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Title: Producing the Fission-Product-Isotope File KIDMAN

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memorandum

TO: R. C. Little, X–6, MS B226

DATE: 15–September–1989

FROM: R. E. Seamon, X–6

MAIL STOP/TELEPHONE: B226 / 7–4809

SYMBOL: X–6:RES–89–340

SUBJECT: Producing the Fission–Product–Isotope File KIDMAN

In Ref. 1 I described the CFS file /076997/MYREDSTUFF/KIDMAN, an ACE file for the Monte Carlo code MCNP (Ref. 2) containing transport cross sections for twenty six fission product isotopes from ENDF/B–V. There is a second file associated with KIDMAN, the directory file stored under /076997/MYREDSTUFF/KIDMAND.

I found that Bob MacFarlane, T–2, had processed the evaluations through the RESR and UNRESR modules of NJOY (Ref. 3) to produce PENDF files; there were no ACER files available for any of the isotopes, however. Starting from the PENDF file and the BCD ENDF/B–V tape indicated in Table II of Ref. 1, I used the HEATR and ACER modules of NJOY to produce what are alleged to be Type 3 ACE files which should be useable in MCNP and related checking codes. Nothing would work; the problem was traced to extra record marks which had to be removed using the code FIXACEFILE. I took the opportunity to remove as well the completely unnecessary photon production matrix (30×20 zero values) at the end of each file. There is no photon production data for any of the 26 isotopes; I am unable to run the ACER module in such a way that the zeroes would disappear.

The corrected ACE files were processed through ADDXS (Ref. 4) to add charged–particle–production cross sections for eleven of the isotopes where it was appropriate, and the individual files were merged using your version of Pat Soran's original code CULIT (Ref. 5). Checks were made using XDATAP (Ref. 6), MARK and MRKACR (Ref. 7), and FISHPC (Ref. 4).

The purpose of this memo is to document explicitly how this work was done, or – more truthfully – how I would do the job again knowing what I know now. First, the codes will be listed, then the data decks, and – finally – what problems were encountered.

The codes – – –

NJOY: Based on experiences in processing the excited–state data for Dave Madland, I chose to use the binary executeable version of NJOY stored on CFS under /NJOY/89/XNJOY0.

FIXACEFILE: The source for this code is stored on CFS under /076997/MYREDSTUFF /FIXACEFILE. A listing thereof is given in Appendix A. Let CODE=FIXACEFILE; one gets the binary executeable file XCODE using RCFT I=CODE,GO.

ADDXS: The source is stored on CFS under /090895/CTSS/ADDXS. One gets the binary executeable XADDXS using RCFT I=ADDXS,GO.

CUL: The source is stored on CFS under /MYREDSTUFF/CUL. One gets the binary executeable XCUL using RCFT I=CUL,GO.

XDATAP: I use the binary version which has grown out of my collaboration with Harl'O Fisher on the *Handbook*; it is stored on CFS under /076997/MYREDSTUFF/XDATAP6.

FISHPC: The source is stored on CFS under /090895/CTSS/FISHPC. One gets the binary executeable XFISHPC using RCFT I=FISHPC,LIB=(CFTLIB,SCCFT,CGSCFT),GO.

MARK: The source is stored on CFS under /076997/PGMS/MARK. One gets the binary executeable XMARK using RCFT I=MARK,GO.

MRKACR: The source is stored on CFS under /076997/PGMS/MRKACR. One gets the binary executeable XMRKACR using RCFT I=MRKACR,GO.

The input decks – – –

NJOY: Here is a listing of the file INPUT associated with the NJOY run for Xe–131.

```
0
5
*MODER*
20 –21
*HEATR*
–21 –23 –28
1351 0 0 0 0 2 /
*ACER*
–21 –28 0 –30 31 /
0 1351 300.0 1 0
0.001 32 /
–1 5000 1.0E10
*STOP*
```

ENDF/B–V BCD input Tape20 was /ENDF/5/A/T/509.
Binary PENDF Tape23 was /PENDF/5/XE/131.
MAT = 1351
Binary Tape30 is the pseudo ACE–formatted file – "pseudo" because of those miserable extra record marks.

FIXACEFILE: No input file is needed. Binary Tape30 is the pseudo ACE file to be corrected and binary Tape31 – a real ACE file – is produced.

ADDXS: Here is a listing of the TAPE8 input file appropriate for Pr^{141}, Nd^{143}, Nd^{145}, Nd^{148}, Pm^{147}, Sm^{147}, Sm^{151}, Sm^{152}, and Eu^{155}. The format is 2I5.

```
    5
  203     2
   28   103
  204     1
  104
  205     1
  105
  206     1
  106
  207     2
   22   107
```

CUL: Here is a listing of the CULINP file for a run in which I merged HERFILE containing 25 ZAIDs with file 9832B containing one ZAID (=63155.50). In this run the output file MYFILE became the final file KIDMAN. These lines start in column 1.

```
MYFILE
2
HERFILE
9832B
40093.50
42095.50
43099.50
44101.50
44103.50
45105.50
46105.50
46108.50
53135.50
.
.
.
.
59141.50
61148.50
61149.50
62147.50
62150.50
62151.50
62152.50
63155.50
0.
```

FISHPC: Requires that KIDMAN be SWITCHed to EXTRA and that input file XSIN be one blank line.

MARK and MRKACR: The file INPUT is stored on CFS under /076997/R028/MARKD. For MARK, Tape7 must be the BCD File3 data; for MRKACR Tape7 is an ACE file like KIDMAN.

Additional Remarks – – –

Before I merged the individual ACE files using CUL, I changed the ZAIDs manually using EDIT so that they would have suffix *nn* = 50 in ZAID=ZZAAA.*nn*. Locations 1_8 and 312_8 in file OUTACE from ADDXS were changed.

There was a threshold problem discovered in Xe^{131} MAT=1351, MT=51 when I ran MRKACR. For reasons unknown to me, NJOY is no longer shifting the thresholds for inelastic scattering to insure that

$$E_{th} \geq |Q| \frac{AWR + 1.0}{AWR}.$$

Specifically, for MAT=1351, MT=51 E_{th} = 8.0616400E–02 while EC=8.0616423051140E–02. Clearly, E can be less than EC in the interval $E_{th} \leq E \leq EC$. I changed EC using EDIT to 8.061600E–02 to eliminate that problem. In subsequent runs with MCNP in which I transported neutrons through Xe^{131} there were no negative–energy secondary neutrons produced.

There were eleven isotopes (Xe^{135}, Tc^{99}, Pr^{141}, Nd^{145}, Nd^{143}, Nd^{148}, Eu^{155}, Pm^{147}, Sm^{147}, Sm^{151}, Sm^{152}) for which some of the reaction cross sections were given in terms of the semi–log interpolation INT=3 on the ENDF/B–V tapes. This interpolation code (y linear in $\ln x$) is not handled in MARK because closed–form expressions cannot be written for the integrals. Therefore, I was forced to rely on the ACE/ENDF comparison plots produced with XDATAP to check the NJOY processing of the cross sections for these reactions. The INT=3 cross sections have scallops on log–log plots. That only increased my apprehension and I decided to reproduce one of MacFarlane's PENDF tapes starting from "scratch." The deck for that NJOY run is listed here.

```
0
5
*MODER*
20 –21
*RECONR*
–21 –22
*PENDF TAPE FOR XE–135 ON TAPE 509* /
1294 0 0/
0.001 0.0 6/
0/
*BROADR*
–22 –23
1294 1 0 0 0.0 /
0.001 1.0E+06 /
300.0 /
0/
*HEATR*
–21 –23 –28
1294 0 0 0 0 2/
*ACER*
–21 –28 0 –30 31 /
0 1294 300. 1 0
0.001 32/
–1 5000 1.0E+10
*STOP*
```

I was processing Xe^{135} MAT=1294 on Tape509. Tape509 was Tape20 in this run. The NJOY outputs for this full run and the "short" run started from the PENDF tape are available in Appendix B. The final ACE files were not identical; I had roughly twice as many points in "my" output ACE file. However, the MRKACR output striped to three and four significant figure agreement and the plots produced in XDATAP run in COMPARE mode were indistinguishable. On the basis of this experience with the one isotope I decided to start my processing from MacFarlane's PENDF tapes – those listed in Table II of Ref. 1. This is not a confession, however, because – after all – I have compared all of the final ACE files on KIDMAN with the original ENDF/B–V cross sections.

Three MCNP runs have been made using KIDMAN. A copy of the first page of each of the runs is included in Appendix C.

I intend to hold on to all the plots and MARK/MRKACR outputs for a while. They are stored in the middle drawer of the filing cabinet in my office under KIDMAN Service Job. The microfiche listings from KIDMAN will be saved to become a permanent addition to our fiche library.

REFERENCES

1. R. E. Seamon, "Fission–Product–Isotope Cross Sections in ACE Format for MCNP," Los Alamos National Laboratory internal memorandum to R. B. Kidman (September13, 1989).
2. J. F. Briesmeister, editor, "MCNP – A General Monte Carlo Code for Neutron and Photon Transport Version 3A," Los Alamos National Laboratory manual LA–7396–M, Rev. 2 (September 1986).
3. R. E. MacFarlane, D. W. Muir, and R. M. Boicourt, "The NJOY Nuclear Data Processing System, Volume I: User's Manual," Los Alamos National Laboratory manual LA–9303–M, Vol. I (ENDF–324) (May 1982).
4. R. C. Little, "Cross Section Processing Codes on the CRAY," Los Alamos National Laboratory internal memorandum X–6:RCL–85–415 to R. E. Seamon and H. M. Fisher (August 13, 1985).
5. R. C. Little, "The Code CUL," Los Alamos National Laboratory internal memorandum to R. E. Seamon (February 1, 1984).
6. H. M. Fisher, "XDATAP," Los Alamos National Laboratory report LA–11155–MS (October 1987).
7. R. E. Seamon, "The MARK and MRKACR Codes," Los Alamos National Laboratory internal memorandum X–6:RES–87–182 to Distribution (March 26, 1987).

DISTRIBUTION

R. C. Little, X–6, MS B226
H. M. Fisher, X–6, MS B226
X–6 Files, MS B226 (2)

RES:res

APPENDIX A

Listing of CFS File /076997/MYREDSTUFF/FIXACEFILE

```
      PROGRAM MUCK(TAPE30=0,TAPE31=0)
      DIMENSION GREAT(2048),IGREAT(2048)
      EQUIVALENCE(GREAT(1),IGREAT(1))
      INTEGER EXTRA
      IDA=1
      IDB=1
      CALL RDISK(30,GREAT,5,IDA)
      IF(UNIT(30)) 299,299,350
  299 LENGTH=IGREAT(4)
      N=LENGTH/2048
      EXTRA=LENGTH-2048*N + N
      NEWLGT=2048*N + EXTRA - 600
      M=NEWLGT/2048
      EXTRA=NEWLGT - M*2048
      IF(M.EQ.0) GO TO 4
      CALL RDISK(30,GREAT,2048,IDA)
      IF(UNIT(30)) 300,300,350
  300 IGREAT(221)=IGREAT(221)-600
      IGREAT(4)=201+IGREAT(221)+4
      CALL WDISK(31,GREAT,2047,IDB)
      IF(UNIT(31)) 301,301,350
  301 IDA=IDA+2048
      IDB=IDB+2047
      IF(M.EQ.1) GO TO 3
      DO 1 I=2,M
      CALL RDISK(30,GREAT,2048,IDA)
      IF(UNIT(30)) 302,302,350
  302 CALL WDISK(31,GREAT,2047,IDB)
      IF(UNIT(31)) 303,303,350
  303 IDA=IDA+2048
      IDB=IDB+2047
    1 CONTINUE
    3 CALL RDISK(30,GREAT,EXTRA,IDA)
      IF(UNIT(30)) 304,304,350
  304 CALL WDISK(31,GREAT,EXTRA,IDB)
      IF(UNIT(31))305,305,350
    4 CALL RDISK(30,GREAT,EXTRA,IDA)
      IF(UNIT(30)) 306,306,350
  306 IGREAT(221)=IGREAT(221)-600
      IGREAT(4)=201+IGREAT(221)+4
      CALL WDISK(31,GREAT,EXTRA,IDB)
      IF(UNIT(31)) 307,307,350
  307 STOP
  305 STOP
  350 STOP 765
      END
```

APPENDIX B

Two NJOY Output Files

MAT=1294 Straight Through NJOY

```
*****************************************************************************
*                                          *                 *              *
*   $$   $$       $$   $$$$$   $$    $$    *                 *  VERS.89.0   *
*   $$$  $$       $$  $$$$$$$   $$  $$     *  NUCLEAR        *  RAN AT LANL *
*   $$$$ $$       $$  $$   $$    $$$$      *  CROSS SECTION  *  ON MACH. 6  *
*   $$ $$$$  $$   $$  $$   $$     $$       *  PROCESSING     *  ON 08/24/89 *
*   $$  $$$  $$$$$$$  $$$$$$$     $$       *  SYSTEM         *  AT 16:23:32 *
*   $$   $$   $$$$$    $$$$$      $$       *                 *              *
*                                          *                 *              *
*****************************************************************************

RECONR...RECONSTRUCT POINTWISE CROSS SECTIONS IN PENDF FORMAT          0.096S

UNIT FOR ENDF/B TAPE ..................        -21
UNIT FOR PENDF TAPE ...................        -22

LABEL FOR PENDF TAPE
-------------------------------------
 PENDF TAPE FOR XE-135 ON TAPE 509

TAPE LABEL
-------------------------------------
 ENDF/B-V TAPE 509 (FISSION PRODUCTS)

                                                          STORAGE  15/100000

MATERIAL TO BE PROCESSED ..............       1294
RECONSTRUCTION TOLERANCE ..............      0.001
RECONSTRUCTION TEMPERATURE ...........         0.K
NO. SIGNIFICANT FIGURES ...............          6
RESONANCE-INTEGRAL-CHECK TOLERANCE ...      0.020
MAX RESONANCE-INTEGRAL ERROR .........  1.000E-07

DESCRIPTIVE CARDS FOR PENDF TAPE
-------------------------------------
  PENDF TAPE PREPARED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM


PROCESSING MAT   1294
-------------------------------------
  54-XE-135 BNW        EVAL-JUN67 B.R.LEONARD,JR. AND K.B.STEWART


MAT HAS NO RESONANCE PARAMETERS

POINTS IN INITIAL UNIONIZED GRID =  381
POINTS ADDED BY LINEARIZATION = 397                                    0.982S

                                                          USAGE  26664/100000
                                                                      1.759S
*****************************************************************************

BROADR...DOPPLER BROADENING OF ENDF/B DATA                             1.779S

UNIT FOR INPUT PENDF TAPE ............        -22
UNIT FOR OUTPUT PENDF TAPE ...........        -23
MATERIAL TO BE PROCESSED ..............       1294
NUMBER OF FINAL TEMPERATURES .........          1
RESTART (0 NO, 1 YES) ................          0
BOOTSTRAP (0 NO, 1 YES) ..............          0
STARTING MATERIAL TEMPERATURE ........         0.K
THINNING TOLERANCE ...................      0.001
MAX. ENERGY ..........................  1.00000E+06
ERRMAX FOR THINNING ..................  2.00000E-02
```

```
ERRINT FOR THINNING ..................   1.00000E-07
FINAL TEMPERATURES ...................   3.00E+02

                                                        STORAGE  10/ 30000

MAX ENERGY FOR BROADENING AND THINNING =   5.30942E+05
                                                                   2.128S
BROADENED MAT1294 FROM  0.0000E+00 TO  3.0000E+02 K
        POINTS IN=   778  POINTS OUT=   720
        MT   2 102
                                                                   4.263S
*****************************************************************************

HEATR...PROMPT KERMA                                               4.280S

                                                        STORAGE  15/ 12000

INPUT ENDF/B UNIT ....................        -21
INPUT PENDF UNIT .....................        -23
OUTPUT PENDF UNIT ....................        -28
MAT TO BE PROCESSED ..................       1294
NO. TEMPERATURES (0=ALL) .............          0
GAMMA HEAT (0 NONLOCAL, 1 LOCAL) .....          0
PRINT OPTION (0 MIN, 1 MORE, 2 CHK) ..          1

NO PHOTON PRODUCTION FILES...ALL PHOTON ENERGY WILL BE DEPOSITED LOCALLY.

PROCESSING AT TEMPERATURE= 3.0000E+02
                                                        TEMP 1     4.538S

NEUTRON HEATING FOR MT  2   QO =  0.0000E+00     Q =  0.0000E+00
```

E	EBAR	XSEC	HEATING
1.0000E-05	9.8528E-06	1.0011E+06	1.4749E-01
1.0962E-04	1.0801E-04	3.5097E+05	5.6680E-01
1.0962E-03	1.0801E-03	2.1893E+05	3.5357E+00
1.1927E-02	1.1751E-02	2.4029E+05	4.2222E+01
1.2000E-01	1.1823E-01	3.8641E+05	6.8312E+02
1.2098E+00	1.1920E+00	1.6388E+03	2.9209E+01
2.4395E+00	2.4036E+00	4.2106E+02	1.5133E+01
4.8985E+00	4.8263E+00	1.2541E+02	9.0501E+00
9.8000E+00	9.6556E+00	4.5469E+01	6.5647E+00
2.0000E+01	1.9705E+01	2.0804E+01	6.1300E+00
4.0000E+01	3.9411E+01	1.2701E+01	7.4844E+00
8.0000E+01	7.8821E+01	9.5476E+00	1.1253E+01
1.6000E+02	1.5764E+02	8.1941E+00	1.9315E+01
3.2000E+02	3.1529E+02	7.5720E+00	3.5697E+01
6.5414E+02	6.4450E+02	7.2754E+00	7.0114E+01
1.3218E+03	1.3023E+03	1.8817E+01	3.6607E+02
2.7244E+03	2.6844E+03	1.4056E+01	5.6278E+02
5.4584E+03	5.3784E+03	1.0975E+01	8.7861E+02
1.1007E+04	1.0846E+04	8.8481E+00	1.4166E+03
2.4000E+04	2.3660E+04	7.2191E+00	2.4527E+03
5.0000E+04	4.9311E+04	6.2551E+00	4.3124E+03
1.0000E+05	9.8723E+04	5.6934E+00	7.2728E+03
2.0000E+05	1.9776E+05	5.4419E+00	1.2164E+04
4.5000E+05	4.4575E+05	5.6629E+00	2.4042E+04
6.0344E+05	5.9801E+05	5.8818E+00	3.1907E+04
8.1067E+05	8.0393E+05	6.1172E+00	4.1249E+04
1.0000E+06	9.9212E+05	6.2712E+00	4.9427E+04
1.2200E+06	1.2111E+06	6.2479E+00	5.6023E+04
1.4076E+06	1.3978E+06	6.1122E+00	5.9952E+04
1.6000E+06	1.5894E+06	5.9057E+00	6.2577E+04
1.8430E+06	1.8315E+06	5.4978E+00	6.3285E+04

2.0000E+06	1.9880E+06	5.2620E+00	6.3393E+04
2.5417E+06	2.5273E+06	4.4131E+00	6.3569E+04
3.0000E+06	2.9831E+06	3.8395E+00	6.4703E+04
3.5529E+06	3.5323E+06	3.3897E+00	6.9926E+04
4.0413E+06	4.0172E+06	3.0473E+00	7.3384E+04
4.5724E+06	4.5442E+06	2.7189E+00	7.6904E+04
5.0000E+06	4.9682E+06	2.4812E+00	7.8820E+04
6.0698E+06	6.0301E+06	2.3324E+00	9.2493E+04
7.0000E+06	6.9553E+06	2.2230E+00	9.9449E+04
8.0420E+06	7.9945E+06	2.4401E+00	1.1579E+05
9.1826E+06	9.1347E+06	2.6476E+00	1.2683E+05
1.0000E+07	9.9526E+06	2.7810E+00	1.3189E+05
1.1221E+07	1.1175E+07	3.0653E+00	1.4366E+05
1.2000E+07	1.1953E+07	3.2308E+00	1.5068E+05
1.3444E+07	1.3397E+07	3.3968E+00	1.6129E+05
1.4208E+07	1.4160E+07	3.4776E+00	1.6819E+05
1.5000E+07	1.4950E+07	3.5568E+00	1.7669E+05
1.6161E+07	1.6107E+07	3.6625E+00	1.9602E+05
1.7380E+07	1.7323E+07	3.7657E+00	2.1675E+05
1.8660E+07	1.8598E+07	3.8664E+00	2.3893E+05
2.0000E+07	1.9934E+07	3.9648E+00	2.6261E+05

NEUTRON HEATING FOR MT 51 QO = 0.0000E+00 Q = -5.2700E+05

E	EBAR	XSEC	HEATING
6.0344E+05	7.0441E+04	2.1975E-02	1.1713E+04
8.1067E+05	2.7449E+05	6.7409E-02	3.6143E+04
1.0000E+06	4.6105E+05	1.0089E-01	5.4375E+04
1.2200E+06	6.7798E+05	1.3171E-01	7.1398E+04
1.4076E+06	8.6306E+05	1.4939E-01	8.1353E+04
1.6000E+06	1.0522E+06	1.6200E-01	8.8750E+04
1.8430E+06	1.2926E+06	1.5590E-01	8.5805E+04
2.0000E+06	1.4470E+06	1.5237E-01	8.4265E+04
2.5417E+06	1.9800E+06	1.0502E-01	5.8984E+04
3.0000E+06	2.4321E+06	6.6016E-02	3.7488E+04
3.5529E+06	2.9771E+06	4.6476E-02	2.6761E+04
4.0413E+06	3.4577E+06	3.1600E-02	1.8440E+04
4.5724E+06	3.9808E+06	1.7336E-02	1.0256E+04
5.0000E+06	4.4021E+06	7.0103E-03	4.1917E+03
6.0698E+06	5.4561E+06	3.5621E-03	2.1861E+03
7.0000E+06	6.3736E+06	1.0262E-03	6.4278E+02
8.0420E+06	7.3992E+06	6.4746E-04	4.1616E+02
9.1826E+06	8.5237E+06	2.8546E-04	1.8808E+02
1.0000E+07	9.3287E+06	5.2721E-05	3.5389E+01
1.1221E+07	1.0533E+07	2.3587E-05	1.6239E+01
1.2000E+07	1.1299E+07	6.6274E-06	4.6452E+00
1.3444E+07	1.2723E+07	5.3754E-06	3.8792E+00
1.4208E+07	1.3474E+07	4.7668E-06	3.4968E+00
1.5000E+07	1.4256E+07	4.1692E-06	3.1028E+00
1.6161E+07	1.5399E+07	3.3480E-06	2.5509E+00
1.7380E+07	1.6600E+07	2.5466E-06	1.9872E+00
1.8660E+07	1.7860E+07	1.7643E-06	1.4097E+00
2.0000E+07	1.9182E+07	1.0000E-06	8.1796E-01

NEUTRON HEATING FOR MT 91 QO = 0.0000E+00 Q = -5.2700E+05

E	EBAR	XSEC	HEATING
1.2200E+06	1.4211E+05	9.3509E-02	1.0080E+05
1.4076E+06	2.5573E+05	2.3120E-01	2.6632E+05
1.6000E+06	3.5467E+05	4.0482E-01	5.0008E+05
1.8430E+06	4.9100E+05	6.9162E-01	9.3508E+05
2.0000E+06	5.6576E+05	8.5743E-01	1.2298E+06
2.5417E+06	7.8256E+05	1.3728E+00	2.4150E+06
3.0000E+06	9.1869E+05	1.6738E+00	3.4837E+06
3.5529E+06	1.0334E+06	1.7325E+00	4.3652E+06
4.0413E+06	1.0992E+06	1.7773E+00	5.2289E+06

4.5724E+06	1.1438E+06	1.8202E+00	6.2407E+06
5.0000E+06	1.1657E+06	1.8512E+00	7.0980E+06
6.0698E+06	1.1908E+06	1.7297E+00	8.4393E+06
7.0000E+06	1.1973E+06	1.6404E+00	9.5188E+06
8.0420E+06	1.1993E+06	1.5827E+00	1.0830E+07
9.1826E+06	1.1999E+06	1.5276E+00	1.2195E+07
1.0000E+07	1.2000E+06	1.4922E+00	1.3131E+07
1.1221E+07	1.2000E+06	1.3747E+00	1.3776E+07
1.2000E+07	1.2000E+06	1.3063E+00	1.4108E+07
1.3444E+07	1.2000E+06	1.2382E+00	1.5160E+07
1.4208E+07	1.2000E+06	1.2050E+00	1.5675E+07
1.5000E+07	1.2000E+06	1.1725E+00	1.6180E+07
1.6161E+07	1.2000E+06	1.1278E+00	1.6873E+07
1.7380E+07	1.2000E+06	1.0842E+00	1.7542E+07
1.8660E+07	1.2000E+06	1.0416E+00	1.8186E+07
2.0000E+07	1.2000E+06	1.0000E+00	1.8800E+07

NEUTRON HEATING FOR MT102 QO = 7.8800E+06 Q = 7.8800E+06

E	EBAR	XSEC	HEATING
1.0000E-05	0.0000E+00	8.8795E+07	6.9970E+14
1.0962E-04	0.0000E+00	2.6883E+07	2.1184E+14
1.0962E-03	0.0000E+00	8.6203E+06	6.7928E+13
1.1927E-02	0.0000E+00	3.0903E+06	2.4351E+13
1.2000E-01	0.0000E+00	1.5712E+06	1.2381E+13
1.2098E+00	0.0000E+00	1.8894E+03	1.4888E+10
2.4395E+00	0.0000E+00	3.0596E+02	2.4110E+09
4.8985E+00	0.0000E+00	5.2446E+01	4.1328E+08
9.8000E+00	0.0000E+00	9.6032E+00	7.5674E+07
2.0000E+01	0.0000E+00	1.9513E+00	1.5376E+07
4.0000E+01	0.0000E+00	5.8812E-01	4.6344E+06
8.0000E+01	0.0000E+00	2.7660E-01	2.1796E+06
1.6000E+02	0.0000E+00	1.7104E-01	1.3478E+06
3.2000E+02	0.0000E+00	1.1660E-01	9.1887E+05
6.5414E+02	0.0000E+00	8.0814E-02	6.3687E+05
1.3218E+03	0.0000E+00	5.4625E-02	4.3052E+05
2.7244E+03	0.0000E+00	3.0608E-02	2.4127E+05
5.4584E+03	0.0000E+00	1.7205E-02	1.3567E+05
1.1007E+04	0.0000E+00	9.9601E-03	7.8595E+04
2.4000E+04	0.0000E+00	5.6940E-03	4.5006E+04
5.0000E+04	0.0000E+00	3.4800E-03	2.7597E+04
1.0000E+05	0.0000E+00	2.1950E-03	1.7516E+04
2.0000E+05	0.0000E+00	1.5490E-03	1.2516E+04
4.5000E+05	0.0000E+00	1.2480E-03	1.0396E+04
6.0344E+05	0.0000E+00	7.9413E-04	6.7369E+03
8.1067E+05	0.0000E+00	5.9043E-04	5.1312E+03
1.0000E+06	0.0000E+00	5.4080E-04	4.8023E+03
1.2200E+06	0.0000E+00	4.7417E-04	4.3149E+03
1.4076E+06	0.0000E+00	4.4206E-04	4.1057E+03
1.6000E+06	0.0000E+00	4.2460E-04	4.0252E+03
1.8430E+06	0.0000E+00	4.0033E-04	3.8924E+03
2.0000E+06	0.0000E+00	3.8630E-04	3.8166E+03
2.5417E+06	0.0000E+00	3.3242E-04	3.4644E+03
3.0000E+06	0.0000E+00	2.7900E-04	3.0355E+03
3.5529E+06	0.0000E+00	6.8135E-04	7.7898E+03
4.0413E+06	0.0000E+00	9.8766E-04	1.1774E+04
4.5724E+06	0.0000E+00	1.2814E-03	1.5956E+04
5.0000E+06	0.0000E+00	1.4940E-03	1.9243E+04
6.0698E+06	0.0000E+00	1.5378E-03	2.1452E+04
7.0000E+06	0.0000E+00	1.5700E-03	2.3362E+04
8.0420E+06	0.0000E+00	1.6805E-03	2.6757E+04
9.1826E+06	0.0000E+00	1.7861E-03	3.0476E+04
1.0000E+07	0.0000E+00	1.8540E-03	3.3150E+04
1.1221E+07	0.0000E+00	2.0089E-03	3.8372E+04
1.2000E+07	0.0000E+00	2.0990E-03	4.1728E+04

1.3444E+07	0.0000E+00	2.3093E-03	4.9245E+04
1.4208E+07	0.0000E+00	2.4116E-03	5.3267E+04
1.5000E+07	0.0000E+00	2.5120E-03	5.7475E+04
1.6161E+07	0.0000E+00	2.3793E-03	5.7201E+04
1.7380E+07	0.0000E+00	2.2499E-03	5.6832E+04
1.8660E+07	0.0000E+00	2.1235E-03	5.6356E+04
2.0000E+07	0.0000E+00	2.0000E-03	5.5760E+04

FINAL KERMA FACTORS

E	301
MIN	6.7373E+00
1.0000E-05	6.9970E+14
MAX	2.1776E+10
	HIGH
MIN	2.2436E+01
1.0962E-04	2.1184E+14
MAX	6.5928E+09
	HIGH
MIN	7.3664E+01
1.0962E-03	6.7928E+13
MAX	2.1141E+09
	HIGH
MIN	3.1575E+02
1.1927E-02	2.4351E+13
MAX	7.5787E+08
	HIGH
MIN	2.0823E+03
1.2000E-01	1.2381E+13
MAX	3.8533E+08
	HIGH
MIN	4.6173E+01
1.2098E+00	1.4888E+10
MAX	4.6340E+05
	HIGH
MIN	2.0672E+01
2.4395E+00	2.4110E+09
MAX	7.5056E+04
	HIGH
MIN	1.0957E+01
4.8985E+00	4.1328E+08
MAX	1.2873E+04
	HIGH
MIN	7.2631E+00
9.8000E+00	7.5674E+07
MAX	2.3624E+03
	HIGH
MIN	6.4196E+00
2.0000E+01	1.5376E+07
MAX	4.8496E+02
	HIGH
MIN	7.6590E+00
4.0000E+01	4.6344E+06
MAX	1.5189E+02

```
                HIGH

       MIN    1.1417E+01
8.0000E+01    2.1796E+06
       MAX    7.9252E+01
                HIGH

       MIN    1.9518E+01
1.6000E+02    1.3478E+06
       MAX    6.1465E+01
                HIGH

       MIN    3.5974E+01
3.2000E+02    9.1891E+05
       MAX    6.4573E+01
                HIGH

       MIN    7.0506E+01
6.5414E+02    6.3694E+05
       MAX    9.0328E+01
                HIGH

       MIN    3.6660E+02
1.3218E+03    4.3088E+05
       MAX    3.8000E+02
                HIGH

       MIN    5.6340E+02
2.7244E+03    2.4184E+05
       MAX    5.7091E+02
                HIGH

       MIN    8.7931E+02
5.4584E+03    1.3655E+05
       MAX    8.8353E+02
                HIGH

       MIN    1.4174E+03
1.1007E+04    8.0012E+04
       MAX    1.4198E+03
                HIGH

       MIN    2.4537E+03
2.4000E+04    4.7458E+04
       MAX    2.4551E+03
                HIGH

       MIN    4.3137E+03
5.0000E+04    3.1909E+04
       MAX    4.3146E+03
                HIGH

       MIN    7.2745E+03
1.0000E+05    2.4789E+04
       MAX    7.2750E+03
                HIGH

       MIN    1.2166E+04
2.0000E+05    2.4680E+04
       MAX    1.2167E+04
                HIGH

       MIN    2.4047E+04
4.5000E+05    3.4438E+04
```

	MAX	2.4047E+04
		HIGH
	MIN	3.2042E+04
6.0344E+05		5.0356E+04
	MAX	3.2042E+04
		HIGH
	MIN	4.1872E+04
8.1067E+05		8.2524E+04
	MAX	4.1872E+04
		HIGH
	MIN	5.0637E+04
1.0000E+06		1.0860E+05
	MAX	5.0637E+04
		HIGH
	MIN	5.8964E+04
1.2200E+06		2.3253E+05
	MAX	5.8965E+04
		HIGH
	MIN	6.5459E+04
1.4076E+06		4.1173E+05
	MAX	6.5459E+04
		HIGH
	MIN	7.1905E+04
1.6000E+06		6.5544E+05
	MAX	7.1906E+04
		HIGH
	MIN	7.9006E+04
1.8430E+06		1.0881E+06
	MAX	7.9006E+04
		HIGH
	MIN	8.3813E+04
2.0000E+06		1.3812E+06
	MAX	8.3814E+04
		HIGH
	MIN	1.0134E+05
2.5417E+06		2.5410E+06
	MAX	1.0134E+05
		HIGH
	MIN	1.1645E+05
3.0000E+06		3.5889E+06
	MAX	1.1645E+05
		HIGH
	MIN	1.3162E+05
3.5529E+06		4.4697E+06
	MAX	1.3162E+05
		HIGH
	MIN	1.4351E+05
4.0413E+06		5.3325E+06
	MAX	1.4351E+05
		HIGH
	MIN	1.5586E+05

4.5724E+06		6.3438E+06
	MAX	1.5586E+05
		HIGH
	MIN	1.6471E+05
5.0000E+06		7.2003E+06
	MAX	1.6471E+05
		HIGH
	MIN	1.8677E+05
6.0698E+06		8.5554E+06
	MAX	1.8677E+05
		HIGH
	MIN	2.0017E+05
7.0000E+06		9.6422E+06
	MAX	2.0017E+05
		HIGH
	MIN	2.2532E+05
8.0420E+06		1.0973E+07
	MAX	2.2532E+05
		HIGH
	MIN	2.4558E+05
9.1826E+06		1.2352E+07
	MAX	2.4558E+05
		HIGH
	MIN	2.5699E+05
1.0000E+07		1.3296E+07
	MAX	2.5699E+05
		HIGH
	MIN	2.7151E+05
1.1221E+07		1.3958E+07
	MAX	2.7151E+05
		HIGH
	MIN	2.7979E+05
1.2000E+07		1.4300E+07
	MAX	2.7979E+05
		HIGH
	MIN	2.9709E+05
1.3444E+07		1.5371E+07
	MAX	2.9709E+05
		HIGH
	MIN	3.0727E+05
1.4208E+07		1.5896E+07
	MAX	3.0727E+05
		HIGH
	MIN	3.1899E+05
1.5000E+07		1.6415E+07
	MAX	3.1899E+05
		HIGH
	MIN	3.4270E+05
1.6161E+07		1.7126E+07
	MAX	3.4271E+05
		HIGH

```
          MIN     3.6766E+05
    1.7380E+07    1.7816E+07
          MAX     3.6766E+05
                    HIGH

          MIN     3.9388E+05
    1.8660E+07    1.8481E+07
          MAX     3.9389E+05
                    HIGH

          MIN     4.2141E+05
    2.0000E+07    1.9118E+07
          MAX     4.2142E+05
                    HIGH

                                                        USAGE   7399/ 12000

                                                                    5.357S
*****************************************************************************

ACER...MONTE CARLO NEUTRON AND PHOTON DATA                              5.441S
INPUT ENDF/B UNIT ....................          -21
INPUT PENDF UNIT .....................          -28
INPUT GENDF UNIT .....................            0
OUTPUT ACE FORMAT UNIT ...............          -30
OUTPUT DIRECTORY UNIT ................           31
RUN TYPE OPTION ......................            0
MAT TO BE PROCESSED ..................         1294
TEMPERATURE ..........................     3.00E+02
PRINT OPTION (0 MIN, 1 MAX) ..........            0
TYPE OF ACE FILE .....................            0
TOLERANCE ............................     1.00E-03
BINS FOR ANGULAR DISTRIBUTIONS .......           32
BINS FOR PHOTON SPECTRA ..............           20
PHOTON OPTION ........................            1
THINNING WT OPTION (1 FLAT, 2 1/E) ...            1
TARGET NO. OF POINTS .................         5000
REFERENCE SIGMA ZERO .................     1.00E+10

                                                        STORAGE  27/ 11100

ORIGINAL GRID=   720 WITH INTEGRALS   9.6085E+07  4.7305E+05

NEW GRID=   562 WITH INTEGRALS   9.6085E+07  4.7305E+05

NEW GRID=   690 WITH INTEGRALS   9.6085E+07  4.7305E+05

TOTAL
  1.6976E-03  2.1954E+04   0.0   0.0
  1.5202E-01  4.1737E+05   0.0   0.0
  5.4000E-01  7.2586E+04   0.0   0.0
  2.3479E+00  8.4242E+03   0.1   0.0
  1.0464E+01  1.4454E+03   0.2   0.0
  8.4000E+01  1.1257E+03   0.1   0.0
  1.0012E+03  6.9913E+03   0.1   0.0
  1.0701E+05  7.2841E+05   0.0   0.0
  2.1939E+06  1.2852E+07   0.0   0.0
  2.0000E+07  8.1975E+07   0.0   0.0

CAPTURE
  1.6976E-03  2.1535E+04   0.0   0.0
  1.5202E-01  3.5750E+05   0.0   0.0
  5.4000E-01  5.4035E+04   0.0   0.0
  2.3479E+00  4.8740E+03   0.1   0.0
```

```
 1.0464E+01  4.6606E+02   0.2   0.0
 8.4000E+01  7.4782E+01   0.2   0.0
 1.0012E+03  9.4888E+01   0.0   0.0
 1.0701E+05  5.6988E+02   0.0   0.0
 2.1939E+06  1.4111E+03   0.0   0.0
 2.0000E+07  3.2488E+04   0.0   0.0

   71    72    72    72    70    68    49    71    72    72

   REMOVED E= 1.00000E+03 FOR MF= 4 MT=  2

                                                                  12.724S
*****************************************************************************
```

Simple NJOY Run Starting from a PENDF Tape

```
*****************************************************************************
*                                          *                 *              *
*   $$   $$       $$   $$$$$   $$    $$   *                 *  VERS.89.0   *
*   $$$  $$       $$  $$$$$$$   $$  $$    *  NUCLEAR        *  RAN AT LANL  *
*   $$$$ $$       $$  $$   $$    $$$$     *  CROSS SECTION  *  ON MACH. 6   *
*   $$ $$$$  $$   $$  $$   $$     $$      *  PROCESSING     *  ON 08/24/89  *
*   $$  $$$  $$$$$$$  $$$$$$$     $$      *  SYSTEM         *  AT 10:39:01  *
*   $$   $$   $$$$$    $$$$$      $$      *                 *              *
*                                          *                 *              *
*****************************************************************************

MODER...CHANGE THE MODE OF AN ENDF/B TAPE OR NJOY OUTPUT TAPE          0.085S

INPUT UNIT (+ FOR CODED, - FOR BB) ...          20
OUTPUT UNIT (+ FOR CODED, - FOR BB) ..         -21

TAPE LABEL
-------------------------------------
 ENDF/B-V TAPE 509 (FISSION PRODUCTS)
                                                                      11.041S
*****************************************************************************

ACER...MONTE CARLO NEUTRON AND PHOTON DATA                            11.105S
INPUT ENDF/B UNIT ....................          -21
INPUT PENDF UNIT .....................          -25
INPUT GENDF UNIT .....................            0
OUTPUT ACE FORMAT UNIT ...............          -30
OUTPUT DIRECTORY UNIT ................           31
RUN TYPE OPTION ......................            0
MAT TO BE PROCESSED ..................         1294
TEMPERATURE ..........................     3.00E+02
PRINT OPTION (0 MIN, 1 MAX) ..........            0
TYPE OF ACE FILE .....................            0
TOLERANCE ............................     1.00E-03
BINS FOR ANGULAR DISTRIBUTIONS .......           32
BINS FOR PHOTON SPECTRA ..............           20
PHOTON OPTION ........................            1
THINNING WT OPTION (1 FLAT, 2 1/E) ...            1
TARGET NO. OF POINTS .................         5000
REFERENCE SIGMA ZERO .................     1.00E+10

                                                        STORAGE  27/ 11100

ORIGINAL GRID=   388 WITH INTEGRALS   9.6080E+07  4.7334E+05

NEW GRID=   342 WITH INTEGRALS   9.6080E+07  4.7335E+05

NEW GRID=   385 WITH INTEGRALS   9.6080E+07  4.7334E+05

TOTAL
  8.6000E-04  1.4996E+04   0.0   0.0
  6.0000E-02  2.0083E+05   0.0   0.0
  2.8000E-01  2.7907E+05   0.0   0.0
  9.4000E-01  2.2576E+04   0.0   0.0
  4.6000E+00  4.0810E+03   0.1   0.0
  1.8000E+01  8.2233E+02   0.1   0.0
  1.6000E+02  1.5395E+03   0.0   0.0
  2.0000E+04  1.9570E+05   0.0   0.0
  1.3711E+06  8.1561E+06   0.0   0.0
  2.0000E+07  8.7205E+07   0.0   0.0

CAPTURE
  8.6000E-04  1.4759E+04   0.0   0.0
  6.0000E-02  1.8092E+05   0.0   0.0
```

```
 2.8000E-01  2.2563E+05   0.0   0.0
 9.4000E-01  1.5266E+04   0.0   0.0
 4.6000E+00  1.9830E+03   0.2   0.0
 1.8000E+01  1.6830E+02   0.3   0.0
 1.6000E+02  5.7074E+01   0.1   0.0
 2.0000E+04  3.5958E+02   0.0   0.0
 1.3711E+06  1.3672E+03   0.0   0.0
 2.0000E+07  3.2828E+04   0.0   0.0

   37    39    39    39    39    37    38    38    39    39

   REMOVED E= 1.00000E+03 FOR MF= 4 MT=  2

                                                                  17.896S
*****************************************************************************
```

APPENDIX C

Three MCNP Runs for Testing KIDMAN

```
MCNP     VERSION 3B5   LD=05/24/89        9406CP20N1  6 09/07/89 14:26:25                                    PROBID = 6 09/07/89 14:26:25
*************************************************************************
INP=DON

                 SERIES C RUN GAMMA-PRIME
          C     CELL CARDS FOR SPHERE CENTERED AT THE ORIGIN.
               1 1 1 -1
               2 0 #1

          C     SURFACE CARDS
               1 SO  .5

           MODE N
          IMP:N 1 0
          SDEF ERG=20.0 POS=0 0 0 WGT=1 CEL=1
          FC1:N   CURRENT ACROSS THE SURFACE OF THE U-235 SPHERE.
             F1:N 1
            F21:N 1
           FM21:N (1.0 2 (102))
            F41:N 1
           FM41:N (1.0 3 (2)(91))
            F61:N 1
           FM61:N (1.0 4 (53)(54)(55)(56)(57)(58))
            F81:N 1
           FM81:N (1.0 5 (2) (2 102))
           F101:N 1
          FM101:N (1.0 6 (61)(62)(63)(64)(65)(66))
           F121:N 1
          FM121:N (1.0 2 (53:54))
          FC2:N   FLUX ACROSS THE SURFACE OF THE U-235 SPHERE.
             F2:N 1
            F22:N 1
           FM22:N (1.0 2 (61)(62)(63)) (1.0 2 (54:55))
             FQ E M
             E0:N 1.0E-11 .025 .2 .235 .55 .7 1.0 2.0 8I 20.0
             M1 40093.50 0.01 42095.50 0.40 60143.50 0.39 63155.50 0.20
             M2 43099.50 0.50 44101.50 0.25 44103.50 0.25
WARNING.  MATERIAL   2 IS USED ONLY FOR TALLYING.
             M3 45105.50 1.0
WARNING.  MATERIAL   3 IS USED ONLY FOR TALLYING.
             M4 46105.50 1.0
WARNING.  MATERIAL   4 IS USED ONLY FOR TALLYING.
             M5 46108.50 1.0
WARNING.  MATERIAL   5 IS USED ONLY FOR TALLYING.
             M6 44101.50 1.0
WARNING.  MATERIAL   6 IS USED ONLY FOR TALLYING.
           CUT:N 1.0E123 0.01
          PRINT
            NPS 7000
```

```
MCNP      VERSION 3B5   LD=05/24/89        9406CP20N1  6 09/08/89 13:28:03
*****************************************************************************
INP=DON1                                                                    PROBID = 6 09/08/89 13:28:03

                 SERIES C RUN GAMMA-PRIME
          C     CELL CARDS FOR SPHERE CENTERED AT THE ORIGIN.
               1 1 1 -1
               2 0 #1

          C     SURFACE CARDS
               1 SO  .5

           MODE N
          IMP:N 1 0
          SDEF ERG=20.0 POS=0 0 0 WGT=1 CEL=1
          FC1:N   CURRENT ACROSS THE SURFACE OF THE U-235 SPHERE.
             F1:N 1
            F21:N 1
           FM21:N (1.0 2 (102))
            F41:N 1
           FM41:N (1.0 3 (2)(91))
            F61:N 1
           FM61:N (1.0 4 (53)(54)(55)(56)(57)(58))
            F81:N 1
           FM81:N (1.0 5 (2) (2 102))
           F101:N 1
          FM101:N (1.0 6 (61)(62)(63)(64)(65)(66))
           F121:N 1
          FM121:N (1.0 2 (53:54))
          FC2:N   FLUX ACROSS THE SURFACE OF THE U-235 SPHERE.
             F2:N 1
            F22:N 1
           FM22:N (1.0 7 (61)(62)(63)) (1.0 7 (54:55))
             FQ E M
             E0:N 1.0E-11 .025 .2 .235 .55 .7 1.0 2.0 8I 20.0
             M1 53135.50 0.01 54131.50 0.40 59141.50 0.39 54135.50 0.20
             M2 43099.50 0.50 44101.50 0.25 44103.50 0.25
WARNING.  MATERIAL   2 IS USED ONLY FOR TALLYING.
             M3 45105.50 1.0
WARNING.  MATERIAL   3 IS USED ONLY FOR TALLYING.
             M4 46105.50 1.0
WARNING.  MATERIAL   4 IS USED ONLY FOR TALLYING.
             M5 61149.50 1.0
WARNING.  MATERIAL   5 IS USED ONLY FOR TALLYING.
             M6 44101.50 1.0
WARNING.  MATERIAL   6 IS USED ONLY FOR TALLYING.
             M7 63155.50  1.0
WARNING.  MATERIAL   7 IS USED ONLY FOR TALLYING.
          CUT:N 1.0E123 0.01
         PRINT
           NPS 7000
```

```
MCNP     VERSION 3B5   LD=05/24/89        9406CP20N1  6 09/08/89 13:37:00
*****************************************************************************                    PROBID - 6 09/08/89 13:37:00
INP=DON2

  1-              SERIES C RUN GAMMA-PRIME
  2-        C    CELL CARDS FOR SPHERE CENTERED AT THE ORIGIN.
  3-            1 1 1 -1
  4-            2 0 #1
  5-
  6-        C    SURFACE CARDS
  7-            1 SO  .5
  8-
  9-         MODE N
 10-        IMP:N 1 0
 11-        SDEF ERG=20.0 POS=0 0 0 WGT=1 CEL=1
 12-        FC1:N   CURRENT ACROSS THE SURFACE OF THE U-235 SPHERE.
 13-           F1:N 1
 14-          F21:N 1
 15-         FM21:N (1.0 2 (102))
 16-          F41:N 1
 17-         FM41:N (1.0 3 (2)(91))
 18-          F61:N 1
 19-         FM61:N (1.0 4 (53)(54)(55)(56)(57)(58))
 20-          F81:N 1
 21-         FM81:N (1.0 5 (2) (2 102))
 22-         F101:N 1
 23-        FM101:N (1.0 6 (61)(62)(63)(64)(65)(66))
 24-         F121:N 1
 25-        FM121:N (1.0 2 (53:54))
 26-        FC2:N   FLUX ACROSS THE SURFACE OF THE U-235 SPHERE.
 27-           F2:N 1
 28-          F22:N 1
 29-         FM22:N (1.0 2 (61)(62)(63)) (1.0 2 (54:55))
 30-           FQ E M
 31-           E0:N 1.0E-11 .025 .2 .235 .55 .7 1.0 2.0 8I 20.0
 32-           M1 62147.50 0.20 62151.50 0.20 62150.50 .2 62152.5 .2 63155.5 .2
 33-           M2 60143.5 .25 60145.5 .25 61148.5 .25 61149.5 .25
WARNING.  MATERIAL   2 IS USED ONLY FOR TALLYING.
 34-           M3 60147.50 1.0
WARNING.  MATERIAL   3 IS USED ONLY FOR TALLYING.
 35-           M4 60148.50 1.0
WARNING.  MATERIAL   4 IS USED ONLY FOR TALLYING.
 36-           M5 61149.50 1.0
WARNING.  MATERIAL   5 IS USED ONLY FOR TALLYING.
 37-           M6 59141.50 1.0
WARNING.  MATERIAL   6 IS USED ONLY FOR TALLYING.
 38-          CUT:N 1.0E123 0.01
 39-         PRINT
 40-           NPS 7000
 41-
```