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MARTIN MARIETTA

ORNL-4972/R2

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The MORSE Monte Carlo Radiation Transport Code System

M. B. Emmett

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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Computer Services

THE MORSE MONTE CARLO RADIATION TRANSPORT CODE SYSTEM

M. B. Emmett*

NOTE:

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PREFACE

This report is an addendum to the MORSE report, ORNL-4972, originally published in 1975 and updated in 1983. This addendum contains descriptions of a set of nine sample problems which includes the two previously published problems in order to make this document complete within itself. All pages have been three-hole punched so that users having loose-leaf copies of the original report can insert these pages in their binders; others can treat this as a third volume of ORNL-4972.

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3.1 MORSE Sample Problem Notebook

For a number of years the MORSE user community has requested additional help in setting up problems using various options. The sample problems distributed with MORSE did not fully demonstrate the capability of the code. At Oak Ridge National Laboratory the code originators had a complete set of sample problems, but funds for documenting and distributing them were never available. Recently the number of requests for listings of input data and results for running some particular option the user was trying to implement has increased to the point where it is not feasible to handle them on an individual basis. Consequently it was decided to package a set of sample problems which illustrates more adequately how to run MORSE.

This write-up may be added to Part III of the MORSE report. In order to make this document complete in itself the write-up for Sample Problem 1 and the PICTURE sample problem are repeated here even though they are part of the original report.

These sample problems include a combined neutron-gamma case, a neutron only case, a gamma only case, an adjoint case, a fission case, a time-dependent fission case, the collision density case, an XCHEKR run and a PICTUR run. It is hoped that users will be able to more clearly understand the options in MORSE as a result of running these problems. The amount of execution time is quite small for each problem. From a quality assurance point-of-view this should verify the accuracy of the code the user receives from the code center whereas in the past the small number of options addressed by the sample problems left a strong possibility of undetected errors in code transmission.

3.2 MORSE Sample Problem #1

The fast-neutron fluence at several radial distances is calculated by MORSE for a point, isotropic. fission source in an infinite medium of air. The air was assumed to be made up of only oxygen and nitrogen with a total density of 1.29 g/ℓ. The combinatorial geometry package (CG) was used to describe the concentric spherical shells of air surrounding the point source. Although the entire medium was air, the geometry medium numbers alternate between each of the shells for use with the boundary-crossing estimator.† This estimator requires that each detector lie on a boundary separating two media. The cross sections for air used in this calculation were for 22 neutron groups wth five Legendre coefficients used for the angular expansion. Only the top 13 neutron groups were analyzed. The group structure with the corresponding fraction of particles emitted in each group is given in Table 3.1. Splitting, Russian roulette, and path length stretching were also implemented. Input data is listed in Table 3.2. The output listing is on microfiche.

For this problem, the standard SOURCE is used, and BANKR is modified to call SDATA and BDRYX during the particle walk. SDATA is a routine for analysis of uncollided fluence, and BDRYX is for analysis of all boundary crossings (equivalent to path length/unit volume). (See Part 4, Section 4.6.4).

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†See Part 4, Section 4.5.3, pg. 4.5-28.

Table 3.1. Fission Spectrum in 14-Group Structure

Group No.	Energy Limits (MeV)	Fraction of Source Neutrons
1	15.0-12.21	1.5579(-4)[a]
2	12.21-10.0	8.9338(-4)
3	10.0-8.187	3.4786(-3)
4	8.187-6.36	1.3903(-2)
5	6.36-4.966	3.4557(-2)
6	4.966-4.066	3.5047(-2)
7	4.066-3.012	1.0724(-1)
8	3.012-2.466	8.8963(-2)
9	2.466-2.350	2.3186(-2)
10	2.350-1.827	1.2030(-1)
11	1.827-1.108	2.1803(-1)
12	1.108-0.5502	1.9837(-1)
13	0.5502-0.1111	1.4036(-1)
14	0.1111-0.3355	1.5489(-2)

[a] Read as 1.5579 x 10^{-4}.

Table 3.2 Listing of Input Cards for MORSE Sample Problem #1

```
MORSE SAMPLE PROBLEM  POINT FISSION SOURCE IN AIR
  200  400   10    1   13    0   22   22    0    0    5    1    0         CARD B
    0   14    0   01.0        0.0        0.0        1.0        2.2      +5  CARD C
       0.0        0.0        0.0        0.0        0.0        0.0       0.0  CARD D
 1.5579 -4 8.9338 -4 3.4786 -3 1.3903 -2 3.4557 -2 3.5047 -2 1.0724 -1  CARDS E
 8.8963 -2 2.3186 -2 1.2030 -1 2.1803 -1 1.9837 -1 1.4036 -1 1.5489 -2  CARDS E
 1.5000 +7 1.2214 +7 1.0000 +7 8.1873 +6 6.3600 +6 4.9658 +6 4.0657 +6  CARDS F
 3.0119 +6 2.4659 +6 2.3500 +6 1.8268 +6 1.1080 +6 5.5020 +5 1.1109 +5  CARDS F
 3.3546 +3 5.8294 +2 1.0130 +2 2.9020 +1 1.0677 +1 3.0590 +0 1.1253 +0  CARDS F
 4.1400 -1                                                              CARDS F
000035FA731A
    1    1    1    0    0    1   13                                     CARD I
    0    0    0    0    0    0 1.0      +01 1.0    -02 1.0    -01 5.0     -1  CARDS J
   -1
    0    0    0    0                                                    CARD L
    0    0          SAMPLE PROB. 1 FOR MORSE
  SPH           0.        0.          0.       3.0E+03
  SPH           0.        0.          0.       5.0E+03
  SPH           0.        0.          0.       7.5E+03
  SPH           0.        0.          0.       1.0E+04
  SPH           0.        0.          0.       1.5E+04
  SPH           0.        0.          0.       2.0E+04
  SPH           0.        0.          0.       3.0E+04
  SPH           0.        0.          0.       6.0E+04
  SPH           0.        0.          0.       7.0E+04
  SPH           0.        0.          0.       9.0E+04
  SPH           0.        0.          0.       1.2E+05
  SPH           0.        0.          0.       1.5E+05
  SPH           0.        0.          0.       1.0E+06
  SPH           0.        0.          0.       1.0E+07
  END
  AIR          +1
  AIR          +2      -1
  AIR          +3      -2
  AIR          +4      -3
  AIR          +5      -4
  AIR          +6      -5
  AIR          +7      -6
  AIR          +8      -7
  AIR          +9      -8
  AIR         +10      -9
  AIR         +11     -10
  AIR         +12     -11
  AIR         +13     -12
  AIR         +14     -13
  END
```

Table 3.2 (continued)

```
   1    1    1    1    1    1    1    1    1    1    1    1    1    1
   1    2    1    2    1    2    1    2    1    2    1    2    1    0
22 GROUP AIR  CROSS SECTIONS --- P5 ---  DENSITY = 1.29 G/L
  22   22    0    0   22   25    4    1    1    1    6    3    1
   0    0    0    0    0    0    0    0    0    0    0
 0 +12031- 9 0 +     0+ 0 0 +70247- 9 0 +22067- 921R+     0+ 0 0 +11281- 9      1
 0 +     0+ 0 0 +65243- 9 0 +21194- 9 0 +14055- 920R+     0+ 0 0 +10355- 9      2
 0 +     0+ 0 0 +57910- 9 0 +19527- 9 0 +14377- 9 0 +31171-1019R+     0+ 0      3
 0 +92492-10 0 +     0+ 0 0 +57436- 9 0 +23946- 9 0 +16100- 9 0 +32754-10      4
 0 +29281-1018R+     0+ 0 0 +90745-10 0 +     0+ 0 0 +63100- 9 0 +27823- 9      5
 0 +19310- 9 0 +16113-10 0 +23152-10 0 +34498-1017R+     0+ 0 0 +14621- 9      6
 0 +     0+ 0 0 +72884- 9 0 +29980- 9 0 +22082- 9 0 +70348-11 0 +13142-10      7
 0 +21940-10 0 +25880-1016R+     0+ 0 0 +13259- 9 0 +     0+ 0 0 +86261- 9      8
 0 +42031- 9 0 +27697- 9 0 +28517-10 0 +97520-11 0 +19957-10 0 +33094-10      9
 0 +32588-1015R+     0+ 0 0 +70810-10 0 +     0+ 0 0 +62171- 9 0 +23374- 9     10
 0 +26782- 9 0 +52500-15 0 +22719-11 0 +56244-11 0 +14450-10 0 +17795-10     11
 0 +17006-1014R+     0+ 0 0 +33771-10 0 +     0+ 0 0 +53538- 9 0 +75580-10     12
 0 +88161-10 0 +31414-10 0 +38131-13 0 +63038-12 0 +12152-11 0 +29969-11     13
 0 +37520-11 0 +35440-1113R+     0+ 0 0 +36572-10 0 +     0+ 0 0 +74575- 9     14
 0 +35996- 9 0 +41220- 9 0 +22817- 9 0 +79882-11 0 +84728-12 0 +28782-11     15
 0 +54518-11 0 +22246-10 0 +16442-10 0 +15359-1012R+     0+ 0 0 +26696-10     16
 0 +     0+ 0 0 +10111- 8 0 +72009- 9 0 +34923- 9 0 +13828-10 0 +     0+ 0     17
 0 +28461-12 0 +25686-11 0 +37451-11 0 +95473-11 0 +20771-10 0 +19773-10     18
 0 +18079-1011R+     0+ 0 0 +13894-10 0 +     0+ 0 0 +10127- 8 0 +80896- 9     19
 0 +26435- 9 3R+     0+ 0 0 +11923-11 0 +16928-11 0 +22410-11 0 +74300-11     20
 0 +71270-11 0 +10911-10 0 +97580-1110R+     0+ 0 0 +23108-11 0 +     0+ 0     21
 0 +15950- 8 0 +14549- 8 0 +18991- 9 3R+     0+ 0 0 +60646-12 0 +97578-12     22
 0 +69178-12 0 +89141-12 0 +31607-11 0 +23569-11 0 +40836-11 0 +35918-11     23
 9R+     0+ 0 0 +56899-12 0 +     0+ 0 0 +27466- 8 0 +26402- 8 0 +13777- 9     24
 4R+     0+ 0 0 +24320-12 0 +50672-13 0 +35016-13 0 +44416-13 0 +10237-12     25
 0 +11424-12 0 +19655-12 0 +17135-12 8R+     0+ 0 0 +27307-11 0 +     0+ 0     26
 0 +35854- 8 0 +33087- 8 0 +10590- 9 5R+     0+ 0 0 +53689-15 0 +61250-16     27
 0 +44470-16 0 +57069-16 0 +99544-16 0 +15180-15 0 +27607-15 0 +24655-15     28
 7R+     0+ 0 0 +70094-11 0 +     0+ 0 0 +38206- 8 0 +35239- 8 0 +27393- 9     29
 6R+     0+ 0 0 +39690-16 0 +38084-17 0 +19369-17 0 +23157-17 0 +28545-17     30
 0 +11206-16 0 +20683-16 0 +16798-16 6R+     0+ 0 0 +14998-10 0 +     0+ 0     31
 0 +39881- 8 0 +35523- 8 0 +28970- 913R+     0+ 0 0 +23985-21 0 +11837-19     32
 5R+     0+ 0 0 +26343-10 0 +     0+ 0 0 +40234- 8 0 +34704- 8 0 +42079- 9     33
14R+     0+ 0 0 +59279-22 0 +24502-20 4R+     0+ 0 0 +46455-10 0 +     0+ 0     34
 0 +40905- 8 0 +36293- 8 0 +52676- 916R+     0+ 0 0 +40545-21 3R+     0+ 0     35
 0 +81039-10 0 +     0+ 0 0 +41602- 8 0 +35628- 8 0 +41478- 920R+     0+ 0     36
 0 +13300- 9 0 +     0+ 0 0 +42106- 8 0 +35798- 8 0 +51629- 920R+     0+ 0     37
 0 +57942- 9 0 +     0+ 0 0 +46612- 8 0 +40818- 8 0 +49769- 920R+     0+ 0     38
 2R+     0+ 0 0 +70247- 9 0 +55366- 923R+     0+ 0 0 +65243- 9 0 +51812- 9      1
 0 +28039-1022R+     0+ 0 0 +57910- 9 0 +46511- 9 0 +82529-12 0 -34105-10      2
```

Table 3.2 (continued)

```
21R+    0+ 0 0 +57436- 9 0 +52074- 9 0 -56910-10 0 -33645-1021R+    0+ 0        3
 0 +63100- 9 0 +56259- 9 0 -95744-10 0 -39411-1121R+    0+ 0 0 +72884- 9        4
 0 +67834- 9 0 -16134- 9 0 -86327-1121R+    0+ 0 0 +86261- 9 0 +75179- 9        5
 0 -17914- 9 0 -68136-1021R+    0+ 0 0 +62171- 9 0 +46303- 9 0 -30410- 9        6
22R+    0+ 0 0 +53538- 9 0 +20210- 9 0 +67313-10 0 -77370-1021R+    0+ 0        7
 0 +74575- 9 0 +57669- 9 0 +84142-10 0 -29471- 9 0 -22037-1020R+    0+ 0        8
 0 +10111- 8 0 +64755- 9 0 -25951- 9 0 -38164-1021R+    0+ 0 0 +10127- 8        9
 0 +42570- 9 0 -23334- 922R+    0+ 0 0 +15950- 8 0 +36793- 9 0 -13650- 9       10
22R+    0+ 0 0 +27466- 8 0 +47370- 9 0 -12684- 922R+    0+ 0 0 +35854- 8       11
 0 +76560- 9 0 -95901-1022R+    0+ 0 0 +38206- 8 0 +81388- 9 0 -24833- 9       12
22R+    0+ 0 0 +39881- 8 0 +95671- 9 0 -26278- 922R+    0+ 0 0 +40234- 8       13
 0 +10563- 8 0 -38215- 922R+    0+ 0 0 +40905- 8 0 +96174- 9 0 -47822- 9       14
22R+    0+ 0 0 +41602- 8 0 +10593- 8 0 -37673- 922R+    0+ 0 0 +42106- 8       15
 0 +10270- 8 0 -46872- 922R+    0+ 0 0 +46612- 8 0 +    0+ 0 0 -45480- 9       16
20R+    0+ 0                                                                  17
 2R+    0+ 0 0 +70247- 9 0 +69107- 923R+    0+ 0 0 +65243- 9 0 +62392- 9        1
 0 -72000-1022R+    0+ 0 0 +57910- 9 0 +54463- 9 0 -78847-10 0 +40544-10        2
21R+    0+ 0 0 +57436- 9 0 +56525- 9 0 -69713-10 0 +38568-1021R+    0+ 0        3
 0 +63100- 9 0 +54019- 9 0 -40874-10 0 +56019-1121R+    0+ 0 0 +72884- 9        4
 0 +69678- 9 0 -17789-10 0 +11990-1021R+    0+ 0 0 +86261- 9 0 +74494- 9        5
 0 +15360- 9 0 +76303-1021R+    0+ 0 0 +62171- 9 0 +34577- 9 0 +21974- 9        6
22R+    0+ 0 0 +53538- 9 0 +26501- 9 0 -44031-10 0 +84248-1021R+    0+ 0        7
 0 +74575- 9 0 +28015- 9 0 -15857- 9 0 +43965-10 0 +30911-1020R+    0+ 0        8
 0 +10111- 8 0 +40335- 9 0 -77993-11 0 +53547-1021R+    0+ 0 0 +10127- 8        9
 0 +22675- 9 0 +98275-1022R+    0+ 0 0 +15950- 8 0 +13766- 9 0 -31135-10       10
22R+    0+ 0 0 +27466- 8 0 +48445-10 0 -10203-1022R+    0+ 0 0 +35854- 8       11
 0 +75791-10 0 -90808-1122R+    0+ 0 0 +38206- 8 0 +80502-10 0 -23240-10       12
22R+    0+ 0 0 +39881- 8 0 +93603-10 0 -24438-1022R+    0+ 0 0 +40234- 8       13
 0 +10285- 9 0 -35087-1022R+    0+ 0 0 +40905- 8 0 +93944-10 0 -43949-10       14
22R+    0+ 0 0 +41602- 8 0 +10258- 9 0 -34279-1022R+    0+ 0 0 +42106- 8       15
 0 +10426- 9 0 -42212-1022R+    0+ 0 0 +46612- 8 0 +    0+ 0 0 -34698-10       16
20R+    0+ 0                                                                  17
 2R+    0+ 0 0 +70247- 9 0 +70321- 923R+    0+ 0 0 +65243- 9 0 +62536- 9        1
 0 +13849-1022R+    0+ 0 0 +57910- 9 0 +54199- 9 0 +29572-10 0 -34172-10        2
21R+    0+ 0 0 +57436- 9 0 +54680- 9 0 +50026-10 0 -30256-1021R+    0+ 0        3
 0 +63100- 9 0 +47578- 9 0 +69933-10 0 -61050-1121R+    0+ 0 0 +72884- 9        4
 0 +54800- 9 0 +51915-10 0 -12584-1021R+    0+ 0 0 +86261- 9 0 +54971- 9        5
 0 -76147-10 0 -54466-1021R+    0+ 0 0 +62171- 9 0 +18010- 9 0 -10531- 9        6
22R+    0+ 0 0 +53538- 9 0 +25118- 9 0 -43162-10 0 -55490-1021R+    0+ 0        7
 0 +74575- 9 0 +10308- 9 0 -12354- 9 0 -27625-10 0 -32964-1020R+    0+ 0        8
 0 +10111- 8 0 +19170- 9 0 -44569-10 0 -57015-1021R+    0+ 0 0 +10127- 8        9
 0 +96616-11 0 -57384-1022R+    0+ 0 0 +15950- 8 0 +14942-10 0 -17019-10       10
22R+    0+ 0 0 +27466- 8 0 -29453-10 0 -11580-1122R+    0+ 0 0 +35854- 8       11
 0 -40830-10 0 -22594-1122R+    0+ 0 0 +38206- 8 0 -43758-10 0 -57987-11       12
22R+    0+ 0 0 +39881- 8 0 -43381-10 0 -61287-1122R+    0+ 0 0 +40234- 8       13
 0 -41300-10 0 -88550-1122R+    0+ 0 0 +40905- 8 0 -44037-10 0 -11322-10       14
```

Table 3.2 (continued)

```
22R+    0+ 0 0 +41602- 8 0 -41799-10 0 -92138-1122R+    0+ 0 0 +42106- 8   15
 0 -24206-10 0 -11908-1022R+    0+ 0 0 +46612- 8 0 +    0+ 0 0 -19669-10   16
20R+    0+ 0                                                               17
 2R+    0+ 0 0 +70247- 9 0 +63319- 923R+    0+ 0 0 +65243- 9 0 +56598- 9    1
 0 +79906-1022R+    0+ 0 0 +57910- 9 0 +47662- 9 0 +85919-10 0 +23298-10    2
21R+    0+ 0 0 +57436- 9 0 +41757- 9 0 +94751-10 0 +18275-1021R+    0+ 0    3
 0 +63100- 9 0 +31740- 9 0 +50361-10 0 +54739-1121R+    0+ 0 0 +72884- 9    4
 0 +33677- 9 0 -65477-10 0 +10656-1021R+    0+ 0 0 +86261- 9 0 +22392- 9    5
 0 -99578-10 0 +21930-1021R+    0+ 0 0 +62171- 9 0 +99323-10 0 -63973-10    6
22R+    0+ 0 0 +53538- 9 0 +17702- 9 0 -60963-10 0 +15008-1021R+    0+ 0    7
 0 +74575- 9 0 +47284-10 0 -20232- 9 0 +51567-10 0 +28578-1020R+    0+ 0    8
 0 +10111- 8 0 +73559-10 0 -79020-11 0 +49040-1021R+    0+ 0 0 +10127- 8    9
 0 +10166-10 0 -44963-1022R+    0+ 0 0 +15950- 8 0 +93530-11 0 -89195-11   10
22R+    0+ 0 0 +27466- 8 0 +83113-10 0 +22143-1122R+    0+ 0 0 +35854- 8   11
 0 +75510-10 0 +52998-1122R+    0+ 0 0 +38206- 8 0 +80679-10 0 +13709-10   12
22R+    0+ 0 0 +39881- 8 0 +78252-10 0 +14581-1022R+    0+ 0 0 +40234- 8   13
 0 +73370-10 0 +21203-1022R+    0+ 0 0 +40905- 8 0 +79796-10 0 +26730-10   14
22R+    0+ 0 0 +41602- 8 0 +74416-10 0 +21278-1022R+    0+ 0 0 +42106- 8   15
 0 +16455- 9 0 +26768-1022R+    0+ 0 0 +46612- 8 0 +    0+ 0 0 +41974-10   16
20R+    0+ 0                                                               17
 2R+    0+ 0 0 +70247- 9 0 +48470- 923R+    0+ 0 0 +65243- 9 0 +42755- 9    1
 0 -37301-1022R+    0+ 0 0 +57910- 9 0 +32130- 9 0 -55982-10 0 -15807-10    2
21R+    0+ 0 0 +57436- 9 0 +19518- 9 0 -81760-10 0 -11315-1021R+    0+ 0    3
 0 +63100- 9 0 +10832- 9 0 -13409- 9 0 -40247-1121R+    0+ 0 0 +72884- 9    4
 0 +11598- 9 0 -21523-10 0 -71699-1121R+    0+ 0 0 +86261- 9 0 +67571-10    5
 0 -67094-10 0 +78990-1221R+    0+ 0 0 +62171- 9 0 +40592-10 0 -16550-10    6
22R+    0+ 0 0 +53538- 9 0 +78886-10 0 -36437-10 0 +11706-1021R+    0+ 0    7
 0 +74575- 9 0 +61549-11 0 -60885-10 0 +22592-10 0 -19893-1020R+    0+ 0    8
 0 +10111- 8 0 +10090-10 0 -14219-10 0 -33189-1021R+    0+ 0 0 +10127- 8    9
 0 -29733-11 0 -22978-1022R+    0+ 0 0 +15950- 8 0 -10402-10 0 -18486-11   10
22R+    0+ 0 0 +27466- 8 0 -75968-10 0 -20242-1122R+    0+ 0 0 +35854- 8   11
 0 -97342-10 0 -11581-1022R+    0+ 0 0 +38206- 8 0 -10417- 9 0 -30083-10   12
22R+    0+ 0 0 +39881- 8 0 -95899-10 0 -31970-1022R+    0+ 0 0 +40234- 8   13
 0 -85091-10 0 -46541-1022R+    0+ 0 0 +40905- 8 0 -99314-10 0 -58362-10   14
22R+    0+ 0 0 +41602- 8 0 -89912-10 0 -46163-1022R+    0+ 0 0 +42106- 8   15
 0 -46088-10 0 -57320-1022R+    0+ 0 0 +46612- 8 0 +    0+ 0 0 -88991-10   16
20R+    0+ 0                                                               17
    1   -1 1.16
```

Table 3.2 (continued)

```
SAMBO ANALYSIS INPUT DATA
 $$ 7    0    0    0    0    1    0    1
 **
     0.         0.         1.0E+4
     0.         0.         2.0E+4
     0.         0.         3.0E+4
     0.         0.         6.0E+4
     0.         0.         7.0E+4
     0.         0.         9.0E+4
     0.         0.        12.0E+4

4 PI R**2 FLUENCE
 **  22R1.0

†$$$$$$$$   MORSE SAMPLE PROBLEM 1   $$$$$$$$
```

† Required only for IBM version.

3.3 MORSE PICTURE Sample Problem

This problem illustrates the use of the PICTURE[1,†] program for looking at the geometry of a given problem. The geometry being illustrated is a tank. This tank model was constructed purely as an illustration of the combinatorial geometry and is in no way accurate or detailed. Both the use of the OR operator and the ARB body is demonstrated. The input data is listed in Table 3.3. The picture produced by the problem is on microfiche.

[†] See Part 5 of this document.

Table 3.3. Listing of Input Cards for PICTURE Sample Problem

```
   7
 .1ETAO
   0     0           COMBINATORIAL GEOMETRY TANK SAMPLE PROBLEM
  ARB       1.25      -1.25      .5         1.25       -2.0       0.0
            1.25      2.0        0.0        1.25       1.25       .5
            -1.25     -1.25      .5         -1.25      -2.0        0.0
            -1.25     2.0        0.0        -1.25       1.25       .5
            1234.     4158.      6587.      2673.      5621.      4378.
  ELL       0.0       -.5        .5         0.0        .5         .5
            1.5
  TRC       0.0       0.0        .8         0.0        2.5        0.0
            .1        .05
  ARB       1.25      -2.0       0.0        1.25       -1.8       -.8
            1.25       2.0       0.0        1.25        1.8       -.8
           -1.25       2.0       0.0       -1.25        1.8       -.8
           -1.25      -2.0       0.0       -1.25       -1.8       -.8
            1243.     7135.      8756.      2864.      7821.      3465.
  BOX       1.25      -1.979     -.6895     0.0        .358       .179
            0.0       -.2        .4         -2.5       0.0        0.0
  BOX       1.25      1.979      -.6895     0.0        -.358      .179
            0.0       .2         .4         -2.5       0.0        0.0
  RCC       1.25      -2.0       -.2        -2.5       0.0        0.0
            .2
  RCC       1.25      -1.8       -.6        -2.5       0.0        0.0
            .2
  RCC       1.25       2.0       -.2        -2.5       0.0        0.0
            .2
  RCC       1.25      1.80       -.6        -2.5       0.0        0.0
            .2
  RCC       1.25      -.9        -.6        -2.5       0.0        0.0
            .2
  RCC       1.25      -.45       -.2        -2.5       0.0        0.0
            .2
  RCC       1.25      0.0        -.6        -2.5       0.0        0.0
           .2
  RCC       1.25      .45        -.2        -2.5       0.0        0.0
            .2
  RCC       1.25      .9         -.6        -2.5       0.0        0.0
            .2
  RPP       -10.      10.        -10.       10.        -10.       10.
  END
   1             +1
   2             +2      -1
   3             +3      -2
   4     OR      +4      -7      -8      -9      -10     -11     -12     -13     -14
               -15OR     +5      -7      -8OR    +6      -9      -10
   5     OR      +7OR    +8OR    +9OR    +10OR   +11OR   +12OR   +13OR   +14OR   +15
   6             +16     -1      -2      -3      -4      -5      -6      -7      -8
                 -9      -10
```

Table 3.3 (continued)

```
 END
   1    1    1    1    1    1
   1    2    3    4    5 1000
0 0  THIS IS A COMBINATORIAL GEOMETRY TANK.
0.0       -3.0      -2.0       0.0       3.0       2.0
0.0        1.0       0.0       0.0       0.0       1.0
      130
```

3.4 MORSE Sample Problem #2

The secondary gamma-ray dose rate due to neutrons of energies greater than .011 MeV at several radial distances is calculated by MORSE for a point, isotropic, 12.2-15 MeV source in an infinite medium of air. The air was assumed to be made up of only oxygen and nitrogen with a total density of 1.29 g/ℓ. The combinatorial geometry package (CG) was used to describe the concentric spherical shells of air surrounding the point source. Although the entire medium was air, the geometry medium numbers alternate between each of the shells for use with the boundary-crossing estimator.† This estimator requires that each detector lie on a boundary separating two media. The cross sections for air used in this calculation were for 22 neutron groups and 18 gamma groups with five Legendre coefficients used for the angular expansion. Only the top 13 neutron groups and the top 17 gamma groups were analyzed. The group structure and the response functions are given in Table 3.4. Splitting, Russian roulette, and path length stretching were also implemented. Input data is listed in Table 3.5. The output listing is on microfiche.

This problem is similar to Problem #1 except that the gamma rays must be produced and transported. The same user routines (SOURCE, BANKR, SDATA, BRDYX) written for problem #1 are used here. Also, additional input is required for time-dependent analysis and for the GWLOW array.

---

†See Part 4, Section 4.5.3, pg. 4.5-28.

Table 3.4. Neutron and Gamma Group Structure and Response Functions

Group	Upper Neutron Energy (eV)	Henderson Tissue Dose	Upper Gamma Energy (eV)	Henderson Tissue Dose*
1	14.0 (+6)	5.4579 (-9)	10.0(+6)	2.7727(-9)
2	12.2 (+6)	5.1339 (-9)	8.0(+6)	2.318 (-9)
3	10.0 (+6)	4.8409 (-9)	6.5(+6)	1.9373(-9)
4	8.18(+6)	4.6175 (-9)	5.0(+6)	1.6091(-9)
5	6.36(+6)	4.4454 (-9)	4.0(+6)	1.3389(-9)
6	4.96(+6)	4.3144 (-9)	3.0(+6)	1.1299(-9)
7	4.06(+6)	4.0126 (-9)	2.5(+6)	9.8058(-10)
8	3.01(+6)	3.3938 (-9)	2.0(+6)	8.4739(-10)
9	2.46(+6)	3.1489 (-9)	1.66(+6)	7.3278(-10)
10	2.35(+6)	3.0892 (-9)	1.33(+6)	6.0565(-10)
11	1.83(+6)	2.6435 (-9)	1.0(+6)	4.6558(-10)
12	1.11(+6)	1.9751 (-9)	0.8(+6)	3.6869(-10)
13	5.50(+5)	1.1236 (-9)	0.6(+6)	2.8622(-10)
14	1.11(+5)	2.2958(-10)	0.4(+6)	1.9841(-10)
15	3.35(+3)	0	0.3(+6)	1.3585(-10)
16	5.83(+2)	0	0.2(+6)	7.3791(-11)
17	1.01(+2)	0	0.1(+6)	3.6825(-11)
18	2.90(+1)	0	0.05(+6)	0
19	1.07(+1)	0		
20	3.06(+0)	0		
21	1.12(+0)	0		
22	0.414(+0)	0		

*Units of rad (γ/cm^2).

Table 3.5. Listing of Input Data for MORSE Sample Problem #2

```
SAMPLE PROBLEM 2
  500 1000    10     1    13    17    22    40     0     0  3.2     1     0
    1    0     0           1.        .025           1.E+4     1.         2.2E+5
   0.         0.         0.          0.         0.         0.         0.
1.5000E+071.2200E+071.0000E+078.1800E+066.3600E+064.9600E+064.0600E+06
 3.01 E+06 2.46 E+06 2.35 E+06 1.826E+06 1.108E+06 5.502E+05 1.109E+05
 3.3546E+3 5.8294E+2 1.0130E+2 2.9020E+1 1.0677E+1 3.0590E+0 1.1253E+0
4.1400E-011.0000E+078.0000E+066.5000E+065.0000E+064.0000E+063.0000E+06
2.5000E+062.0000E+061.6600E+061.3300E+061.0000E+068.0000E+056.0000E+05
4.0000E+053.0000E+052.0000E+051.0000E+05      5.E+4
5317A47C8301
    1    1     1     0     0     1    40
    1    1    13     1     1     1     10.          1.E-3      .5          0.5
   14    1    19     1     1     1     10.          1.E-3      .5          0.
   20    1    22     1     1     1     2.           1.E-3      .2          0.0
   23    1    35     1     1     1    5.0        1. E-03 1.0   E+00 5.0   E-01
   36    1    40     1     1     1    2.0        1. E-03  .5   E+00        0.0
   -1
    0    0     0     0
     .7       .7          .5          .3          .1         .05        .005
    .1 E-2      0.0        0.          0.0         0.0        0.         0.
       0.       5.E-4      5.E-4       5.E-3       1.E-3      2.E-3      2.E-3
     1.E-2
    0    0           SAMPLE PROB. 1 FOR MORSE
  SPH               0.         0.          0.      3.0E+03
  SPH               0.         0.          0.      5.0E+03
  SPH               0.         0.          0.      7.5E+03
  SPH               0.         0.          0.      1.0E+04
  SPH               0.         0.          0.      1.5E+04
  SPH               0.         0.          0.      2.0E+04
  SPH               0.         0.          0.      3.0E+04
  SPH               0.         0.          0.      6.0E+04
  SPH               0.         0.          0.      7.0E+04
  SPH               0.         0.          0.      9.0E+04
  SPH               0.         0.          0.      1.2E+05
  SPH               0.         0.          0.      1.5E+05
  SPH               0.         0.          0.      1.0E+06
  SPH               0.         0.          0.      1.0E+07
  END
  AIR             +1
  AIR             +2      -1
  AIR             +3      -2
  AIR             +4      -3
  AIR             +5      -4
  AIR             +6      -5
  AIR             +7      -6
  AIR             +8      -7
  AIR             +9      -8
  AIR            +10      -9
  AIR            +11     -10
  AIR            +12     -11
  AIR            +13     -12
  AIR            +14     -13
  END
```

Table 3.5 (continued)

```
   1   1   1   1   1   1   1   1   1   1   1   1   1   1
   1   2   1   2   1   2   1   2   1   2   1   2   1   0
AIR XSECT
  22  22  18  18  40  43   4   1   1   1   6   3   0
                .  0
 0 +12031- 9 0 +     0+ 0 0 +70247- 9 0 +22067- 939R+      0+ 0 0 +11281- 9        1
 0 +     0+ 0 0 +65243- 9 0 +21194- 9 0 +14055- 938R+      0+ 0 0 +10355- 9        2
 0 +     0+ 0 0 +57910- 9 0 +19527- 9 0 +14377- 9 0 +31171-1037R+      0+ 0        3
 0 +92492-10 0 +     0+ 0 0 +57436- 9 0 +23946- 9 0 +16100- 9 0 +32754-10        4
 0 +29281-1036R+     0+ 0 0 +90745-10 0 +     0+ 0 0 +63100- 9 0 +27823- 9        5
 0 +19310- 9 0 +16113-10 0 +23152-10 0 +34498-1035R+      0+ 0 0 +14621- 9        6
 0 +     0+ 0 0 +72884- 9 0 +29980- 9 0 +22082- 9 0 +70348-11 0 +13142-10        7
 0 +21940-10 0 +25880-1034R+      0+ 0 0 +13259- 9 0 +     0+ 0 0 +86261- 9        8
 0 +42031- 9 0 +27697- 9 0 +28517-10 0 +97520-11 0 +19957-10 0 +33094-10        9
 0 +32588-1033R+     0+ 0 0 +70810-10 0 +     0+ 0 0 +62171- 9 0 +23374- 9       10
 0 +26782- 9 0 +52500-15 0 +22719-11 0 +56244-11 0 +14450-10 0 +17795-10       11
 0 +17006-1032R+     0+ 0 0 +33771-10 0 +     0+ 0 0 +53538- 9 0 +75580-10       12
 0 +88161-10 0 +31414-10 0 +38131-13 0 +63038-12 0 +12152-11 0 +29969-11       13
 0 +37520-11 0 +35440-1131R+      0+ 0 0 +36572-10 0 +     0+ 0 0 +74575- 9       14
 0 +35996- 9 0 +41220- 9 0 +22817- 9 0 +79882-11 0 +84728-12 0 +28782-11       15
 0 +54518-11 0 +22246-10 0 +16442-10 0 +15359-1030R+      0+ 0 0 +26696-10       16
 0 +     0+ 0 0 +10111- 8 0 +72009- 9 0 +34923- 9 0 +13828-10 0 +     0+ 0       17
 0 +28461-12 0 +25686-11 0 +37451-11 0 +95473-11 0 +20771-10 0 +19773-10       18
 0 +18079-1029R+     0+ 0 0 +13894-10 0 +     0+ 0 0 +10127- 8 0 +80896- 9       19
 0 +26435- 9 3R+     0+ 0 0 +11923-11 0 +16928-11 0 +22410-11 0 +74300-11       20
 0 +71270-11 0 +10911-10 0 +97580-1128R+      0+ 0 0 +23108-11 0 +     0+ 0       21
 0 +15950- 8 0 +14549- 8 0 +18991- 9 3R+      0+ 0 0 +60646-12 0 +97578-12       22
 0 +69178-12 0 +89141-12 0 +31607-11 0 +23569-11 0 +40836-11 0 +35918-11       23
27R+     0+ 0 0 +56899-12 0 +     0+ 0 0 +27466- 8 0 +26402- 8 0 +13777- 9       24
 4R+     0+ 0 0 +24320-12 0 +50672-13 0 +35016-13 0 +44416-13 0 +10237-12       25
 0 +11424-12 0 +19655-12 0 +17135-1226R+      0+ 0 0 +27307-11 0 +     0+ 0       26
 0 +35854- 8 0 +33087- 8 0 +10590- 9 5R+      0+ 0 0 +53689-15 0 +61250-16       27
 0 +44470-16 0 +57069-16 0 +99544-16 0 +15180-15 0 +27607-15 0 +24655-15       28
25R+     0+ 0 0 +70094-11 0 +     0+ 0 0 +38206- 8 0 +35239- 8 0 +27393- 9       29
 6R+     0+ 0 0 +39690-16 0 +38084-17 0 +19369-17 0 +23157-17 0 +28545-17       30
 0 +11206-16 0 +20683-16 0 +16798-1624R+      0+ 0 0 +14998-10 0 +     0+ 0       31
 0 +39881- 8 0 +35523- 8 0 +28970- 913R+      0+ 0 0 +23985-21 0 +11837-19       32
23R+     0+ 0 0 +26343-10 0 +     0+ 0 0 +40234- 8 0 +34704- 8 0 +42079- 9       33
14R+     0+ 0 0 +59279-22 0 +24502-2022R+      0+ 0 0 +46455-10 0 +     0+ 0       34
 0 +40905- 8 0 +36293- 8 0 +52676- 916R+      0+ 0 0 +40545-2121R+      0+ 0       35
 0 +81039-10 0 +     0+ 0 0 +41602- 8 0 +35628- 8 0 +41478- 938R+      0+ 0       36
 0 +13300- 9 0 +     0+ 0 0 +42106- 8 0 +35798- 8 0 +51629- 938R+      0+ 0       37
 0 +57942- 9 0 +     0+ 0 0 +46612- 8 0 +40818- 8 0 +49769- 938R+      0+ 0       38
 0 +14909- 8 0 +     0+ 0 0 +23065- 9 0 +97723-11 0 +15540-11 0 +28676-12       39
 0 +17278-12 0 +95847-13 0 +54470-13 0 +29422-13 0 +11928-13 0 +35389-14       40
 0 +16010-1510R+     0+ 0 0 +17539-11 0 +83066-11 0 +12818-1017R+      0+ 0       41
 0 +12621- 8 0 +     0+ 0 0 +25258- 9 0 +11325-10 0 +16034-10 0 +24536-11       42
 0 +45278-12 0 +27281-12 0 +15134-12 0 +86008-13 0 +46455-13 0 +18834-13       43
 0 +55877-14 0 +25280-15 9R+      0+ 0 0 +29731-12 0 +10293-10 0 +32203-10       44
 0 +47365-1016R+     0+ 0 0 +10663- 8 0 +     0+ 0 0 +28176- 9 0 +17754-10       45
 0 +24667-10 0 +16988-10 0 +28898-10 0 +53325-11 0 +32131-11 0 +17825-11       46
 0 +10130-11 0 +54714-12 0 +22182-12 0 +65812-13 0 +29774-14 7R+      0+ 0       47
 0 +90377-14 0 +65386-11 0 +39159-10 0 +84145-10 0 +94747-10 0 +87075-10       48
15R+     0+ 0 0 +89866- 9 0 +     0+ 0 0 +31825- 9 0 +19466-10 0 +26223-10       49
```

Table 3.5 (continued)

```
 0 +17461-10 0 +12607-10 0 +43620-11 0 +80493-12 0 +48498-12 0 +26905-12       50
 0 +15290-12 0 +82587-13 0 +33483-13 0 +99337-14 0 +44943-15 7R+    0+ 0       51
 0 +31632-13 0 +42177-11 0 +16061-10 0 +26326-10 0 +46104-10 0 +49634-10       52
14R+    0+ 0 0 +75663- 9 0 +    0+ 0 0 +36329- 9 0 +31606-10 0 +42413-10       53
 0 +27871-10 0 +19599-10 0 +14732-10 0 +87240-11 0 +16099-11 0 +97000-12       54
 0 +53809-12 0 +30580-12 0 +16517-12 0 +66964-13 0 +19867-13 0 +89882-15       55
6R+     0+ 0 0 +89610-13 0 +35759-12 0 +62391-12 0 +33847-10 0 +20618-10       56
 0 +30743-10 0 +29184-1013R+    0+ 0 0 +64344- 9 0 +    0+ 0 0 +41235- 9       57
 0 +26227-10 0 +34982-10 0 +22263-10 0 +15443-10 0 +11335-10 0 +87715-11       58
14R+    0+ 0 0 +27262-12 0 +12975-11 0 +28653-11 0 +50697-11 0 +10311-10       59
 0 +25347-10 0 +53925-10 0 +55999-1012R+    0+ 0 0 +56065- 9 0 +    0+ 0       60
 0 +45958- 9 0 +38616-10 0 +55355-10 0 +35994-10 0 +24124-10 0 +17406-10       61
 0 +13146-10 0 +10359-1014R+    0+ 0 0 +27262-12 0 +12975-11 0 +28653-11       62
 0 +11068-10 0 +19609-10 0 +29237-10 0 +55912-10 0 +14506-1011R+    0+ 0       63
 0 +48582- 9 0 +    0+ 0 0 +51319- 9 0 +40002-10 0 +55975-10 0 +38163-10       64
 0 +26100-10 0 +18343-10 0 +13679-10 0 +10565-10 0 +84396-1115R+    0+ 0       65
 0 +17429-14 0 +10324-11 0 +37041-11 0 +77040-11 0 +18449-10 0 +35409-10       66
 0 +31797-1010R+    0+ 0 0 +41895- 9 0 +    0+ 0 0 +57095- 9 0 +57287-10       67
 0 +80911-10 0 +54588-10 0 +38988-10 0 +27927-10 0 +20417-10 0 +15615-10       68
 0 +12257-10 0 +98841-1115R+    0+ 0 0 +20390-14 0 +12078-11 0 +43333-11       69
 0 +90130-11 0 +21745-10 0 +43555-10 0 +44825-10 9R+    0+ 0 0 +34438- 9       70
 0 +    0+ 0 0 +64989- 9 0 +91749-10 0 +11931- 9 0 +80671-10 0 +57855-10       71
 0 +43634-10 0 +32810-10 0 +24903-10 0 +19473-10 0 +15493-10 0 +12587-10       72
19R+    0+ 0 0 +12419-12 0 +11824-10 0 +25207-10 8R+    0+ 0 0 +27898- 9       73
 0 +    0+ 0 0 +73725- 9 0 +94243-10 0 +11707- 9 0 +71452-10 0 +51747-10       74
 0 +39388-10 0 +31125-10 0 +24289-10 0 +18921-10 0 +15005-10 0 +12035-10       75
 0 +98177-1129R+    0+ 0 0 +22337- 9 0 +    0+ 0 0 +82914- 9 0 +14997- 9       76
 0 +18813- 9 0 +11300- 9 0 +75921-10 0 +58659-10 0 +46854-10 0 +38279-10       77
 0 +30584-10 0 +24178-10 0 +19312-10 0 +15542-10 0 +12696-1019R+    0+ 0       78
 0 +43907-12 0 +17079-10 0 +32956-10 6R+    0+ 0 0 +16033- 9 0 +    0+ 0       79
 0 +96123- 9 0 +27222- 9 0 +29044- 9 0 +17723- 9 0 +12407- 9 0 +95320-10       80
 0 +82964-10 0 +75743-10 0 +73191-10 0 +75192-10 0 +80989-10 0 +90084-10       81
 0 +10111- 9 0 +11386- 927R+    0+ 0 0 +11650- 9 0 +    0+ 0 0 +11068- 8       82
 0 +28177- 9 0 +26614- 9 0 +13999- 9 0 +10499- 9 0 +83506-10 0 +67594-10       83
 0 +56960-10 0 +47718-10 0 +39928-10 0 +32207-10 0 +25463-10 0 +20238-10       84
 0 +16187-10 0 +13146-1026R+    0+ 0 0 +76425-10 0 +    0+ 0 0 +12528- 8       85
 0 +48854- 9 0 +48508- 9 0 +27591- 9 0 +20533- 9 0 +16774- 9 0 +12049- 9       86
 0 +84732-10 0 +64076-10 0 +48604-10 0 +37219-10 0 +27467-10 0 +19989-10       87
 0 +14887-10 0 +11296-10 0 +88155-1125R+    0+ 0 0 +28050-10 0 +    0+ 0       88
 0 +14826- 8 0 +11150- 8 0 +76423- 9 0 +33997- 9 0 +14694- 9 0 +43437-10       89
 0 +49124-1134R+    0+ 0 0 +13163-10 0 +    0+ 0 0 +18120- 8 0 +15464- 8       90
 0 +36124- 938R+    0+ 0 0 +39665-10 0 +    0+ 0 0 +30831- 8 0 +18936- 8       91
 0 +19302- 938R+    0+ 0                                                      92
 2R+    0+ 0 0 +70247- 9 0 +55366- 941R+    0+ 0 0 +65243- 9 0 +51812- 9       1
 0 +28039-1040R+    0+ 0 0 +57910- 9 0 +46511- 9 0 +82529-12 0 -34105-10       2
39R+    0+ 0 0 +57436- 9 0 +52074- 9 0 -56910-10 0 -33645-1039R+    0+ 0       3
 0 +63100- 9 0 +56259- 9 0 -95744-10 0 -39411-1139R+    0+ 0 0 +72884- 9       4
 0 +67834- 9 0 -16134- 9 0 -86327-1139R+    0+ 0 0 +86261- 9 0 +75179- 9       5
 0 -17914- 9 0 -68136-1039R+    0+ 0 0 +62171- 9 0 +46303- 9 0 -30410- 9       6
40R+    0+ 0 0 +53538- 9 0 +20210- 9 0 +67313-10 0 -77370-1039R+    0+ 0       7
 0 +74575- 9 0 +57669- 9 0 +84142-10 0 -29471- 9 0 -22037-1038R+    0+ 0       8
 0 +10111- 8 0 +64755- 9 0 -25951- 9 0 -38164-1039R+    0+ 0 0 +10127- 8       9
 0 +42570- 9 0 -23334- 940R+    0+ 0 0 +15950- 8 0 +36793- 9 0 -13650- 9       10
40R+    0+ 0 0 +27466- 8 0 +47370- 9 0 -12684- 940R+    0+ 0 0 +35854- 8       11
```

Table 3.5 (continued)

```
 0 +76560- 9 0 -95901-1040R+    0+ 0 0 +38206- 8 0 +81388- 9 0 -24833- 9      12
40R+    0+ 0 0 +39881- 8 0 +95671- 9 0 -26278- 940R+    0+ 0 0 +40234- 8      13
 0 +10563- 8 0 -38215- 940R+    0+ 0 0 +40905- 8 0 +96174- 9 0 -47822- 9      14
40R+    0+ 0 0 +41602- 8 0 +10593- 8 0 -37673- 940R+    0+ 0 0 +42106- 8      15
 0 +10270- 8 0 -46872- 940R+    0+ 0 0 +46612- 8 0 +12485- 8 0 -45480- 9      16
41R+    0+ 0 0 +29197-1042R+    0+ 0 0 +33815-10 0 +47462-1041R+    0+ 0      17
 0 +52860-10 0 +72650-10 0 +49328-1040R+    0+ 0 0 +57917-10 0 +76802-10      18
 0 +50128-10 0 +35669-1039R+    0+ 0 0 +93539-10 0 +12314- 9 0 +78833-10      19
 0 +54300-10 0 +40201-1038R+    0+ 0 0 +77820-10 0 +10102- 9 0 +62002-10      20
 0 +41858-10 0 +30073-10 0 +22908-1037R+    0+ 0 0 +11396- 9 0 +15931- 9      21
 0 +99394-10 0 +64137-10 0 +44978-10 0 +33217-10 0 +25746-1036R+    0+ 0      22
 0 +11799- 9 0 +15953- 9 0 +10385- 9 0 +67977-10 0 +45900-10 0 +33211-10      23
 0 +25049-10 0 +19660-1035R+    0+ 0 0 +16769- 9 0 +22785- 9 0 +14516- 9      24
 0 +98656-10 0 +67390-10 0 +47185-10 0 +34924-10 0 +26717-10 0 +21134-10      25
34R+    0+ 0 0 +26435- 9 0 +32393- 9 0 +20319- 9 0 +13657- 9 0 +97363-10      26
 0 +69335-10 0 +50085-10 0 +37713-10 0 +29121-10 0 +23137-1033R+    0+ 0      27
 0 +27134- 9 0 +30856- 9 0 +16619- 9 0 +11026- 9 0 +77720-10 0 +57429-10      28
 0 +41965-10 0 +30774-10 0 +23294-10 0 +17999-10 0 +14278-1032R+    0+ 0      29
 0 +42040- 9 0 +47552- 9 0 +24132- 9 0 +13851- 9 0 +95526-10 0 +68882-10      30
 0 +51368-10 0 +37443-10 0 +27157-10 0 +20260-10 0 +15423-10 0 +12076-10      31
31R+    0+ 0 0 +71461- 9 0 +62461- 9 0 +28527- 9 0 +14941- 9 0 +83629-10      32
 0 +53598-10 0 +34329-10 0 +21838-10 0 +12590-10 0 +65477-11 0 +32062-11      33
 0 +13292-11 0 +34417-1230R+    0+ 0 0 +73814- 9 0 +48461- 9 0 +11223- 9      34
 0 +29187-10 0 -94859-11 0 -28060-10 0 -34528-10 0 -36323-10 0 -35402-10      35
 0 -32278-10 0 -28050-10 0 -23771-10 0 -19918-10 0 -16711-1029R+    0+ 0      36
 0 +11194- 8 0 +64242- 9 0 -41841-10 0 -23481- 9 0 -27414- 9 0 -22433- 9      37
 0 -17056- 9 0 -13519- 9 0 -10639- 9 0 -83880-10 0 -63537-10 0 -47278-10      38
 0 -35777-10 0 -27480-10 0 -21633-1028R+    0+ 0 0 +10869- 8 0 -32793- 9      39
 0 -55365- 9 0 -32797- 9 0 -11704- 9 0 -14331-1037R+    0+ 0 0 +70727- 9      40
 0 -40510- 941R+    0+ 0 0 +34960- 9 0 -22139- 938R+    0+ 0                  41
 2R+    0+ 0 0 +70247- 9 0 +69107- 941R+    0+ 0 0 +65243- 9 0 +62392- 9       1
 0 -72000-1040R+    0+ 0 0 +57910- 9 0 +54463- 9 0 -78847-10 0 +40544-10       2
39R+    0+ 0 0 +57436- 9 0 +56525- 9 0 -69713-10 0 +38568-1039R+    0+ 0       3
 0 +63100- 9 0 +54019- 9 0 -40874-10 0 +56019-1139R+    0+ 0 0 +72884- 9       4
 0 +69678- 9 0 -17789-10 0 +11990-1039R+    0+ 0 0 +86261- 9 0 +74494- 9       5
 0 +15360- 9 0 +76303-1039R+    0+ 0 0 +62171- 9 0 +34577- 9 0 +21974- 9       6
40R+    0+ 0 0 +53538- 9 0 +26501- 9 0 -44031-10 0 +84248-1039R+    0+ 0       7
 0 +74575- 9 0 +28015- 9 0 -15857- 9 0 +43965-10 0 +30911-1038R+    0+ 0       8
 0 +10111- 8 0 +40335- 9 0 -77993-11 0 +53547-1039R+    0+ 0 0 +10127- 8       9
 0 +22675- 9 0 +98275-1040R+    0+ 0 0 +15950- 8 0 +13766- 9 0 -31135-10      10
40R+    0+ 0 0 +27466- 8 0 +48445-10 0 -10203-1040R+    0+ 0 0 +35854- 8      11
 0 +75791-10 0 -90808-1140R+    0+ 0 0 +38206- 8 0 +80502-10 0 -23240-10      12
40R+    0+ 0 0 +39881- 8 0 +93603-10 0 -24438-1040R+    0+ 0 0 +40234- 8      13
 0 +10285- 9 0 -35087-1040R+    0+ 0 0 +40905- 8 0 +93944-10 0 -43949-10      14
40R+    0+ 0 0 +41602- 8 0 +10258- 9 0 -34279-1040R+    0+ 0 0 +42106- 8      15
 0 +10426- 9 0 -42212-1040R+    0+ 0 0 +46612- 8 0 +20124- 8 0 -34698-10      16
41R+    0+ 0 0 +48262-1042R+    0+ 0 0 +55824-10 0 +76992-1041R+    0+ 0      17
 0 +86777-10 0 +11666- 9 0 +76887-1040R+    0+ 0 0 +94949-10 0 +12191- 9      18
 0 +76281-10 0 +52585-1039R+    0+ 0 0 +15170- 9 0 +19197- 9 0 +11618- 9      19
 0 +76399-10 0 +54607-1038R+    0+ 0 0 +12685- 9 0 +15571- 9 0 +88254-10      20
 0 +55957-10 0 +38162-10 0 +27935-1037R+    0+ 0 0 +18375- 9 0 +24382- 9      21
 0 +13884- 9 0 +81835-10 0 +53376-10 0 +37100-10 0 +27440-1036R+    0+ 0      22
 0 +19006- 9 0 +23912- 9 0 +14018- 9 0 +82361-10 0 +49895-10 0 +33028-10      23
 0 +23096-10 0 +17080-1035R+    0+ 0 0 +26596- 9 0 +33286- 9 0 +18549- 9      24
 0 +11072- 9 0 +65836-10 0 +39913-10 0 +26121-10 0 +17928-10 0 +12984-10      25
```

Table 3.5 (continued)

```
34R+     0+ 0 0 +40590- 9 0 +43623- 9 0 +22575- 9 0 +12469- 9 0 +72422-10      26
 0 +40450-10 0 +21948-10 0 +12387-10 0 +70396-11 0 +41032-1133R+     0+ 0      27
 0 +41605- 9 0 +38745- 9 0 +14448- 9 0 +67026-10 0 +29800-10 0 +10834-10      28
 0 -28409-13 0 -53883-11 0 -72210-11 0 -75310-11 0 -71404-1132R+     0+ 0      29
 0 +60980- 9 0 +53849- 9 0 +15134- 9 0 +23221-10 0 -15261-10 0 -31345-10      30
 0 -37142-10 0 -37361-10 0 -34334-10 0 -30014-10 0 -25659-10 0 -21809-10      31
31R+     0+ 0 0 +90134- 9 0 +43434- 9 0 -38515-10 0 -14482- 9 0 -16185- 9      32
 0 -15345- 9 0 -13786- 9 0 -12064- 9 0 -10060- 9 0 -81418-10 0 -65624-10      33
 0 -52964-10 0 -43254-1030R+     0+ 0 0 +92634- 9 0 +13215- 9 0 -25480- 9      34
 0 -24263- 9 0 -19751- 9 0 -15135- 9 0 -11839- 9 0 -90768-10 0 -69108-10      35
 0 -49873-10 0 -35013-10 0 -25030-10 0 -18207-10 0 -13673-1029R+     0+ 0      36
 0 +10438- 8 0 -21793- 9 0 -51822- 9 0 -18886- 9 0 +30595-10 0 +88969-10      37
 0 +96279-10 0 +90949-10 0 +80992-10 0 +69941-10 0 +57224-10 0 +45329-10      38
 0 +35828-10 0 +28422-10 0 +22891-1028R+     0+ 0 0 +71362- 9 0 -21019- 9      39
 0 +10505- 9 0 +27276- 9 0 +15570- 9 0 +22573-1037R+     0+ 0 0 +83690- 9      40
 0 +15353- 941R+     0+ 0 0 +95711- 9 0 +87501-1038R+     0+ 0                 41
 2R+     0+ 0 0 +70247- 9 0 +70321- 941R+     0+ 0 0 +65243- 9 0 +62536- 9      1
 0 +13849-1040R+     0+ 0 0 +57910- 9 0 +54199- 9 0 +29572-10 0 -34172-10       2
39R+     0+ 0 0 +57436- 9 0 +54680- 9 0 +50026-10 0 -30256-1039R+     0+ 0       3
 0 +63100- 9 0 +47578- 9 0 +69933-10 0 -61050-1139R+     0+ 0 0 +72884- 9       4
 0 +54800- 9 0 +51915-10 0 -12584-1039R+     0+ 0 0 +86261- 9 0 +54971- 9       5
 0 -76147-10 0 -54466-1039R+     0+ 0 0 +62171- 9 0 +18010- 9 0 -10531- 9       6
40R+     0+ 0 0 +53538- 9 0 +25118- 9 0 -43162-10 0 -55490-1039R+     0+ 0       7
 0 +74575- 9 0 +10308- 9 0 -12354- 9 0 -27625-10 0 -32964-1038R+     0+ 0       8
 0 +10111- 8 0 +19170- 9 0 -44569-10 0 -57015-1039R+     0+ 0 0 +10127- 8       9
 0 +96616-11 0 -57384-1040R+     0+ 0 0 +15950- 8 0 +14942-10 0 -17019-10      10
40R+     0+ 0 0 +27466- 8 0 -29453-10 0 -11580-1140R+     0+ 0 0 +35854- 8      11
 0 -40830-10 0 -22594-1140R+     0+ 0 0 +38206- 8 0 -43758-10 0 -57987-11      12
40R+     0+ 0 0 +39881- 8 0 -43381-10 0 -61287-1140R+     0+ 0 0 +40234- 8      13
 0 -41300-10 0 -88550-1140R+     0+ 0 0 +40905- 8 0 -44037-10 0 -11322-10      14
40R+     0+ 0 0 +41602- 8 0 -41799-10 0 -92138-1140R+     0+ 0 0 +42106- 8      15
 0 -24206-10 0 -11908-1040R+     0+ 0 0 +46612- 8 0 +27279- 8 0 -19669-10      16
41R+     0+ 0 0 +66736-1042R+     0+ 0 0 +77043-10 0 +10344- 941R+     0+ 0      17
 0 +11875- 9 0 +15428- 9 0 +96937-1040R+     0+ 0 0 +12967- 9 0 +15831- 9      18
 0 +92397-10 0 +60255-1039R+     0+ 0 0 +20380- 9 0 +24225- 9 0 +13315- 9      19
 0 +80272-10 0 +53443-1038R+     0+ 0 0 +17175- 9 0 +19289- 9 0 +94830-10      20
 0 +52922-10 0 +32008-10 0 +21138-1037R+     0+ 0 0 +24467- 9 0 +29854- 9      21
 0 +14401- 9 0 +69658-10 0 +37450-10 0 +21330-10 0 +13060-1036R+     0+ 0      22
 0 +25269- 9 0 +28271- 9 0 +13555- 9 0 +61405-10 0 +25857-10 0 +10815-10      23
 0 +36953-11 0 +41985-1235R+     0+ 0 0 +34526- 9 0 +37653- 9 0 +15902- 9      24
 0 +65122-10 0 +19233-10 0 -13584-11 0 -86688-11 0 -11009-10 0 -11159-10      25
34R+     0+ 0 0 +50095- 9 0 +42416- 9 0 +12987- 9 0 +18959-10 0 -24138-10      26
 0 -40168-10 0 -42765-10 0 -39398-10 0 -34549-10 0 -29761-1033R+     0+ 0      27
 0 +51235- 9 0 +32405- 9 0 +64317-11 0 -58394-10 0 -73734-10 0 -72815-10      28
 0 -64578-10 0 -54181-10 0 -44573-10 0 -36470-10 0 -30058-1032R+     0+ 0      29
 0 +68706- 9 0 +34715- 9 0 -10960- 9 0 -17566- 9 0 -16349- 9 0 -13980- 9      30
 0 -11637- 9 0 -92113-10 0 -71035-10 0 -55109-10 0 -43120-10 0 -34390-10      31
31R+     0+ 0 0 +80153- 9 0 -11137- 9 0 -43859- 9 0 -33995- 9 0 -22734- 9      32
 0 -15685- 9 0 -10485- 9 0 -68502-10 0 -40201-10 0 -21174-10 0 -10462-10      33
 0 -43928-11 0 -11919-1130R+     0+ 0 0 -81503- 9 0 -39359- 9 0 -30894- 9      34
 0 -92549-10 0 +30163-10 0 +87236-10 0 +10321- 9 0 +10362- 9 0 +96341-10      35
 0 +83255-10 0 +68602-10 0 +55582-10 0 +44848-10 0 +36527-1029R+     0+ 0      36
 0 +52661- 9 0 -68876- 9 0 +79093-10 0 +35210- 9 0 +19167- 9 0 +97629-10      37
 0 +45348-10 0 +16698-10 0 -12900-11 0 -11341-10 0 -16450-10 0 -17666-10      38
 0 -16546-10 0 -14659-10 0 -12686-1028R+     0+ 0 0 +32512- 9 0 -21775- 9      39
```

Table 3.5 (continued)

```
 0 +24147- 9 0 -62774-10 0 -15044- 9 0 -28992-1037R+     0+ 0 0 +19444- 9     40
 0 -99845-1041R+     0+ 0 0 +75158-10 0 -56136-1038R+     0+ 0                41
 2R+     0+ 0 0 +70247- 9 0 +63319- 941R+     0+ 0 0 +65243- 9 0 +56598- 9     1
 0 +79906-1040R+     0+ 0 0 +57910- 9 0 +47662- 9 0 +85919-10 0 +23298-10     2
39R+     0+ 0 0 +57436- 9 0 +41757- 9 0 +94751-10 0 +18275-1039R+     0+ 0     3
 0 +63100- 9 0 +31740- 9 0 +50361-10 0 +54739-1139R+     0+ 0 0 +72884- 9     4
 0 +33677- 9 0 -65477-10 0 +10656-1039R+     0+ 0 0 +86261- 9 0 +22392- 9     5
 0 -99578-10 0 +21930-1039R+     0+ 0 0 +62171- 9 0 +99323-10 0 -63973-10     6
40R+     0+ 0 0 +53538- 9 0 +17702- 9 0 -60963-10 0 +15008-1039R+     0+ 0     7
 0 +74575- 9 0 +47284-10 0 -20232- 9 0 +51567-10 0 +28578-1038R+     0+ 0     8
 0 +10111- 8 0 +73559-10 0 -79020-11 0 +49040-1039R+     0+ 0 0 +10127- 8     9
 0 +10166-10 0 -44963-1040R+     0+ 0 0 +15950- 8 0 +93530-11 0 -89195-11    10
40R+     0+ 0 0 +27466- 8 0 +83113-10 0 +22143-1140R+     0+ 0 0 +35854- 8    11
 0 +75510-10 0 +52998-1140R+     0+ 0 0 +38206- 8 0 +80679-10 0 +13709-10    12
40R+     0+ 0 0 +39881- 8 0 +78252-10 0 +14581-1040R+     0+ 0 0 +40234- 8    13
 0 +73370-10 0 +21203-1040R+     0+ 0 0 +40905- 8 0 +79796-10 0 +26730-10    14
40R+     0+ 0 0 +41602- 8 0 +74416-10 0 +21278-1040R+     0+ 0 0 +42106- 8    15
 0 +16455- 9 0 +26768-1040R+     0+ 0 0 +46612- 8 0 +22557- 7 0 +41974-10    16
41R+     0+ 0 0 +84392-1042R+     0+ 0 0 +97169-10 0 +12576- 941R+     0+ 0    17
 0 +14807- 9 0 +18345- 9 0 +10739- 940R+     0+ 0 0 +16124- 9 0 +18340- 9    18
 0 +96066-10 0 +56936-1039R+     0+ 0 0 +24784- 9 0 +26910- 9 0 +12607- 9    19
 0 +63920-10 0 +35836-1038R+     0+ 0 0 +21110- 9 0 +20831- 9 0 +79188-10    20
 0 +32204-10 0 +12261-10 0 +37564-1137R+     0+ 0 0 +29396- 9 0 +31671- 9    21
 0 +11184- 9 0 +28871-10 0 +81641-12 0 -94773-11 0 -12563-1036R+     0+ 0    22
 0 +30297- 9 0 +28355- 9 0 +88302-10 0 +94040-11 0 -18528-10 0 -24692-10    23
 0 -24478-10 0 -22228-1035R+     0+ 0 0 +40050- 9 0 +35052- 9 0 +69393-10    24
 0 -24527-10 0 -53130-10 0 -55725-10 0 -49456-10 0 -41961-10 0 -35245-10    25
34R+     0+ 0 0 +54101- 9 0 +29057- 9 0 -51960-10 0 -13033- 9 0 -13557- 9    26
 0 -11657- 9 0 -93122-10 0 -73265-10 0 -57736-10 0 -46220-1033R+     0+ 0    27
 0 +55147- 9 0 +13896- 9 0 -17759- 9 0 -18086- 9 0 -14765- 9 0 -11444- 9    28
 0 -83074-10 0 -58527-10 0 -41980-10 0 -30646-10 0 -23090-1032R+     0+ 0    29
 0 +64823- 9 0 -11440-10 0 -35895- 9 0 -26528- 9 0 -17648- 9 0 -11096- 9    30
 0 -66982-10 0 -34616-10 0 -14139-10 0 -35175-11 0 +19187-11 0 +43478-11    31
31R+     0+ 0 0 +51070- 9 0 -57030- 9 0 -44880- 9 0 -12047- 9 0 +48006-10    32
 0 +10580- 9 0 +12524- 9 0 +12513- 9 0 +11276- 9 0 +95290-10 0 +78298-10    33
 0 +63740-10 0 +52206-1030R+     0+ 0 0 +50635- 9 0 -53953- 9 0 +12054- 9    34
 0 +27085- 9 0 +23351- 9 0 +15595- 9 0 +97619-10 0 +52666-10 0 +22012-10    35
 0 +35102-12 0 -11788-10 0 -16381-10 0 -17333-10 0 -16520-1029R+     0+ 0    36
 0 +91303-10 0 -30733- 9 0 +32627- 9 0 -62178-10 0 -11032- 9 0 -11289- 9    37
 0 -10282- 9 0 -82080-10 0 -60430-10 0 -42429-10 0 -26698-10 0 -15341-10    38
 0 -85746-11 0 -45642-11 0 -23310-1128R+     0+ 0 0 +57140-10 0 +47368-12    39
 0 -67201-10 0 -11076- 9 0 +10757- 9 0 +33124-1037R+     0+ 0 0 +17792-10    40
 0 -77441-1141R+     0+ 0 0 -83743-11 0 +20626-1138R+     0+ 0                41
 2R+     0+ 0 0 +70247- 9 0 +48470- 941R+     0+ 0 0 +65243- 9 0 +42755- 9     1
 0 -37301-1040R+     0+ 0 0 +57910- 9 0 +32130- 9 0 -55982-10 0 -15807-10     2
39R+     0+ 0 0 +57436- 9 0 +19518- 9 0 -81760-10 0 -11315-1039R+     0+ 0     3
 0 +63100- 9 0 +10832- 9 0 -13409- 9 0 -40247-1139R+     0+ 0 0 +72884- 9     4
 0 +11598- 9 0 -21523-10 0 -71699-1139R+     0+ 0 0 +86261- 9 0 +67571-10     5
 0 -67094-10 0 +78990-1239R+     0+ 0 0 +62171- 9 0 +40592-10 0 -16550-10     6
40R+     0+ 0 0 +53538- 9 0 +78886-10 0 -36437-10 0 +11706-1039R+     0+ 0     7
 0 +74575- 9 0 +61549-11 0 -60885-10 0 +22592-10 0 -19893-1038R+     0+ 0     8
 0 +10111- 8 0 +10090-10 0 -14219-10 0 -33189-1039R+     0+ 0 0 +10127- 8     9
 0 -29733-11 0 -22978-1040R+     0+ 0 0 +15950- 8 0 -10402-10 0 -18486-11    10
40R+     0+ 0 0 +27466- 8 0 -75968-10 0 -20242-1140R+     0+ 0 0 +35854- 8    11
```

Table 3.5 (continued)

```
 0 -97342-10 0 -11581-1040R+    0+ 0 0 +38206- 8 0 -10417- 9 0 -30083-10       12
40R+    0+ 0 0 +39881- 8 0 -95899-10 0 -31970-1040R+    0+ 0 0 +40234- 8       13
 0 -85091-10 0 -46541-1040R+    0+ 0 0 +40905- 8 0 -99314-10 0 -58362-10       14
40R+    0+ 0 0 +41602- 8 0 -89912-10 0 -46163-1040R+    0+ 0 0 +42106- 8       15
 0 -46088-10 0 -57320-1040R+    0+ 0 0 +46612- 8 0 +42903- 8 0 -88991-10       16
41R+    0+ 0 0 +10102- 942R+    0+ 0 0 +11594- 9 0 +14303- 941R+    0+ 0       17
 0 +17413- 9 0 +20256- 9 0 +10696- 940R+    0+ 0 0 +18894- 9 0 +19535- 9       18
 0 +86299-10 0 +42511-1039R+    0+ 0 0 +28226- 9 0 +26989- 9 0 +94944-10       19
 0 +29405-10 0 +48324-1138R+    0+ 0 0 +24372- 9 0 +20009- 9 0 +42977-10       20
 0 -22504-11 0 -16242-10 0 -19284-1037R+    0+ 0 0 +32956- 9 0 +29594- 9       21
 0 +47209-10 0 -30563-10 0 -45104-10 0 -44123-10 0 -39138-1036R+    0+ 0       22
 0 +33872- 9 0 +24110- 9 0 +73474-11 0 -58257-10 0 -66102-10 0 -57324-10       23
 0 -47065-10 0 -38404-1035R+    0+ 0 0 +42875- 9 0 +25900- 9 0 -60377-10       24
 0 -12550- 9 0 -11711- 9 0 -92250-10 0 -69951-10 0 -53077-10 0 -41139-10       25
34R+    0+ 0 0 +52557- 9 0 +71770-10 0 -24918- 9 0 -24480- 9 0 -18950- 9       26
 0 -12935- 9 0 -83420-10 0 -54593-10 0 -36310-10 0 -25082-1033R+    0+ 0       27
 0 +53310- 9 0 -10533- 9 0 -30484- 9 0 -20765- 9 0 -12089- 9 0 -63792-10       28
 0 -24766-10 0 -23640-11 0 +76428-11 0 +11726-10 0 +12728-1032R+    0+ 0       29
 0 +51611- 9 0 -37834- 9 0 -41246- 9 0 -13785- 9 0 -10953-10 0 +50313-10       30
 0 +75258-10 0 +80390-10 0 +74273-10 0 +63905-10 0 +53500-10 0 +44575-10       31
31R+    0+ 0 0 +18863- 9 0 -62380- 9 0 -43746-10 0 +25321- 9 0 +27072- 9       32
 0 +21879- 9 0 +15932- 9 0 +10955- 9 0 +66485-10 0 +35865-10 0 +18030-10       33
 0 +77616-11 0 +22917-1130R+    0+ 0 0 +16922- 9 0 -22540- 9 0 +38173- 9       34
 0 +15113- 9 0 -49413-10 0 -13734- 9 0 -15074- 9 0 -13780- 9 0 -11579- 9       35
 0 -88425-10 0 -63649-10 0 -45497-10 0 -32689-10 0 -24110-1029R+    0+ 0       36
 0 -20953-10 0 +40017-10 0 -19294-10 0 -11363- 9 0 -76470-10 0 -22474-10       37
 0 +33486-10 0 +52268-10 0 +55341-10 0 +50710-10 0 +41415-10 0 +31486-10       38
 0 +23450-10 0 +17436-10 0 +13222-1028R+    0+ 0 0 -29008-11 0 +34866-10       39
 0 -16767- 9 0 +13002- 9 0 -45312-10 0 -34741-1037R+    0+ 0 0 -10107-10       40
 0 -18460-1141R+    0+ 0 0 +11634-10 0 +13325-1138R+    0+ 0                   41
    1   -1   1.16
SAMBO DATA FOR SAMPLE PROBLEM 2
 $$ 10    0     0     0     0     2     0     1
 **
      0.         0.        5.0E+3
      0.         0.        7.5E+3
      0.         0.        1.0E+4
      0.         0.        1.5E+4
      0.         0.        3.0E+4
      0.         0.        6.0E+4
      0.         0.        7.0E+4
      0.         0.        9.0E+4
      0.         0.       12.0E+4
      0.         0.       15.0E+4
(CM**2 RAD/SOURCE)
4 PI R**2 NEUTRON DOSE RATE
 **
 5.4579E-9 5.1339E-9 4.8409E-9 4.6175E-9 4.4454E-9 4.3144-9 4.0126E-9
 3.3938E-9 3.1489E-9 3.0892E-9 2.6435E-9 1.9751E-9 1.1236E-9
  2.2958E-10  26R0.0
```

Table 3.5 (continued)

```
4 PI R**2 GAMMA DOSE RATE
 **
  22R0.0
 2.7727-9 2.3180-9 1.9373-9 1.6091-9 1.3389-9 1.1299-9 9.8058-10
 8.4739-10 7.3278-10 6.0565-10 4.6558-10 3.6869-10 2.8622-10 1.9841-10
 1.3585-10 7.3791-11 3.6825-11 F0.0

†$$$$$$$$   MORSE SAMPLE PROBLEM 2   $$$$$$$$
```

---

†Required only for IBM version.

3.5 MORSE Sample Problem #3 Adjoint Case

The time-dependent secondary gamma-ray dose rate versus range due to both fission and 12.2-15 MeV neutron sources is calculated by MORSE in infinite air of density 1.29 g/ℓ. Cross sections are 22 neutron groups and 18 gamma groups P_5.

The source and analysis routines from Problem Nos. 1 and 2 are used, but the adjoint option is chosen since results for two source energy distributions are required. The input data is similar to Problem No. 2; but the gamma response function is now the source spectrum, and the source group 1 has become a response function with a value of '1' for group one and '0' for other groups. The second response function for this problem is the fission source spectrum from Problem #1. Note that for an adjoint problem the GWLOW array has NMTG-NMGP values. Input data is listed in Table 3.6. Output listing is on microfiche.

REMINDER: MORSE will adjoint everything for the user; input should be forward group structure.

Table 3.6. Listing of Input Data for MORSE Sample Problem #3

```
SAMPLE PROBLEM 3  (ADJOINT)
  500 1000   30    1   22   17   22   40    0    1    5    1    0
   -1   40    0        1.        .025        0.        1.        2.2E +5
     0.
     0.         0.         0.         0.         0.         0.         0.
     0.         0.         0.         0.         0.         0.         0.
     0.         0.         0.         0.         0.         0.         0.
       0.02.7727E-092.3180E-091.9373E-091.6091E-091.3389E-091.1299E-09
9.8058E-108.4739E-107.3278E-106.0565E-104.6558E-103.6869E-102.8622E-10
1.9841E-101.3585E-107.3791E-113.6825E-11
1.5000E 071.2200E 071.0000E 078.1800E 066.3600E 064.9600E 064.0600E 06
 3.01 E 06 2.46 E 06 2.35 E 06 1.826E 06 1.108E 06 5.502E 05 1.109E 05
 3.3546E+3 5.8294E+2 1.0130E+2 2.9020E+1 1.0677E+1 3.0590E+0 1.1253E+0
4.1400E-011.0000E 078.0000E 066.5000E 065.0000E 064.0000E 063.0000E 06
2.5000E 062.0000E 061.6600E 061.3300E 061.0000E 068.0000E 056.0000E 05
4.0000E 053.0000E 052.0000E 051.0000E 05    5. E+4
5317A47C8301
    1    1    1    0    0    1   40
    1    1   13    1    1    1   10.         1.E-3     .5          0.5
   14    1   19    1    1    1   10.         1.E-3     .5          0.
   20    1   22    1    1    1    2.         1.E-3     .2          0.0
   23    1   35    1    1    1 5.0   E 00   1. E-03 1.0   E 00 5.0  E-01
   36    1   40    1    1    1 2.0   E 00   1. E-03  .5   E 00      0.0
   -1
    0
     .1         .2         1.         .5         .3         .3         .2
     .2        .2         .2      .01          .05        .1         .2
    .2        .2         .3        .3
    0    0           SAMPLE PROB. 1 FOR MORSE
  SPH           0.         0.         0.       3.0E+03
  SPH           0.         0.         0.       5.0E+03
  SPH           0.         0.         0.       7.5E+03
  SPH           0.         0.         0.       1.0E+04
  SPH           0.         0.         0.       1.5E+04
  SPH           0.         0.         0.       2.0E+04
  SPH           0.         0.         0.       3.0E+04
  SPH           0.         0.         0.       6.0E+04
  SPH           0.         0.         0.       7.0E+04
  SPH           0.         0.         0.       9.0E+04
  SPH           0.         0.         0.       1.2E+05
  SPH           0.         0.         0.       1.5E+05
  SPH           0.         0.         0.       1.0E+06
  SPH           0.         0.         0.       1.0E+07
  END
  AIR          +1
  AIR          +2      -1
  AIR          +3      -2
  AIR          +4      -3
  AIR          +5      -4
  AIR          +6      -5
```

Table 3.6 (continued)

```
 AIR          +7     -6
 AIR          +8     -7
 AIR          +9     -8
 AIR         +10     -9
 AIR         +11    -10
 AIR         +12    -11
 AIR         +13    -12
 AIR         +14    -13
 END
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    2    1    2    1    2    1    2    1    2    1    2    1    0
AIR XSECT
   22   22   18   18   40   43    4    1    1    1    6    3    1
    0    0    0    0    0    0    0
 INSERT HERE THE SAME CROSS SECTION DATA AS USED IN S. PROB #2
    1   -1  1.16
SAMBO FOR SAMPLE ADJOINT PROBLEM            TEST CASE
 $$
   10    0    0  -25    0    2    0    1
 **
      0.         0.         5.0+3
      0.         0.         7.5+3
      0.         0.         1.0+4
      0.         0.         1.5+4
      0.         0.         3.0+4
      0.         0.         6.0+4
      0.         0.         7.0+4
      0.         0.         9.0+4
      0.         0.        1.20+5
      0.         0.        1.50+5
(CM**2 RAD/SOURCE)
4 PI R**2 GAMMA DOSE (14 MEV SOURCE)
 **   1.         0.         0.         0.         0.         0.         0.
      0.         0.         0.         0.         0.         0.         0.
      0.         0.         0.         0.         0.         0.         0.
      0.         0.         0.         0.         0.         0.         0.
      0.         0.         0.         0.         0.         0.         0.
      0.         0.         0.         0.         0.
4 PI R**2 GAMMA DOSE  (FISSION SOURCE)
 **
1.5579-4 8.9338-4 3.4786-3 1.3903-2 3.4557-2 3.5047-2 1.0724E-1
8.8963-2 2.3186-2 1.203E-1 2.1803-1 1.9837-1 1.4036-1 1.5489E-2
  26R0.0
```

Table 3.6 (continued)

```
(NEUTRONS/EV/SEC/SOURCE)  (ADJOINT)
 **  .3E-6     .6E-6     1.E-6    1.5E-6    2.E-6    3.0E-6    4.E-6
     5.E-6    6.0E-6     8.E-6    1.2E-5    1.8-5    3.00-5    5.00-5
     1.0-4     2.0-4     4.0-4     8.0-4    2.0-3     5.0-3     2.0-2
     7.0-2     2.0-1     7.0-1     1.0
```

†$$$$$$$$ MORSE SAMPLE PROBLEM 3 $$$$$$$$

---

†Required only for IBM version.

3.6 MORSE Sample Problem #4 - Fission Problem

The k_{eff} and the fraction of leakage fluence and absorptions for neutrons in each group for the GODIVA sphere is calculated by MORSE. The GODIVA sphere has an 8.71 cm radius and contains a mixture of ^{235}U and ^{238}U. Cross sections used are six-group Hansen-Roach and are isotropic.

User routines which were written for this problem include SOURCE, BANKR, ESCAPE and RELCOL. SOURCE provides for the first batch a spatial distribution of the source neutrons. For subsequent batches, SOURCE selects only the energy since the spatial distribution is obtained from the fission bank where it was stored during the previous batch, BANKR calls ESCAPE to score the fluence leaking in each group and RELCOL to score the absorption weight (the difference between incoming and outgoing weight) as a function of group. Response function arrays are used to store the desired information.

Input data is listed in Table 3.7. Output listing is on microfiche.

Table 3.7. Listing of Input Data for MORSE Sample Problem #4

```
SAMPLE PROBLEM 4
  100  500  200    1    6    0    6    6    0    0    4    1    0
   -1    6    0         1.        0.        0.        1.E-6     2.9E+8
   0.
 .204      .344      .168      .18       .09       .014
   18.0E+6     3.E+6     1.4E+6     .9E+6     .4E+6     .1E+6
01734C8B93A3
    1    1    0    0    0    1    6
    1    1    6    1    1    1     2.5        .01       .5
   -1
    1    1    3    1
     1.
 .204      .344      .168      .18       .09       .014
    0    0              SPHERE
  SPH    1    0.        0.        0.        8.71
  SPH    2    0.        0.        0.        10.
  END
   IS   50      +1
   EV           +2      -1
  END
    1    1
    1    0
6 GROUP HANSEN ROACH CROSS SECTIONS FOR U-235 AND U-238 DTF-IV ANL 7416
    6    6    0    0    6    9    4    1    2    2    1    0
    1    1    0    0    1    0    1
      U235 HANSEN ROACH XSECT  DTF-IV ANL 7416
    1.260       3.557       4.25        1.20          0.0         0.0
    0.0         0.0         0.0         1.30          3.196       4.5
    1.77         .27        0.0         0.0           0.0         0.0
    1.33        3.087       4.65        2.30           .24         .37
    0.0         0.0         0.0         1.35          2.988       5.20
    3.42         .55         .67         .65          0.0         0.0
    1.66        3.518       7.90        6.16           .35         .4
     .45         .44        0.0         2.94          5.71       12.0
    9.06         .08         .08         .07           .07         .06
      U238 HANSEN ROACH XSECT  DTF-IV ANL 7416
     .566       1.725       4.0         1.254         0.0         0.0
    0.0         0.0         0.0          .535         1.213       4.4
    1.825        .33        0.0         0.0           0.0         0.0
     .144        .108       4.5         2.906          .35         .46
    0.0         0.0         0.0          .14          0.0         5.25
    4.53         .80         .96         .79          0.0         0.0
    0.16        0.0         8.2         7.96           .5          .55
     .64         .53        0.0          .40          0.0        11.8
   11.4          .08         .08         .1            .09         .07
    1    1 .045447
    1   -2 .00256
```

Table 3.7 (continued)

```
SAMBO FOR FISSION PROBLEM
 $$ 2    0    0    0    0    6    0    0
 ** 0.         0.         0.
    0.         0.           0.
RESULTS FOR 1 SOURCE NEUTRON
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 1
 ** 1. 5R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 2
 ** 0. 1. 4R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 3
 ** 2R0.0   1.  3R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 4
 ** 3R0.0   1.  2R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 5
 ** 4R0.0 1.0  0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 6
 ** 5R0.0 1.0
†$$$$$$$$   MORSE SAMPLE PROBLEM 4   $$$$$$$$
```

† Required only for IBM version.

3.7 MORSE Sample Problem #5 - Time Dependent Fission

The k_{eff} and the time-dependent fission rate in a bare uranium sphere of 7.5 cm radius is calculated by MORSE. This problem is similar to Problem No. 4 with the exception that the desired results are time-dependent.

In order to determine statistics for the time-dependent fission problem a modification to subroutine BANKR is made and multiple consecutive runs are made (NQUIT>1). BANKR also calls subroutine FISN to sum the fission weight in addition to calling the RELCOL and ESCAPE routines from Problem No. 4 to calculate absorptions and time-dependent leakage. Subroutine SOURCE is the same one as in Problem No. 4 except RAD = 7.5 cm.

Input data is given in Table 3.8. Output listing is on microfiche.

Table 3.8. Listing of Input Data for MORSE Sample Problem #5

```
SAMPLE PROBLEM 5  - FISSION PROB
   50  250   50    4    6    0    6    6    0    0    5    1    0       CARD B
   -1    6    0         1.        0.        0.         1.E-6    2.9E+8
    0.
  .204     .344      .168      .18       .09       .014
   18.0E+6   3.E+6    1.4E+6    .9E+6     .4E+6     .1E+6
75863A42C351
    1    1    0    0    0    1    6
    1    1    6    1    1    1     2.5        .01      .5
   -1
    1    1    3    1
    .85
  .204     .344      .168      .18       .09       .014
    0    0              TEST
  SPH           0.        0.         0.      7.5
  SPH           0.        0.         0.      10.
  END
   IS   50      +1
   EV           +2      -1
  END
    1    1
    1    0
6 GROUP HANSEN ROACH CROSS SECTIONS FOR U-235 AND U-238 DTF-IV ANL 7416
    6    6    0    0    6    9    4    1    2    2    1    0    0
    1    1    0    0    1    0    1
      U235 HANSEN ROACH XSECT  DTF-IV ANL 7416
    1.260       3.557       4.25        1.20          0.0         0.0
    0.0         0.0         0.0         1.30          3.196       4.5
    1.77         .27        0.0         0.0           0.0         0.0
    1.33        3.087       4.65        2.30           .24         .37
    0.0         0.0         0.0         1.35          2.988       5.20
    3.42         .55         .67         .65          0.0         0.0
    1.66        3.518       7.90        6.16           .35         .4
     .45         .44        0.0         2.94          5.71       12.0
    9.06         .08         .08         .07           .07         .06
      U238 HANSEN ROACH XSECT  DTF-IV ANL 7416
     .566       1.725       4.0         1.254         0.0         0.0
    0.0         0.0         0.0          .535         1.213       4.4
    1.825        .33        0.0         0.0           0.0         0.0
     .144        .108       4.5         2.906          .35         .46
    0.0         0.0         0.0          .14          0.0         5.25
    4.53         .80         .96         .79          0.0         0.0
    0.16        0.0         8.2         7.96           .5          .55
     .64         .53        0.0          .40          0.0        11.8
   11.4          .08         .08         .1            .09         .07
```

Table 3.8 (continued)

```
    1     1 .045447
    1    -2 .00256
SAMBO FOR FISSION PROBLEM
 $$ 3     0     0  -14     0     7     0     0
 ** 0.          0.          0.
    0.          0.          0.
    0.          0.          0.
RESULTS FOR 1 SOURCE NEUTRON
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 1
 **  1.  5R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 2
 **  0.  1.  4R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 3
 ** 2R0.  1.  3R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 4
 **  3R0.0  1. 2R0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 5
 **  4R0.0 1.  0.0
FOR DET. 1 ABSORBED WEIGHT - FOR DET. 2 LEAKAGE WGT - FOR ENERGY GROUP 6
 **  5R0.0   1.0
FISSIONS/SOURCE
 ** 6R1.0
(FISSIONS/SEC/SOURCE)
 **  .2E-7      .4E-7      .6E-7      .8E-7      1.E-7     1.5E-7      2.E-7
    2.5E-7      3.E-7    3.5E-7      4.E-7    4.5E-7      5.E-7       1.-5

†$$$$$$$$   MORSE SAMPLE PROBLEM 5   $$$$$$$$
```

† Required only for IBM version.

3.8 MORSE Sample Problem #6 Gamma Only

The gamma ray dose rate for a point, isotropic, 4-5 MeV source in an infinite medium of air is calculated by MORSE. The air is assumed to be made up of only oxygen and nitrogen with a total density of 1.29 g/ℓ. The cross section data had 22 neutron-18 gamma groups, but MORSE selected only the 18 gamma groups when preparing the cross section mixture. Users will note that this means inputting only the gamma-ray energy group structure.

This problem is similar to Problem #1 except it is a gamma only problem. The same user routines (BANKR, SDATA, BDRYX, SOURCE, DIREC and GTMED) written for Problem #1 are used here.

Input data is given in Table 3.9 and output is on microfiche.

Table 3.9. Listing of Input Data for MORSE Sample Problem #6

```
SAMPLE PROBLEM 6 (GAMMA ONLY)
 1000 1000    5    1    0   17   18   18    0    0    2    1    0       CARD B
    4    0    0    0  1.0       0.0           5.0E+4 1.0        0.       CARD C
      0.0        0.0        0.0        0.0        0.0        0.0        0.0  CARD D
 1.0000 +7   8.00 +6 6.5000 +6   5.00 +6 4.0000 +6 3.0000 +6 2.5000 +6  CARDS F
   2.00 +6 1.6600 +6 1.3300 +6  1.000 +6  8.000 +5  6.000 +5  4.000 +5  CARDS F
   3.00 +5   2.00 +5   1.00 +5   5.00 +4
000035FA731A
    1    1    1    0    0    1   18                                     CARD I
    0    0    0    0    0    0 1.0     +01 1.0    -03     .5     5.0    -1  CARDS J
   -1
    0    0    0    0                                                    CARD L
    0    0          SAMPLE PROB. 1 FOR MORSE
  SPH          0.       0.        0.      3.0E+03
  SPH          0.       0.        0.      5.0E+03
  SPH          0.       0.        0.      7.5E+03
  SPH          0.       0.        0.      1.0E+04
  SPH          0.       0.        0.      1.5E+04
  SPH          0.       0.        0.      2.0E+04
  SPH          0.       0.        0.      3.0E+04
  SPH          0.       0.        0.      6.0E+04
  SPH          0.       0.        0.      7.0E+04
  SPH          0.       0.        0.      9.0E+04
  SPH          0.       0.        0.      1.2E+05
  SPH          0.       0.        0.      1.5E+05
  SPH          0.       0.        0.      1.0E+06
  SPH          0.       0.        0.      1.0E+07
  END
  AIR         +1
  AIR         +2      -1
  AIR         +3      -2
  AIR         +4      -3
  AIR         +5      -4
  AIR         +6      -5
  AIR         +7      -6
  AIR         +8      -7
  AIR         +9      -8
  AIR        +10      -9
  AIR        +11     -10
  AIR        +12     -11
  AIR        +13     -12
  AIR        +14     -13
  END
    1    1    1    1    1    1    1    1    1    1    1    1    1    1
    1    2    1    2    1    2    1    2    1    2    1    2    1    0
```

Table 3.9 (continued)

```
22 GROUP AIR  CROSS SECTIONS --- P5 ---  DENSITY = 1.29 G/L
    0    0   18   18   40   43    4    1    1    1    6    3    0
    0    0    0    0    0    0    0    0    0    0    0
  INSERT HERE THE SAME CROSS SECTION DATA AS USED FOR S. PROB. #2
    1   -1  1.16
SAMBO ANALYSIS INPUT DATA
 $$ 10    0    0    0    0    1    0    1
 **   0.     0.      5.E+3
    0.       0.    7.5E+3
     0.         0.        1.0E+4
     0.         0.        1.5E+4
     0.         0.        3.0E+4
     0.         0.        6.0E+4
     0.         0.        7.0E+4
     0.         0.        9.0E+4
     0.         0.       12.0E+4
     0.         0.       15.0E+4

4 PI R**2 GAMMA DOSE RATE
 **
 2.7727-9 2.3180-9 1.9373-9 1.6091-9 1.3389-9 1.1299-9 9.8058-10
 8.4739-10 7.3278-10 6.0565-10 4.6558-10 3.6869-10 2.8622-10 1.9841-10
 1.3585-10 7.3791-11 3.6825-11 F0.0

†$$$$$$$$   MORSE SAMPLE PROBLEM 6   $$$$$$$$
```

---

†Required only for IBM version.

3.9 MORSE Sample Problem #7 - XCHEKR Run

This problem demonstrates running XCHEKR to premix cross sections for MORSE so that the MORSE run itself requires only the permanent portion of the cross section storage. This is a good way to reduce the size of the blank common array in MORSE, and it also serves to check your cross section data.

This sample problem represents such a simple case that ordinarily a user would not premix, but it is designed just to show how to set up an XCHEKR run.

Input data is given in Table 3.10 and output is on microfiche. The mixed cross section data is written on TAPE2 (JXTAPE=2) which would be read in MORSE by setting IXTAPE = -2 on Card XC of the input.†

---

†See pp. 12-14 of section 4.3, ORNL-4972 (the MORSE report).

Table 3.10. Listing of Input Data for MORSE Sample Problem #7

```
   0    1   22   40
22 GROUP AIR  CROSS SECTIONS --- P5 ---  DENSITY = 1.29 G/L
  22   22   18   18   40   43    4    1    1    1    6    3    0
   0    0    0    0    0    0    0    0    2    0    0
 INSERT HERE THE SAME CROSS SECTION DATA AS USED IN S. PROB #2
   1   -1  1.16
```

3.10 MORSE Sample Problem #8 - Collision Density Problem

The collision density sample problem is similar to Sample Problem #1 except in the types of estimates calculated. First, a boundary crossing estimator is used for five spherical shells (NDC = 5). Second, a collision density estimator is used in RELCOL for nine detector regions. Third, subroutine ENDRUN as described in Reference 2 is used to obtain estimates of the collision density fluence averaged over regions specified by the geometry input. Also, in versions of MORSE containing the track length/ unit volume calculation, ENDRUN calculates track length per unit volume estimators for the geometry regions.

This problem uses special versions of subroutines INSCOR, BRDYX, RELCOL, RGTOMD, SDATA, BANKR as well as the SOURCE and GTMED routines from Sample Problem 1. INSCOR reads in NDC, the number of detectors to be stored in by BDRYX and SDATA; RELCOL uses detector numbers NDC+1 to ND.

Input is in Table 3.11, and output is on microfiche.

Table 3.11. Listing of Input Data for MORSE Sample Problem #8

```
COLLISION DENSITY SAMPLE PROBLEM
   40  100   50    1   13   17   22   40    0    0    3    1    0
    1    0    0         1.        .025         1.E+4    1.         2.2E+5
   0.        0.        0.         0.         0.         0.         0.
1.5000E+071.2200E+071.0000E+078.1800E+066.3600E+064.9600E+064.0600E+06
 3.01 E+06 2.46 E+06 2.35 E+06 1.826E+06 1.108E+06 5.502E+05 1.109E+05
 3.3546E+3 5.8294E+2 1.0130E+2 2.9020E+1 1.0677E+1 3.0590E+0 1.1253E+0
4.1400E-011.0000E+078.0000E+066.5000E+065.0000E+064.0000E+063.0000E+06
2.5000E+062.0000E+061.6600E+061.3300E+061.0000E+068.0000E+056.0000E+05
4.0000E+053.0000E+052.0000E+051.0000E+05        5.E+4
235467251643
    1    1    0    0    0   10   40
    1    1   13    1    1   10   10.         1.E-3     .5         0.5
   14    1   19    1    1   10   10.         1.E-3     .5         0.
   20    1   22    1    1   10    2.         1.E-3     .2         0.0
   23    1   35    1    1   10 5.0  E+00   1. E-03 1.0  E+00 5.0  E-01
   36    1   40    1    1   10 2.0  E+00   1. E-03  .5  E+00      0.0
   -1
    0    0    0    0
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
    5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
    1.E-2
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
    5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
    1.E-2
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
    5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
    1.E-2
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
    5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
    1.E-2
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
    5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
    1.E-2
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
    5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
    1.E-2
    .3        .3        .2        .2        .2        .1        .05
   .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
```

Table 3.11 (continued)

```
  5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
  1.E-2
  .3       .3        .2         .2        .2        .1        .05
 .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
  5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
  1.E-2
  .3       .3        .2         .2        .2        .1        .05
 .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
  5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
  1.E-2
  .3       .3        .2         .2        .2        .1        .05
 .1 E-1    .1 E-1    .1 E-1    .1 E-1    .5E-2     .1 E-2    .5 E-3
  5.E-4     5.E-4     1.E-3     1.E-3     1.E-3     1.E-3     1.E-2
  1.E-2
 1    0          COMBINATORIAL GEOMETRY FOR INFINITE AIR PROBLEM
SPH        0.0       0.0       0.0      10000.
SPH        0.0       0.0       0.0      15000.
SPH        0.0       0.0       0.0      20000.
SPH        0.0       0.0       0.0      30000.
SPH        0.0       0.0       0.0      40000.
SPH        0.0       0.0       0.0      45000.
SPH        0.0       0.0       0.0      50000.
SPH        0.0       0.0       0.0      70000.
SPH        0.0       0.0       0.0      75000.
SPH        0.0       0.0       0.0      80000.
SPH        0.0       0.0       0.0      90000.
SPH        0.0       0.0       0.0     100000.
SPH        0.0       0.0       0.0     120000.
SPH        0.0       0.0       0.0     140000.
SPH        0.0       0.0       0.0     500000.
SPH        0.0       0.0       0.0     900000.
END
 1        +   1
 2        +   2   -   1
 3        +   3   -   2
 4        +   4   -   3
 5        +   5   -   4
 6        +   6   -   5
 7        +   7   -   6
 8        +   8   -   7
 9        +   9   -   8
10        +  10   -   9
11        +  11   -  10
12        +  12   -  11
13        +  13   -  12
14        +  14   -  13
15        +  15   -  14
16        +  16   -  15
```

Table 3.11 (continued)

```
  END
    1    2    2    3    3    4    4    5    6    6    7    7    8    9
   10   10
    1    1    2    2    1    1    2    2    2    1    1    2    2    2
    2    0

AIR XSECT
   22   22   18   18   40   43    4    1    1    1    6    3    1
                          1
 INSERT HERE THE SAME CROSS SECTION DATA AS USED IN S. PROB #2
    1   -1   1.16
SAMBO FOR 10 REGION AIR
 $$ 14     7    10     0     1     5    12     1
 **
      0.          0.          1.5E+4
      0.          0.          3.0E+4
      0.          0.          4.5E+4
      0.          0.          7.5E+4
      0.          0.          9.0E+4
      0.          0.          1.0E+4
      0.          0.          2.0E+4
      0.          0.          4.0E+4
      0.          0.          5.0E+4
      0.          0.          7.0E+4
      0.          0.          8.0E+4
      0.          0.         10.0E+4
      0.          0.         12.0E+4
      0.          0.         14.0E+4

4 PI R**2 GROUP 1 FLUENCE (NEUTRONS/SOURCE)
 **
   1.0 39R0.0
4 PI R**2 GROUP 10 + 11 FLUENCE (NEUTRONS/SOURCE)
 **
  9R0.0 2R1.0 29R0.0
4 PI R**2 GROUP 28 FLUENCE ( GAMMAS/SOURCE )
 **
  27R0.0 1.0 12R0.0
4 PI R**2 FAST NEUTRON FLUENCE (NEUTRONS/SOURCE)
 **
  22R1.0 18R0.0
4 PI R**2 GAMMA RAY FLUENCE (GAMMAS/SOURCE)
 **
  22R0.0 18R1.0
(NEUTRONS/EV/SOURCE)
 $$ 1    3    4    6    9   11   13   27   28   39
    5

†$$$$$$$$   MORSE COLLISION DENSITY PROBLEM 8   $$$$$$$$
```

---

†Required only for IBM version.

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