E-08	2.1654E-08
25	1.051E+01	1.838E-01	14.631	54.37	7.5120E+00	.85	.90	.92	4.5397E+00	6.6420E-01
26	1.962E+01	5.595E-07	164.876	.00	1.0890E+01	.85	.90	.92	2.5416E-05	4.1905E-05
27	3.395E+01	2.394E-10	199.995	.00	1.8840E+01	.85	.90	.92	1.8949E-08	3.7897E-08
28	5.673E+01	4.249E-12	138.299	.00	3.2600E+01	.85	.90	.92	5.8184E-10	8.0468E-10
29	1.016E+02	3.709E-03	177.771	8.23	5.6350E+01	1.00	1.00	1.00	8.7860E-01	1.5619E+00
30	1.758E+02	2.002E-11	200.000	.00	9.7600E+01	1.00	1.00	1.00	8.2055E-09	1.6411E-08
31	3.041E+02	1.948E-12	194.909	.00	1.6880E+02	1.00	1.00	1.00	1.3813E-09	2.6923E-09

DETECTOR	INPUT COUNTS	RECALCULATED COUNTS	PERCENT DIFFERENCE
BARE	2.591E-04	2.521E-04	-2.753E+00
2 INCH	7.787E-03	7.823E-03	4.639E-01
3 INCH	5.581E-02	5.561E-02	-3.552E-01
5 INCH	2.751E-01	2.740E-01	-4.147E-01
8 INCH	5.036E-01	5.041E-01	9.777E-02
10 INCH	5.102E-01	5.121E-01	3.785E-01
12 INCH	4.580E-01	4.601E-01	4.761E-01
18 INCH	2.626E-01	2.593E-01	-1.279E+00

TOTAL FLUENCE (FLUX) = 2.539E+00 N/CM**2 STD DEV = 4.325E-01
ABSORBED DOSE (RATE) = 1.550E-08RADS ST DEV = 4.448E-09
DOSE EQUIVALENT (RATE)= 1.089E-07 REMS ST DEV = 2.182E-08
AVERAGE ENERGY = .15E+02 MEV
QUALITY FACTOR = 7.0255

Table 7B: Example 3

THE OUTPUT ON THIS PAGE IS FOR THE FOUR INDIVIDUA SPECTRA

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
TEST 7

SAMPLE SPACE	INVERSE	INVERSE	INVERSE	INVERSE
ERROR ESTIMATOR	2.871E-02	3.446E-02	4.366E-02	5.009E-02
HISTORY NUMBER	1402936	2235124	2958195	697093
TOTAL FLUENCE	2.380E+00	2.912E+00	2.439E+00	2.425E+00
ABSORBED DOSE	1.349E-08	2.037E-08	1.412E-08	1.403E-08
DOSE EQUIV.	1.004E-07	1.265E-07	1.035E-07	1.033E-07
QUALITY FACTOR	7.443E+00	6.311E+00	7.326E+00	7.358E+00

DETECTOR	INPUT CTS	RECALCULATED CTS....			
BARE	2.591E-04	-4.519E-01	-2.172E+00	-4.366E+00	-4.119E+00
2 INCH	7.787E-03	-8.957E-01	3.445E+00	3.330E+00	-4.450E+00
3 INCH	5.581E-02	-1.313E+00	3.193E+00	1.335E+00	-5.010E+00
5 INCH	2.751E-01	-5.065E-01	2.350E+00	-1.315E-01	-3.544E+00
8 INCH	5.036E-01	4.799E-01	9.262E-01	-1.584E-01	-8.750E-01
10 INCH	5.102E-01	7.748E-01	-1.067E-01	1.639E-01	6.767E-01
12 INCH	4.580E-01	6.726E-01	-1.141E+00	4.784E-01	1.849E+00
18 INCH	2.626E-01	-2.870E+00	-3.035E+00	-1.112E+00	1.753E+00

GRP	N(E)	% N(E)*DE						
1	8.17E-03	.00	2.44E-06	.00	8.84E-14	.00	1.61E-01	.00
2	2.51E+01	.00	1.56E-19	.00	6.94E-09	.00	3.63E-06	.00
3	3.29E-14	.00	3.09E-03	.00	1.36E-11	.00	4.61E-11	.00
4	5.14E-02	.00	5.62E-06	.00	2.00E-18	.00	1.71E-16	.00
5	7.99E+01	.01	7.62E-19	.00	1.34E-07	.00	4.75E-33	.00
6	3.96E-14	.00	5.39E-06	.00	1.40E-10	.00	3.23E-14	.00
7	6.46E-07	.00	8.65E-18	.00	1.12E-10	.00	1.72E-05	.00
8	1.27E-13	.00	2.27E-20	.00	4.09E-12	.00	1.03E+01	.01
9	9.64E-13	.00	1.55E-22	.00	9.41E-13	.00	1.93E-12	.00
10	1.54E-11	.00	5.48E-10	.00	3.23E-06	.00	7.87E-15	.00
11	5.16E-18	.00	9.81E-08	.00	4.62E-08	.00	1.76E-10	.00
12	6.73E-24	.00	1.62E-03	.00	1.10E-03	.00	2.06E-14	.00
13	5.15E-13	.00	8.14E-12	.00	1.75E-09	.00	5.22E-11	.00
14	1.43E-16	.00	2.13E-20	.00	1.41E-14	.00	6.53E-13	.00
15	1.12E-08	.00	5.23E-11	.00	5.23E-19	.00	5.80E-14	.00
16	6.48E-21	.00	4.46E-07	.00	1.79E-10	.00	5.88E-10	.00
17	1.62E-02	.02	2.20E-13	.00	1.77E-14	.00	8.85E-11	.00
18	1.57E-05	.00	7.45E-36	.00	6.97E-16	.00	1.14E-12	.00
19	4.28E-16	.00	6.26E-20	.00	1.79E-13	.00	4.29E-18	.00
20	6.03E-16	.00	5.33E-11	.00	4.30E-13	.00	2.36E-02	.22
21	1.75E-26	.00	1.46E-12	.00	7.74E-02	1.45	4.37E-15	.00
22	6.18E-06	.00	1.37E-18	.00	9.55E-08	.00	2.12E-09	.00
23	5.12E-01	39.80	5.73E-01	36.43	4.78E-01	36.34	4.65E-01	35.55
24	9.66E-21	.00	1.07E-15	.00	5.53E-15	.00	3.53E-09	.00
25	1.91E-01	60.13	1.44E-01	37.28	1.95E-01	60.01	2.05E-01	63.56
26	1.91E-06	.00	3.10E-07	.00	1.93E-16	.00	4.70E-14	.00
27	9.58E-10	.00	2.31E-18	.00	1.70E-14	.00	2.56E-18	.00
28	1.26E-12	.00	1.88E-12	.00	1.30E-11	.00	8.24E-13	.00
29	1.58E-05	.04	1.36E-02	26.29	9.54E-04	2.20	2.85E-04	.66
30	7.80E-19	.00	2.12E-23	.00	8.01E-11	.00	1.22E-26	.00
31	7.64E-12	.00	1.43E-13	.00	7.06E-16	.00	5.47E-15	.00

Table 8A: Example 4

SWIFT ANALYSIS--BASED UN WORST CASE BALL COMPARISON.
R314495
TEST 16-1

GPP	E(MEV)	N(E)	% STD. DEV.	PERCENT N(E)*DE	DE	INT RAD	INT REM	INT FLUX	E*N(E)	ERROR
1	6.434E-08	2.509E+06	7.007	25.56	4.0400E-07	.23	.22	.26	6.2678E-01	4.3921E-02
2	5.316E-07	1.532E-06	135.626	.00	2.6860E-07	.23	.22	.26	1.8951E-12	2.5703E-12
3	9.932E-07	3.871E+05	1.411	74.41	7.6240E-07	1.00	1.00	1.00	9.0604E+00	1.2781E-01
4	2.102E-06	1.226E-08	155.224	.00	1.6140E-06	1.00	1.00	1.00	6.0747E-14	9.4294E-14
5	4.451E-06	4.910E-01	200.000	.00	3.4170E-06	1.00	1.00	1.00	5.1510E-06	1.0302E-05
6	9.423E-06	3.659E+01	200.000	.01	7.2340E-06	1.00	1.00	1.00	8.1262E-04	1.6252E-03
7	1.995E-05	4.804E+01	197.182	.02	1.5310E-05	1.00	1.00	1.00	2.2583E-03	4.4529E-03
8	4.223E-05	8.668E-02	200.000	.00	3.2420E-05	1.00	1.00	1.00	8.6469E-06	1.7294E-05
9	8.941E-05	5.286E+00	113.386	.01	6.8660E-05	1.00	1.00	1.00	1.1139E-03	1.2630E-03
10	1.893E-04	6.249E-07	188.186	.00	1.4530E-04	1.00	1.00	1.00	2.7874E-10	5.2454E-10
11	4.041E-04	3.650E-07	199.825	.00	3.1750E-04	1.00	1.00	1.00	3.4802E-10	6.9543E-10
12	8.554E-04	2.960E-04	188.942	.00	6.4110E-04	1.00	1.00	1.00	5.9619E-07	1.1265E-06
13	1.796E-03	3.427E-04	145.167	.00	1.3790E-03	1.00	1.00	1.00	1.4503E-06	2.1053E-06
14	3.802E-03	1.219E-04	195.682	.00	2.9180E-03	1.00	1.00	1.00	1.0922E-06	2.1372E-06
15	8.048E-03	6.707E-07	200.000	.00	6.1790E-03	1.00	1.00	1.00	1.2722E-08	2.5444E-08
16	1.704E-02	4.333E-05	183.977	.00	1.3080E-02	1.00	1.00	1.00	1.7400E-06	3.2011E-06
17	3.607E-02	2.339E-09	115.538	.00	2.7680E-02	1.00	1.00	1.00	1.9886E-10	2.2975E-10
18	7.635E-02	1.818E-06	199.929	.00	5.8630E-02	1.00	1.00	1.00	3.2720E-07	6.5417E-07
19	1.576E-01	5.084E-11	200.000	.00	1.1260E-01	1.00	1.00	1.00	1.8834E-11	3.7667E-11
20	3.176E-01	1.634E-09	184.033	.00	2.2710E-01	1.00	1.00	1.00	1.2196E-09	2.2445E-09
21	6.395E-01	1.555E-08	200.000	.00	4.5640E-01	1.00	1.00	1.00	2.3366E-08	4.6732E-08
22	1.287E+00	6.838E-05	195.730	.00	9.1980E-01	1.00	1.00	1.00	2.0688E-04	4.0700E-04
23	2.593E+00	6.676E-12	184.568	.00	1.8520E+00	1.00	1.00	1.00	4.0672E-11	7.5068E-11
24	5.221E+00	2.358E-07	199.811	.00	3.7290E+00	1.00	1.00	1.00	2.8927E-06	5.7799E-06
25	1.051E+01	1.513E-10	199.998	.00	7.5120E+00	1.00	1.00	1.00	3.7387E-09	7.4774E-09
26	1.952E+01	1.491E-15	197.556	.00	1.0890E+01	1.00	1.00	1.00	6.8219E-14	1.3477E-13
27	3.395E+01	1.712E-10	185.488	.00	1.8840E+01	1.00	1.00	1.00	1.3552E-08	2.5137E-08
28	5.873E+01	3.547E-08	199.999	.00	3.2600E+01	1.00	1.00	1.00	4.8575E-06	9.7149E-06
29	1.016E+02	2.911E-08	199.984	.00	5.6350E+01	1.00	1.00	1.00	6.8960E-06	1.3791E-05
30	1.758E+02	3.989E-11	199.649	.00	9.7600E+01	1.00	1.00	1.00	1.6346E-08	3.2634E-08
31	3.041E+02	1.876E-13	199.808	.00	1.6880E+02	1.00	1.00	1.00	1.3316E-10	2.6607E-10

DETECTOR	INPUT COUNTS	RECALCULATED COUNTS	PERCENT DIFFERENCE
BARE	4.507E-01	4.505E-01	-3.439E-02
2 INCH	9.785E-01	9.843E-01	5.908E-01
3 INCH	8.465E-01	8.457E-01	-9.607E-02
5 INCH	4.238E-01	4.205E-01	-7.912E-01
8 INCH	1.113E-01	1.103E-01	-9.202E-01
10 INCH	4.200E-02	4.163E-02	-8.921E-01
12 INCH	1.512E-02	1.498E-02	-9.105E-01
18 INCH	3.677E-04	3.846E-04	-7.999E-01

TOTAL FLUENCE (FLUX) = 3.966E+00 N/CM**2 STD DEV = 8.234E-02
ABSORBED DOSE (RATE) = 2.356E-09RADS ST DEV = 4.536E-11
DOSE EQUIVALENT (RATE)= 4.689E-09 REMS ST DEV = 8.922E-11
AVERAGE ENERGY = .82E-04 MEV
QUALITY FACTOR = 1.9901

Table 8B: Example 4

THE OUTPUT UN THIS PAGE IS FOR THE FOUR INDIVIDUA SPECTRA

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
TEST 16-1

	SAMPLE SPACE	INVERSE	INVERSE	INVERSE	INVERSE
	ERROR ESTIMATOR	1.145E-02	1.430E-02	1.509E-02	2.222E-02
	HISTORY NUMBER	1741879	2250029	1008923	702503
	TOTAL FLUENCE	3.975E+00	3.942E+00	3.941E+00	4.005E+00
	ABSORBED DOSE	2.360E-09	2.347E-09	2.346E-09	2.373E-09
	DOSE EQUIV.	4.694E-09	4.670E-09	4.668E-09	4.725E-09
	QUALITY FACTOR	1.989E+00	1.990E+00	1.990E+00	1.991E+00

DETECTOR	INPUT CTS	RECALCULATED CTS....			
BARE	4.507E-01	4.856E-01	-1.431E+00	-1.509E+00	2.221E+00
2 INCH	9.785E-01	4.984E-01	7.982E-01	8.101E-01	2.545E-01
3 INCH	8.465E-01	-2.018E-01	1.970E-01	2.139E-01	-5.979E-01
5 INCH	4.238E-01	-8.828E-01	-4.979E-01	-4.806E-01	-1.308E+00
8 INCH	1.113E-01	-1.015E+00	-6.540E-01	-6.377E-01	-1.377E+00
10 INCH	4.200E-02	-1.000E+00	-6.471E-01	-6.313E-01	-1.293E+00
12 INCH	1.512E-02	-1.039E+00	-6.914E-01	-6.769E-01	-1.237E+00
18 INCH	3.877E-04	-1.146E+00	-8.124E-01	-8.643E-01	-3.803E-01

GRP	N(E)	% N(E)*DE						
1	2.56E+06	26.05	2.37E+06	24.32	2.37E+06	24.25	2.73E+06	27.58
2	4.29E-14	.00	4.08E-20	.00	4.40E-06	.00	1.73E-06	.00
3	3.65E+06	73.86	3.91E+06	75.68	3.92E+06	75.75	3.80E+06	72.38
4	1.23E-09	.00	1.29E-11	.00	7.40E-09	.00	4.04E-08	.00
5	1.59E-16	.00	1.96E+00	.00	3.53E-17	.00	4.33E-14	.00
6	2.28E-07	.00	1.80E-12	.00	1.44E-17	.00	1.46E+02	.03
7	1.90E+02	.07	1.96E-24	.00	2.34E-07	.00	2.04E+00	.00
8	9.88E-14	.00	3.97E-13	.00	1.41E-13	.00	3.48E-01	.00
9	1.20E+01	.02	4.78E-01	.00	1.11E-15	.00	8.64E+00	.01
10	1.12E-07	.00	4.85E-10	.00	2.61E-14	.00	2.39E-06	.00
11	9.59E-10	.00	9.77E-16	.00	1.72E-14	.00	1.46E-06	.00
12	2.35E-06	.00	4.74E-05	.00	1.13E-03	.00	4.28E-11	.00
13	3.74E-16	.00	1.05E-03	.00	2.17E-21	.00	3.16E-04	.00
14	3.27E-08	.00	7.90E-06	.00	8.49E-19	.00	4.80E-04	.00
15	2.68E-06	.00	2.90E-13	.00	3.10E-13	.00	5.98E-13	.00
16	2.27E-12	.00	1.07E-05	.00	5.42E-14	.00	1.63E-04	.00
17	4.79E-09	.00	4.56E-09	.00	2.65E-34	.00	8.21E-14	.00
18	3.83E-13	.00	1.94E-09	.00	1.07E-16	.00	7.27E-06	.00
19	3.75E-34	.00	2.03E-10	.00	9.62E-32	.00	2.44E-19	.00
20	2.29E-10	.00	6.14E-09	.00	5.95E-17	.00	1.65E-10	.00
21	7.79E-17	.00	8.76E-26	.00	7.74E-17	.00	6.22E-08	.00
22	3.37E-06	.00	5.71E-17	.00	1.27E-15	.00	2.70E-04	.01
23	1.21E-15	.00	1.27E-12	.00	2.51E-11	.00	2.87E-13	.00
24	9.43E-07	.00	9.76E-12	.00	2.03E-27	.00	6.60E-10	.00
25	2.34E-41	.00	9.12E-25	.00	5.33E-15	.00	6.05E-10	.00
26	5.48E-17	.00	2.56E-21	.00	5.91E-15	.00	1.56E-37	.00
27	3.80E-11	.00	5.48E-19	.00	6.47E-10	.00	6.99E-23	.00
28	4.69E-13	.00	1.42E-07	.00	9.59E-27	.00	1.52E-19	.00
29	1.20E-16	.00	7.14E-12	.00	2.90E-27	.00	1.16E-07	.00
30	1.59E-10	.00	2.80E-14	.00	1.82E-13	.00	3.01E-17	.00
31	5.34E-16	.00	6.37E-18	.00	7.65E-28	.00	7.51E-13	.00

Table 9A: Example 5

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
R314495
SUM SPECTRUM

GRP	E(MEV)	N(E)	% STD. DEV.	PERCENT N(E)*DE	DE	INT RAD	INT REM	INT FLUX	E*N(E)	ERROR
1	6.434E-08	2.461E+06	9.694	3.19	4.0400E-07	.00	.00	.03	6.1496E-01	5.9617E-02
2	5.316E-07	3.763E+06	36.778	3.24	2.6860E-07	.01	.00	.06	4.6545E+00	1.7118E+00
3	9.932E-07	1.323E+06	61.817	3.24	7.6240E-07	.02	.01	.10	3.0975E+00	1.9148E+00
4	2.102E-06	5.036E+05	80.421	2.61	1.6140E-06	.02	.01	.12	2.4953E+00	2.0068E+00
5	4.451E-06	2.958E+05	46.345	3.24	3.4170E-06	.03	.01	.16	3.1027E+00	1.4380E+00
6	9.423E-06	1.719E+05	26.623	3.99	7.2340E-06	.03	.01	.20	3.8173E+00	1.0163E+00
7	1.995E-05	6.477E+04	41.725	3.18	1.5310E-05	.04	.01	.23	3.0448E+00	1.2704E+00
8	4.223E-05	3.122E+04	53.623	3.25	3.2420E-05	.04	.02	.26	3.1067E+00	1.6659E+00
9	8.941E-05	1.932E+04	20.190	4.26	6.8660E-05	.05	.02	.30	4.0711E+00	8.2195E-01
10	1.893E-04	3.350E+03	142.382	1.56	1.4530E-04	.05	.02	.32	1.4945E+00	2.1279E+00
11	4.041E-04	3.476E+03	64.248	3.54	3.1750E-04	.06	.02	.35	3.3141E+00	2.1292E+00
12	8.554E-04	1.809E+03	37.921	3.72	6.4110E-04	.06	.02	.39	3.6432E+00	1.3815E+00
13	1.796E-03	7.373E+02	85.335	3.26	1.3790E-03	.07	.02	.42	3.1205E+00	2.6629E+00
14	3.802E-03	2.787E+02	74.677	2.61	2.9180E-03	.07	.03	.45	2.4975E+00	1.8651E+00
15	8.048E-03	1.679E+02	28.752	3.33	6.1790E-03	.08	.03	.48	3.1842E+00	9.1554E-01
16	1.704E-02	7.493E+01	45.516	3.14	1.3080E-02	.08	.03	.51	3.0090E+00	1.3696E+00
17	3.607E-02	2.431E+01	116.758	2.16	2.7680E-02	.08	.03	.54	2.0666E+00	2.4129E+00
18	7.635E-02	1.398E+01	31.327	2.63	5.8630E-02	.09	.04	.56	2.5158E+00	7.8811E-01
19	1.576E-01	1.120E+01	26.511	4.05	1.1260E-01	.10	.06	.60	4.1509E+00	1.1004E+00
20	3.176E-01	6.653E+00	18.644	4.85	2.2710E-01	.12	.10	.65	4.9648E+00	9.2563E-01
21	6.395E-01	2.149E+00	44.972	3.15	4.5640E-01	.14	.14	.68	3.2300E+00	1.4526E+00
22	1.287E+00	4.918E-01	30.442	1.45	9.1980E-01	.15	.17	.70	1.4878E+00	4.5292E-01
23	2.593E+00	6.963E-01	49.825	4.14	1.8520E+00	.20	.24	.74	4.2418E+00	2.1135E+00
24	5.221E+00	3.197E-01	41.698	3.82	3.7290E+00	.26	.32	.78	3.9215E+00	1.6352E+00
25	1.051E+01	7.786E-02	65.330	1.88	7.5120E+00	.30	.37	.79	1.9236E+00	1.2567E+00
26	1.952E+01	1.260E-01	38.001	4.40	1.0890E+01	.41	.50	.84	5.7634E+00	2.1901E+00
27	3.395E+01	4.914E-02	56.123	2.97	1.8840E+01	.49	.61	.87	3.8895E+00	2.1829E+00
28	5.873E+01	2.718E-02	58.236	2.84	3.2600E+01	.57	.72	.90	3.7215E+00	2.1673E+00
29	1.016E+02	1.620E-02	44.335	2.93	5.6350E+01	.66	.80	.93	3.8383E+00	1.7017E+00
30	1.758E+02	9.960E-03	47.048	3.12	9.7600E+01	.79	.88	.96	4.0812E+00	1.9201E+00
31	3.041E+02	7.856E-03	47.909	4.25	1.6880E+02	1.00	1.00	1.00	5.5705E+00	2.6688E+00

DETECTOR	INPUT COUNTS	RECALCULATED COUNTS	PERCENT DIFFERENCE
BARE	6.555E-01	6.548E-01	-1.001E-01
2 INCH	3.434E+00	3.440E+00	1.629E-01
3 INCH	5.168E+00	5.190E+00	4.756E-02
5 INCH	5.234E+00	5.238E+00	7.259E-02
8 INCH	2.941E+00	2.934E+00	-2.431E-01
10 INCH	1.956E+00	1.947E+00	-4.479E-01
12 INCH	1.389E+00	1.393E+00	2.994E-01
18 INCH	7.222E-01	7.227E-01	6.439E-02

TOTAL FLUENCE (FLUX) = 3.117E+01 N/CM**2 STD DEV = 2.810E+00
ABSORBED DOSE (RATE) = 1.126E-07RADS ST DEV = 1.725E-08
DOSE EQUIVALENT (RATE)= 6.285E-07 REMS ST DEV = 8.932E-08
AVERAGE ENERGY = .26E+02 MEV
QUALITY FACTOR = 5.5790

Table 9B: Example 5

THE OUTPUT ON THIS PAGE IS FOR THE FOUR INDIVIDUA SPECTRA

SWIFT ANALYSIS--BASED ON WORST CASE BALL COMPARISON.
SUM SPECTRUM

SAMPLE SPACE	UNWEIGHT	UNWEIGHT	UNWEIGHT	UNWEIGHT
ERROR ESTIMATOR	3.968E-03	6.186E-03	6.786E-03	7.889E-03
HISTORY NUMBER	1402476	2703464	750387	2100530
TOTAL FLUENCE	3.126E+01	3.165E+01	3.130E+01	3.046E+01
ABSORBED DOSE	1.145E-07	1.215E-07	1.153E-07	9.919E-08
DOSE EQUIV.	6.560E-07	6.433E-07	6.338E-07	5.807E-07
QUALITY FACTOR	5.729E+00	5.293E+00	5.496E+00	5.854E+00

DETECTOR	INPUT CTS	RECALCULATED CTS....			
BARE	6.555E-01	-3.596E-01	-4.639E-01	5.082E-01	-9.083E-02
2 INCH	3.434E+00	-2.551E-01	6.186E-01	1.863E-01	9.804E-02
3 INCH	5.188E+00	-8.090E-02	1.864E-01	3.353E-01	-2.526E-01
5 INCH	5.234E+00	1.698E-01	-2.510E-01	-8.645E-02	4.551E-01
8 INCH	2.941E+00	6.725E-02	-4.195E-01	-6.764E-01	5.426E-02
10 INCH	1.956E+00	-1.040E-01	-3.901E-01	-5.110E-01	-7.888E-01
12 INCH	1.389E+00	3.965E-01	2.708E-01	5.023E-01	2.665E-02
18 INCH	7.222E-01	1.168E-01	1.633E-01	1.555E-02	-3.836E-02

GRP	N(E)	% N(E)*DE						
1	2.36E+06	3.05	2.44E+06	3.12	2.80E+06	3.61	2.24E+06	2.98
2	5.13E+06	4.41	4.74E+06	4.02	2.86E+06	2.45	2.32E+06	2.04
3	1.70E+06	4.15	1.29E+05	.31	1.50E+06	3.66	1.96E+06	4.91
4	6.06E+03	.04	9.15E+05	4.67	3.54E+05	1.82	7.37E+05	3.91
5	1.00E+05	1.10	3.28E+05	3.55	4.21E+05	4.60	3.33E+05	3.73
6	2.38E+05	5.51	1.36E+05	3.10	1.49E+05	3.43	1.65E+05	3.93
7	7.61E+04	3.73	9.63E+04	4.66	3.48E+04	1.70	5.19E+04	2.61
8	3.29E+04	3.41	4.14E+04	4.24	4.35E+04	4.51	7.06E+03	.75
9	2.02E+04	4.45	1.36E+04	2.94	2.15E+04	4.72	2.20E+04	4.95
10	1.05E+04	4.66	8.19E+02	.38	1.75E+03	.81	3.78E+02	.18
11	3.50E+02	.36	3.47E+03	3.48	4.67E+03	4.73	5.42E+03	5.65
12	1.95E+03	3.99	2.29E+03	4.64	2.19E+03	4.49	8.03E+02	1.69
13	1.36E+03	6.01	1.97E+02	.86	1.94E+02	.85	1.19E+03	5.41
14	3.78E+01	.35	2.99E+02	2.76	2.36E+02	2.20	5.43E+02	5.20
15	1.48E+02	2.93	1.51E+02	2.95	2.39E+02	4.72	1.33E+02	2.69
16	5.15E+01	2.15	9.07E+01	3.75	1.15E+02	4.82	4.23E+01	1.82
17	1.76E+01	1.56	6.57E+01	5.75	1.59E+00	.14	1.24E+01	1.12
18	1.27E+01	2.37	8.39E+00	1.55	1.81E+01	3.38	1.68E+01	3.24
19	1.56E+01	5.61	9.38E+00	3.34	1.06E+01	3.80	9.30E+00	3.44
20	7.57E+00	5.50	4.86E+00	3.50	6.73E+00	4.89	7.43E+00	5.54
21	1.24E+00	1.61	2.25E+00	3.25	1.65E+00	2.41	3.46E+00	5.19
22	6.67E-01	1.96	3.17E-01	.92	5.47E-01	1.61	4.36E-01	1.32
23	8.00E-01	4.74	1.08E+00	6.34	6.49E-01	3.84	2.52E-01	1.53
24	2.34E-01	2.79	1.79E-01	2.11	4.13E-01	4.93	4.52E-01	5.53
25	6.40E-02	2.02	4.95E-02	1.17	3.12E-02	.75	1.47E-01	3.62
26	1.41E-01	4.91	1.79E-01	6.15	1.20E-01	4.17	6.42E-02	2.29
27	4.86E-02	2.93	1.05E-02	.63	7.20E-02	4.33	6.55E-02	4.05
28	4.89E-02	5.10	2.87E-02	2.96	1.78E-02	1.85	1.34E-02	1.43
29	6.72E-03	1.21	2.22E-02	3.95	1.46E-02	2.62	2.13E-02	3.94
30	3.04E-03	.95	1.32E-02	4.08	1.12E-02	3.49	1.24E-02	3.97
31	1.12E-02	6.04	9.13E-03	4.87	8.66E-03	4.67	2.45E-03	1.36

TABLE 10 Comparison of Dose, Dose Equivalent, and Quality Factors for Examples

Examples	Dose (rad)		Dose Equivalent (rem)		Quality Factor	
	Calc.	SWIFT	Calc.	SWIFT	Calc.	SWIFT
1	1.08E-08	1.09E-08	8.23E-08	8.24E-08	7.62	7.59
2	5.26E-10	5.26E-10	1.03E-09	1.06E-09	1.96	2.01
3	2.05E-08	1.55E-08	1.57E-07	1.09E-07	7.66	7.03
4	2.37E-09	2.36E-09	4.72E-09	4.69E-07	1.99	1.99
5	1.09E-07	1.13E-07	6.17E-07	6.29E-09	5.66	5.58

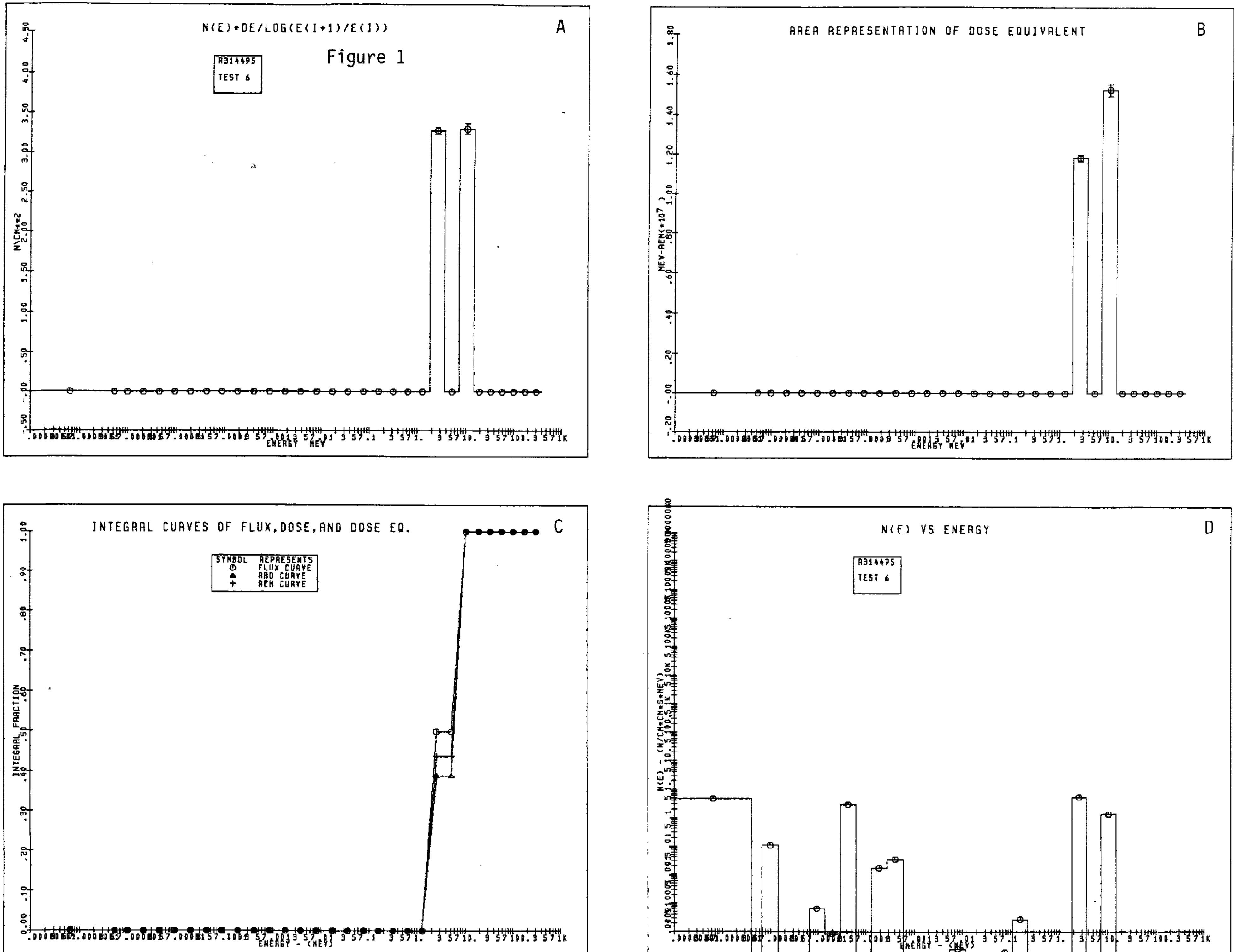


Figure 1
A
N(E)*DE/LOG(E(I+1)/E(I))
R314495
TEST 6
N\CM**2
ENERGY MEV
B
AREA REPRESENTATION OF DOSE EQUIVALENT
MEV-REM(*10^7)
ENERGY MEV
C
INTEGRAL CURVES OF FLUX,DOSE,AND DOSE EQ.
SYMBOL REPRESENTS
FLUX CURVE
RAD CURVE
REM CURVE
INTEGRAL FRACTION
ENERGY - (MEV)
D
N(E) VS ENERGY
R314495
TEST 6
N(E) - (N/CM*CM*S*MEV)
ENERGY - (MEV)

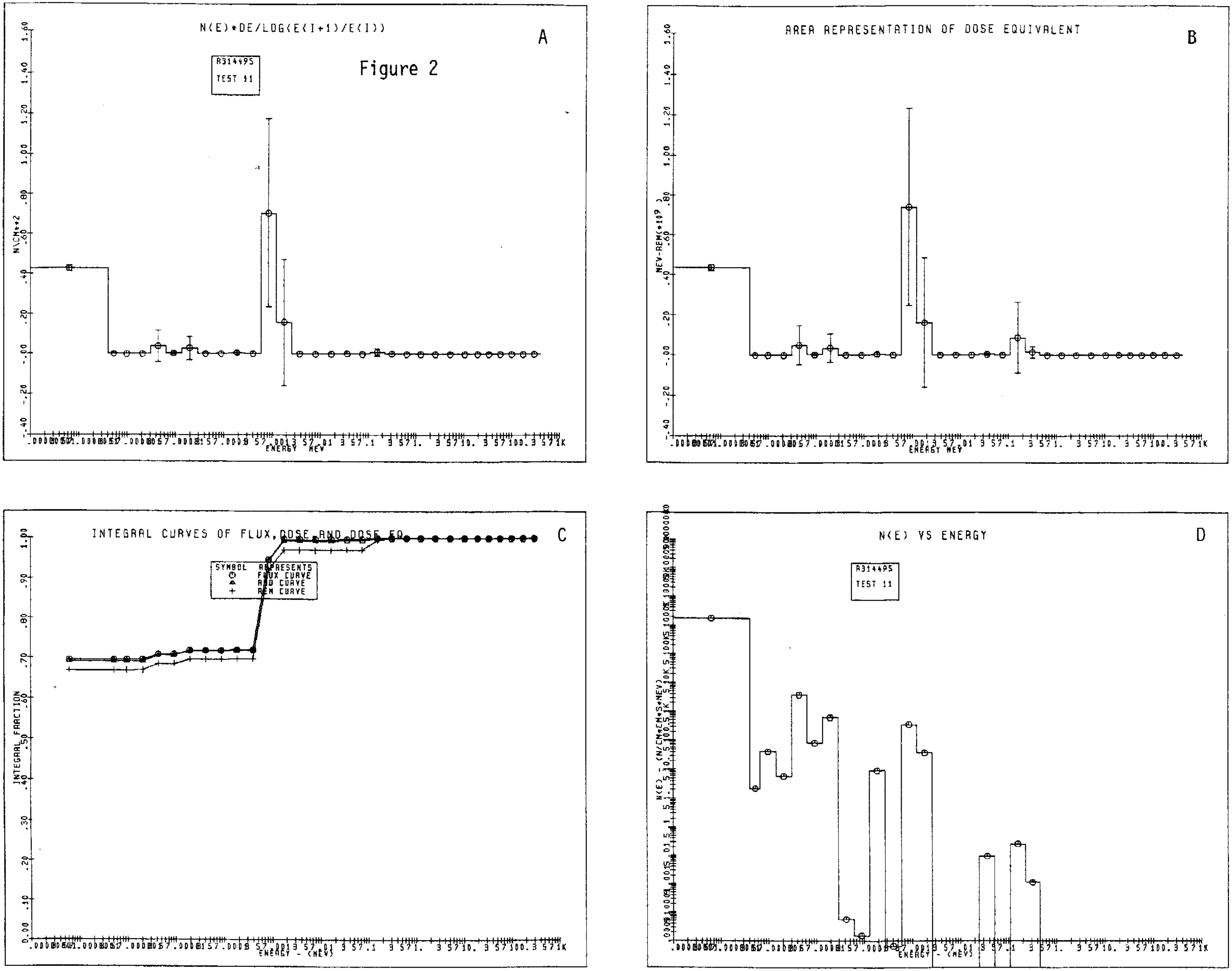
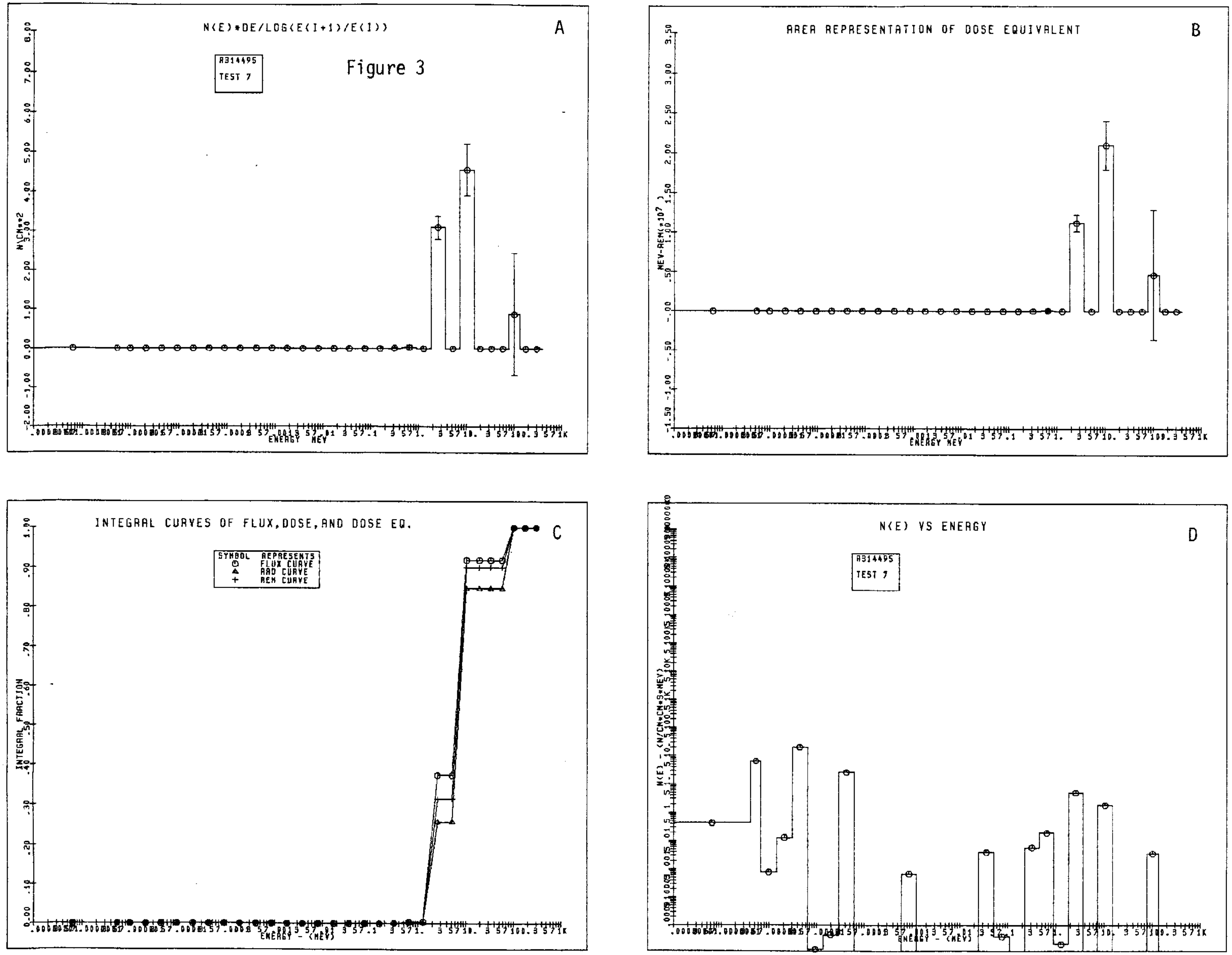

N(E)*DE/LOG(E(I+1)/E(I))
A
R314495
TEST 11
N\CM**2
ENERGY MEV
AREA REPRESENTATION OF DOSE EQUIVALENT
B
MEV-REM(*10⁹)
ENERGY MEV
INTEGRAL CURVES OF FLUX,DOSE AND DOSE EQ
C
SYMBOL REPRESENTS
FLUX CURVE
RAD CURVE
REM CURVE
INTEGRAL FRACTION
ENERGY - (MEV)
N(E) VS ENERGY
D
R314495
TEST 11
N(E) - (N/CM*CM*S*MEV)
ENERGY - (MEV)

Figure 2

Figure 3



A
N(E)*DE/LOG(E(I+1)/E(I))
R314495
TEST 7
N\CM**2
ENERGY MEV
B
AREA REPRESENTATION OF DOSE EQUIVALENT
MEV-REM(*10^7)
ENERGY MEV
C
INTEGRAL CURVES OF FLUX,DOSE,AND DOSE EQ.
SYMBOL REPRESENTS
FLUX CURVE
RAD CURVE
REM CURVE
INTEGRAL FRACTION
ENERGY - (MEV)
D
N(E) VS ENERGY
R314495
TEST 7
N(E) - (N/CM*CM*S*MEV)
ENERGY - (MEV)

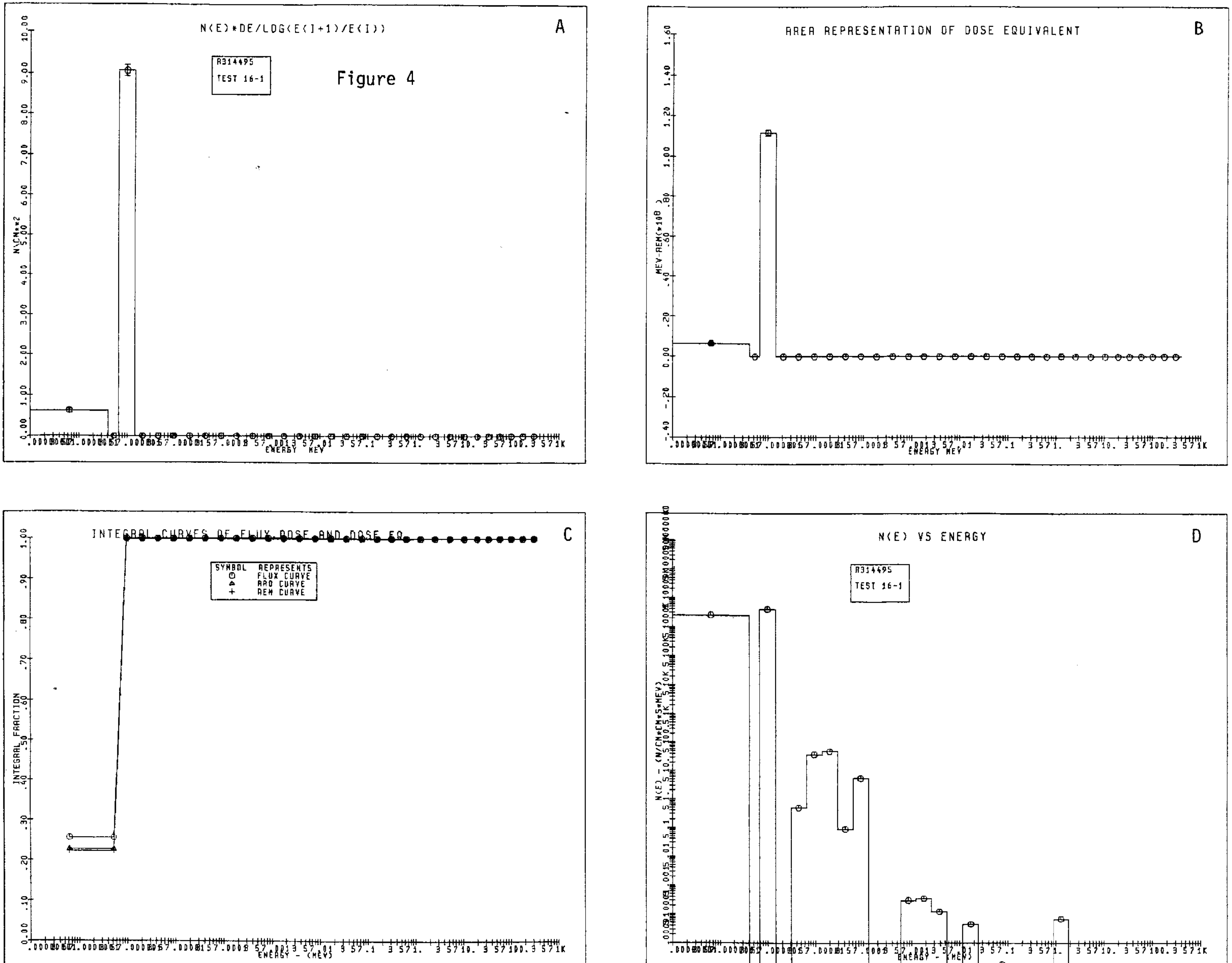

N(E)*DE/LOG(E(I+1)/E(I))
A
R314495
TEST 16-1
N\CM**2
ENERGY MEV
AREA REPRESENTATION OF DOSE EQUIVALENT
B
MEV-REM(*10^8)
ENERGY MEV
INTEGRAL CURVES OF FLUX DOSE AND DOSE EQ
C
SYMBOL REPRESENTS
FLUX CURVE
RAD CURVE
REM CURVE
INTEGRAL FRACTION
ENERGY - (MEV)
N(E) VS ENERGY
D
R314495
TEST 16-1
N(E) - (N/CM*CM*S*MEV)
ENERGY - (MEV)

Figure 4

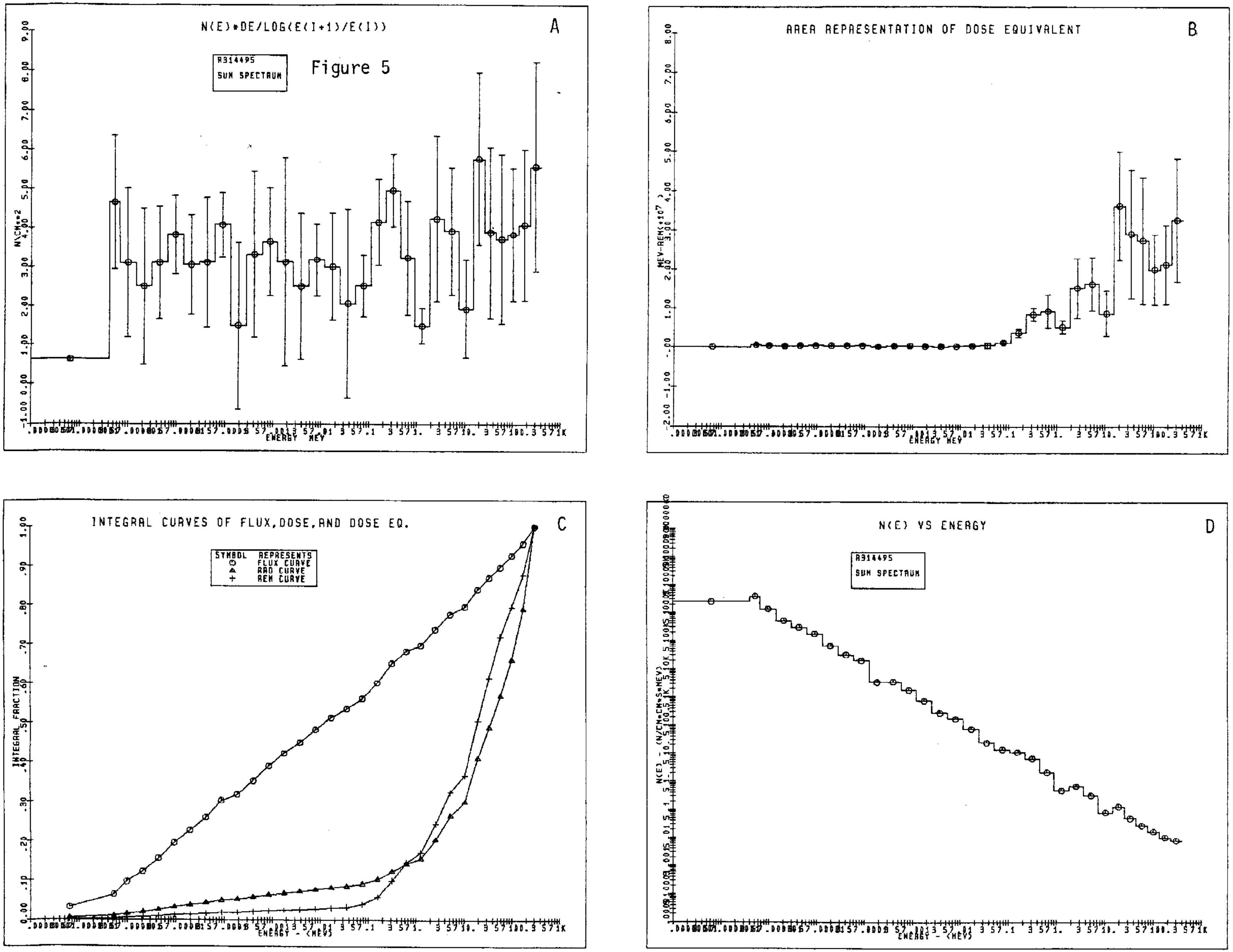

A
N(E)*DE/LOG(E(I+1)/E(I))
R314495
SUM SPECTRUM
N\CM**2
ENERGY MEV
B
AREA REPRESENTATION OF DOSE EQUIVALENT
MEV-REM(*10^7)
ENERGY MEV
C
INTEGRAL CURVES OF FLUX,DOSE,AND DOSE EQ.
SYMBOL REPRESENTS
FLUX CURVE
RAD CURVE
REM CURVE
INTEGRAL FRACTION
ENERGY - (MEV)
D
N(E) VS ENERGY
R314495
SUM SPECTRUM
N(E) - (N/CM*CM*S*MEV)
ENERGY - (MEV)

Figure 5