SCIENTIFIC NOTEBOOK

170-10E

Scientific Notebook 170-10e
James Weldy
8/12/99
20-1402-761

Differential Analysis on TPA 3.2 for inclusion in the Sensitivity Studies Report

Goal: Perform a differential analysis on all sampled parameters in the TPA 3.2 Code. The analysis will include both base case parameters and disruptive event parameters and will start from seven different sets of baseline values. Since there is no compelling reason to bias the sampling of the baseline parameter set, these will be randomly sampled using LHS. Ideally, more sets of baseline values should be sampled in order to take an average sensitivity over all of parameter space, but time constraints do not make this feasible.

Background: Differential analysis is a technique that involves perturbing a single parameter in a code slightly while leaving all other sampled parameter constant to determine the impact on peak dose from that change in parameter. Sensitive parameters are those that have the largest relative impact on the peak dose, but can be defined as being based on their sampling range or not.

Two values will be calculated in this analysis,

$\frac{dD}{dx} \bullet \frac{\bar{x}}{\bar{D}}$, where D represents dose and x represents the parameter value. This calculates the absolute impact of the parameter on dose and doesn't take into account the sampling range of the parameter.

$\frac{dD}{dx} \bullet \sigma_x$, where σ_x represents the standard deviation in parameter x. This calculates the impact that the parameter has on the uncertainty in the results of the code calculation. This is the value that the results will be sorted by.

Procedure: (Note that all files listed here and all results are located in the following directory)

/home/jweldy/tpa32/sensanalTPA32

1. Set up a folder to run TPA Version 3.2 (call it tpa32)
2. Make two folders to hold the runs - one called base<something descriptive> to hold the output from the base values run and one called diff<something descriptive> to hold the differential output
3. Run a one realization, 7 subarea run of the code using tpa.inp.master as the input data with LHS sampling on and all disruptive events on. This is to create the samplpar.res file using LHS sampling which selects the baseline values for the differential analysis. If necessary, change the value of the seed in the tpa.inp file

Scientific Notebook 170-10e
James Weldy
8/12/99
20-1402-761

4. Run quantinp.f and select option 8 to use the values from an input file. This will create 2 important files. The first is tpa.inp.gen, which is a tpa.inp file consisting of all constant values from the samplpar.resfile. The second is vars.min.max.gen, which will be used later during the running of the awk script files.
5. Open vars.min.max.gen and delete any variable names that you do not wish to perform a differential analysis. Possible reasons for this include not testing disruptive events, removing variables that relate to a critical group distance that you are not interested in, etc. Add any variables that are constants in the input file that you are interested in testing in the appropriate format. Note the number of lines in the file when you are done as this is equal to the number of parameters that are being tested.
6. Modify tpa.inp.gen as appropriate for the analysis (time period of interest, disruptive events on/off, one realization, etc)and save as tpa.inp.<something descriptive> and tpa.inp
7. Run the TPA code using this input file.
8. Save all .res, .tpa, and .out files along with tpa.inp in the base folder
9. Modify the run.tpa.sh file if necessary to put the appropriate perturbationin each of the parameter value and the appropriate command to run the TPA code
10. Save vars.min.max.gen as vars.<something descriptive>
11. Type "run.tpa.sh tpa.inp.<something descriptive> diff<something descriptive> <number of parameters> vars.<something descriptive>" to start the TPA code running. That is "run.tpa.sh <input file> <output folder> <#> <vars file>."An example would be "run.tpa.sh tpa.inp.r1.10k diff10kr1 223 vars.r1". If you have a lot of parameters, this will take quite a while to run.
12. Once the script is finished, copy the following files to your diff folder:getsenssig.f, data.proc.sh, vars.<something descriptive>, tpa.inp.<something desc>, and stdevc22.out
13. Change directories to your diff folder.
14. Open your vars file. Replace all occurrences of / with another character (-). The slashwill cause errors in processing.
15. Open data.proc.sh. Change line 66 which should read MEAN_pkdos = <#> to MEAN_pkdos = <the dose calculated in your baseline run>.
16. Open getsenssig.f. Change the values for title, nparams, and meandose to the titleof the run, the number of parameters, and the dose calculated in yourbaseline run, respectively.
17. Type "data.proc.sh tpa.inp.<something descriptive> <# of parameters> vars.<something desc>Example: data.proc.sh tpa.inp.r1.10k 223 vars.r1
18. Compile and run getsenssig.f.
19. Congratulations, you are finished. Your output files are sens.out for the scaled sensitivitycoefficients, sens.sort, for sorted output of the same, sens.sigma, for the dD/dx * sigma,and sigma.sort, for sorted output of the same.

The procedure was confirmed to be working correctly by performing hand calculations of selected parameters within the results.

Scientific Notebook 170-10e
James Weldy
8/12/99
20-1402-761

For example, the sensitivity coefficient for ArealAverageMeanAnnualInfiltration@Start for run1, 10 kyr, no disruptive events is calculated by the following:

Base Dose: 3.8512e-6 rem/yr Base Parameter Value: 9.4474 mm/yr
Perturbed Dose: 3.9454e-6 rem/yr Perturbed Parameter Value: 9.54187 mm/yr
Standard Deviation of Parameter Value: 2.7181 mm/yr

Therefore, the scaled sensitivity coefficient for this value is:

$$\frac{3.9454 \cdot 10^{-6} - 3.8512 \cdot 10^{-6}}{9.54187 - 9.4474} \cdot \frac{9.4474}{3.8512 \cdot 10^{-6}} = 2.446$$

and the sigma-weighted sensitivity coefficient for this value is:

$$\frac{3.9454 \cdot 10^{-6} - 3.8512 \cdot 10^{-6}}{9.54187 - 9.4474} \cdot 2.7181 = 2.71 \cdot 10^{-6}$$

These calculated values are the same as are output from the differential analysis runs. This confirms that the codes being used to calculate the sensitivity coefficients in the differential analysis are performing correctly. Note that a number of parameters were checked for several iterations of the differential analysis to be sure that it was working correctly.

The results for each set of baseline values were averaged in the files called TableE1-E2.xls, TableE3-E4.xls, and TableE5.xls located in the directory

D:\personal\excel files\sensanal99

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Generation of an Improved Estimate of the Inventory of Radionuclides in the Repository

Goal: Generate an average inventory of radionuclides in all the waste packages based on actual burnup and enrichment values for the best estimate of spent fuel that will be disposed of in the repository.

1/20/00

Software used: Origen 2.1 Isotope Generation and Depletion Code
Microsoft Excel

Procedure: Input files were created for the Origen 2.1 program for PWR fuel with enrichments ranging from 1% to 5.5% U-235 and burnups ranging from 5 GWd/MTU to 70 GWd/MTU and for BWR fuel with enrichments ranging from 0.5% to 5.5% U-235 and burnups ranging from 5 GWd/MTU to 55 GWd/MTU. A sample input file is attached at the end of this notebook entry as attachment 1. All the input files generated are located at /home/jweldy/origen2/runs2/. All of the input files were run and the results were transferred to excel spreadsheets, bwrtotals.xls and pwrtotals.xls. The output files are located at /home/jweldy/origen2/runs2/. The input files were based on the sample input file provided with the Origen 2.1 code, which also provided output files for that run. This input file was for fuel enriched to 2.75% with a burnup of 27.5 GWd/MTU and was run to ensure that the output file generated matched the output file provided. The results matched precisely, so confidence was gained that the input file was correct and the code was functioning properly. In addition to the data sets that were directly generated, additional data points at 3.5% enrichment and burnup values of 35 and 45 GWd/MTU were generated using linear interpolation between the nearest data points. This is reasonable because the steps between data points are relatively small and therefore any error introduced due to the interpolation will be small.

After the radioactivity for the 43 chosen radionuclides were calculated, each value had to be weighted according to the abundance based on burnup and enrichment that is estimated to be present in the spent fuel that will be disposed of in the Yucca Mountain repository. This was done using data from "Characteristics of Potential Repository Waste" (Notz, et al., 1990) Figures 4.5 and 4.6 and Tables 4.22a and 4.22b. These abundance values were multiplied by the inventory for each radionuclide for each burnup and enrichment data point. All the results for each weighted burnup and enrichment data point were summed in order to get the average

inventory for each radionuclide for all the PWR and BWR fuel that will be disposed of in the repository. Finally, the PWR and BWR fuel inventories were combined by weighing the PWR results by 65% and the BWR results by 35%, because these are the relative fractions that PWR and BWR fuel will make up the total repository inventory (CRWMS, 1997 - Characteristics of Fuel that will be Stored at the Yucca Mountain Repository).

Results: The results of the calculations show an increase in the inventory for almost all radionuclides. For the fission products, this is primarily due to the increase in median burnup of the latest estimate of fuels destined for the repository. This causes about a 20%-30% increase in inventory for all fission products. For the actinides, this increase is due to the increased burnup effect and the averaging of inventories across all potential burnups and enrichments instead of just utilizing a median enrichment and burnup to calculate the inventory.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

isotopes	bwr	pwr	Total (ci/MTU)	Current Inventory in TPA Code	Ratio of new value to old
Ac 227	6.67E-06	8.666E-06	7.967E-06	5.19E-06	1.54E+00
Am 241	1.72E+03	2.294E+03	2.092E+03	1.64E+03	1.28E+00
Am 242m	1.08E+01	1.246E+01	1.189E+01	7.49E+00	1.59E+00
Am 243	2.08E+01	3.334E+01	2.894E+01	1.54E+01	1.88E+00
Cm 243	2.01E+01	3.528E+01	2.995E+01	1.53E+01	1.96E+00
Cm 244	1.97E+03	3.851E+03	3.191E+03	1.15E+03	2.78E+00
Cm 245	2.52E-01	5.891E-01	4.713E-01	1.25E-01	3.77E+00
Cm 246	7.56E-02	2.307E-01	1.764E-01	2.56E-02	6.89E+00
Np 237	3.12E-01	4.460E-01	3.992E-01	2.87E-01	1.39E+00
Pa 231	2.35E-05	3.085E-05	2.828E-05	1.95E-05	1.45E+00
Pb 210	5.61E-08	6.955E-08	6.485E-08	4.72E-08	1.37E+00
Pu 238	2.66E+03	4.212E+03	3.670E+03	2.11E+03	1.74E+00
Pu 239	2.99E+02	3.557E+02	3.357E+02	3.08E+02	1.09E+00
Pu 240	4.96E+02	5.605E+02	5.380E+02	5.08E+02	1.06E+00
Pu 241	7.44E+04	1.025E+05	9.264E+04	7.44E+04	1.25E+00
Pu 242	1.82E+00	2.673E+00	2.373E+00	1.60E+00	1.48E+00
Ra 226	3.93E-07	4.807E-07	4.501E-07	3.67E-07	1.23E+00
Th 229	2.56E-07	4.693E-07	3.947E-07	1.39E-07	2.84E+00
Th 230	1.25E-04	1.601E-04	1.479E-04	1.69E-04	8.75E-01
U 232	2.59E-02	5.722E-02	4.627E-02	2.48E-02	1.87E+00
U 233	2.32E-05	3.721E-05	3.232E-05	2.40E-05	1.35E+00
U 234	1.02E+00	1.369E+00	1.247E+00	1.13E+00	1.10E+00
U 235	1.70E-02	1.824E-02	1.782E-02	1.69E-02	1.05E+00
U 236	2.48E-01	3.217E-01	2.959E-01	2.40E-01	1.23E+00
U 238	3.18E-01	3.129E-01	3.147E-01	3.19E-01	9.86E-01
Ag 108m	1.26E-02	1.407E-02	1.356E-02	1.20E-02	1.13E+00
C 14	1.74E+00	1.693E+00	1.710E+00	1.33E+00	1.29E+00
Cl 36	1.23E-02	1.296E-02	1.274E-02	1.17E-02	1.09E+00
Cs 135	4.48E-01	5.308E-01	5.019E-01	3.51E-01	1.43E+00
Cs 137	7.91E+04	1.054E+05	9.620E+04	7.64E+04	1.26E+00
I 129	3.07E-02	4.087E-02	3.732E-02	2.95E-02	1.26E+00
Mo 93	6.74E-04	3.193E-02	2.099E-02	1.01E-02	2.08E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Attachment 1. Sample Input File for Origen 2.1

```
-1
-1
-1
RDA *  BURNUP OF BWR 4.5% UO2 FUEL & ASSY HDWARE, 45,000 MWD/MT
RDA    ** CROSS SECTION LIBRARY = BWRU, 4 CYCLE
RDA    *** SCOTT B. LUDWIG, OAK RIDGE NATIONAL LABORATORY
RDA    **** (615) 574-7916, FTS 624-7916
RDA    -1 = FRESH BWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
RDA    -2 = FRESH ZIRCALOY-4 COMPOSITION (1 KG)
RDA    -3 = FRESH ZIRCALOY-2 COMPOSITION (1 KG)
RDA    -4 = FRESH SS 304 COMPOSITION (1 KG)
RDA    -5 = FRESH SS 302 COMPOSITION (1 KG)
RDA    -6 = FRESH INCONEL X-750 COMPOSITION (1 KG)
RDA    WARNING:  VECTORS ARE CHANGED WITH RESPECT TO CONTENT.
RDA            THESE CHANGES WILL BE NOTED ON RDA CARDS.
CUT    5 1.0E-10 7 1.0E-14 9 1.0E-10 -1
LIP    0 0 0
RDA      DECAY LIB    XSECT LIB                VAR. XSECT
LIB    0   1 2 3    251 252 253   9   50   0   1      4
RDA     PHOTON LIB
PHO    101 102 103  10
TIT  INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL MAT'LS
RDA    READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
INP    -1  1  -1  -1  1  1
RDA    READ ZIRCALOY-4 COMPOSITION (1.0 KG)
INP    -2  1  -1  -1  1  1
RDA    READ ZIRCALOY-2 COMPOSITION (1.0 KG)
INP    -3  1  -1  -1  1  1
RDA    READ SS304 COMPOSITION (1.0 KG)
INP    -4  1  -1  -1  1  1
RDA    READ SS302 COMPOSITION (1.0 KG)
INP    -5  1  -1  -1  1  1
RDA    READ INCONEL X-750 COMPOSITION (1.0 KG)
INP    -6  1  -1  -1  1  1
TIT    IRRADIATION OF ONE METRIC TON OF BWRU FUEL
MOV    -1  1  0  1.0
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
PCH     1  1  1
HED     1                                   CHARGE
BUP
IRP    265.45   25.90   1   2   4  2   BURNUP= 6,875 MWD/MTIHM
DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
IRP    636.90   25.90   3   4   4  0   BURNUP=13,750 MWD/MTIHM
DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
IRP   1008.35   25.90   5   6   4  0   BURNUP=20,625 MWD/MTIHM
DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
IRP   1379.80   25.90   7   8   4  0   BURNUP=27,500 MWD/MTIHM
DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
IRP   1751.25   25.90   9  10   4  0   BURNUP=34,375 MWD/MTIHM
DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
IRP   2122.70   25.90  11  12   4  0   BURNUP=41,250 MWD/MTIHM
DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
IRP   2373.49   25.90  13  14   4  0   BURNUP=45,000 MWD/MTIHM
BUP
RDA    -10 = IRRADIATED U FUEL AT DISCHARGE
MOV     14  -10    0    1.0
PCH    -10  -10  -10
RDA     IRRADIATION OF ZIRCALOY-2 CLADDING AT 1.000 FLUX
TIT     IRRADIATION OF ZIRCALOY-2 CLADDING AT 1.000 FLUX
MOV     -3    1    0  279.50      ZIRCALOY-2 CLAD
HED     1                                   CHARGE
IRF    265.45   -1.0   1   2   4  2   BURNUP= 6,875 MWD/MTIHM
DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
IRF    636.90   -1.0   3   4   4  0   BURNUP=13,750 MWD/MTIHM
DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
IRF   1008.35   -1.0   5   6   4  0   BURNUP=20,625 MWD/MTIHM
DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
IRF   1379.80   -1.0   7   8   4  0   BURNUP=27,500 MWD/MTIHM
DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
IRF   1751.25   -1.0   9  10   4  0   BURNUP=34,375 MWD/MTIHM
DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
IRF   2122.70   -1.0  11  12   4  0   BURNUP=41,250 MWD/MTIHM
DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
IRF   2373.49   -1.0  13  14   4  0   BURNUP=45,000 MWD/MTIHM
RDA     -9 = IRRADIATED ZIRCALOY-2 CLADDING AT DISCHARGE
MOV     14    -9     0     1.0
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
RDA     IRRADIATION OF ZIRCALOY CLADDING AT 0.500 FLUX
TIT     IRRADIATION OF ZIRCALOY CLADDING AT 0.500 FLUX
MOV     -3     1     0    25.4    ZIRCALOY-2 CLAD
MOV     -3     2     0   304.90   TOTAL ZIRC-2 CLAD
PCH     2     2     2
HED     1                                CHARGE
IRF    265.45   -0.5   1   2   4  2   BURNUP= 6,875 MWD/MTIHM
DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
IRF    636.90   -0.5   3   4   4  0   BURNUP=13,750 MWD/MTIHM
DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
IRF   1008.35   -0.5   5   6   4  0   BURNUP=20,625 MWD/MTIHM
DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
IRF   1379.80   -0.5   7   8   4  0   BURNUP=27,500 MWD/MTIHM
DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
IRF   1751.25   -0.5   9  10   4  0   BURNUP=34,375 MWD/MTIHM
DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
IRF   2122.70   -0.5  11  12   4  0   BURNUP=41,250 MWD/MTIHM
DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
IRF   2373.49   -0.5  13  14   4  0   BURNUP=45,000 MWD/MTIHM
RDA     -9 = IRRADIATED ZIRCALOY CLADDING AT DISCHARGE
ADD     14     -9     0     1.0    TOTAL IRRAD ZIRC-2 CLAD
PCH     -9     -9     -9
RDA     IRRADIATION OF ZIRCALOY-4 CHANNEL AT 1.000 FLUX
TIT     IRRADIATION OF ZIRCALOY-4 CHANNEL AT 1.000 FLUX
MOV     -2     1     0   227.50    ZIRCALOY-4 CHANNEL
HED     1                                CHARGE
IRF    265.45   -1.0   1   2   4  2   BURNUP= 6,875 MWD/MTIHM
DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
IRF    636.90   -1.0   3   4   4  0   BURNUP=13,750 MWD/MTIHM
DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
IRF   1008.35   -1.0   5   6   4  0   BURNUP=20,625 MWD/MTIHM
DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
IRF   1379.80   -1.0   7   8   4  0   BURNUP=27,500 MWD/MTIHM
DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
IRF   1751.25   -1.0   9  10   4  0   BURNUP=34,375 MWD/MTIHM
DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
IRF   2122.70   -1.0  11  12   4  0   BURNUP=41,250 MWD/MTIHM
DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
IRF   2373.49   -1.0  13  14   4  0   BURNUP=45,000 MWD/MTIHM
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
RDA     -8 = IRRADIATED ZIRCALOY CHANNEL AT DISCHARGE
MOV     14    -8    0    1.0
RDA     IRRADIATION OF ZIRCALOY-4 CHANNEL AT 0.500 FLUX
TIT     IRRADIATION OF ZIRCALOY-4 CHANNEL AT 0.500 FLUX
MOV     -2     1   0    20.70    ZIRCALOY-4 CHANNEL
MOV     -2     2   0   248.20    TOTAL ZIRCALOY-4 CHANNEL
PCH     2     2   2
HED     1                                CHARGE
IRF    265.45   -0.5   1   2   4  2   BURNUP= 6,875 MWD/MTIHM
DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
IRF    636.90   -0.5   3   4   4  0   BURNUP=13,750 MWD/MTIHM
DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
IRF   1008.35   -0.5   5   6   4  0   BURNUP=20,625 MWD/MTIHM
DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
IRF   1379.80   -0.5   7   8   4  0   BURNUP=27,500 MWD/MTIHM
DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
IRF   1751.25   -0.5   9  10   4  0   BURNUP=34,375 MWD/MTIHM
DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
IRF   2122.70   -0.5  11  12   4  0   BURNUP=41,250 MWD/MTIHM
DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
IRF   2373.49   -0.5  13  14   4  0   BURNUP=45,000 MWD/MTIHM
RDA     -8 = IRRADIATED ZIRCALOY CHANNEL AT DISCHARGE
ADD     14    -8    0    1.0
PCH     -8    -8    -8
RDA     IRRADIATION OF ZIRCALOY GRID SPACERS AND INCONEL SPRINGS
TIT     IRRADIATION OF ZIRCALOY GRID SPACERS AND INCONEL SPRINGS
MOV     -2     1    0    10.60    ZIRCALOY GRIDS
ADD     -6     1    0     1.80    INCONEL SPRINGS
PCH     1     1     1
HED     1                                CHARGE
IRF    265.45   -1.0   1   2   4  2   BURNUP= 6,875 MWD/MTIHM
DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
IRF    636.90   -1.0   3   4   4  0   BURNUP=13,750 MWD/MTIHM
DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
IRF   1008.35   -1.0   5   6   4  0   BURNUP=20,625 MWD/MTIHM
DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
IRF   1379.80   -1.0   7   8   4  0   BURNUP=27,500 MWD/MTIHM
DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
IRF   1751.25   -1.0   9  10   4  0   BURNUP=34,375 MWD/MTIHM
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
DEC   1857.25       10  11   4  0   DECAY FOR 106.0 DAYS
IRF   2122.70  -1.0  11  12   4  0   BURNUP=41,250 MWD/MTIHM
DEC   2228.70       12  13   4  0   DECAY FOR 106.0 DAYS
IRF   2373.49  -1.0  13  14   4  0   BURNUP=45,000 MWD/MTIHM
RDA   -7 = IRRADIATED ZIRCALOY GRID SPACERS AND INCONEL SPRINGS
RDA        AT DISCHARGE
MOV    14    -7    0    1.0
PCH    -7    -7    -7
RDA IRRAD. OF SS 304 END PIECES & INCONEL SPRINGS AT 0.130 FLUX
TIT IRRAD. OF SS 304 END PIECES & INCONEL SPRINGS AT 0.130 FLUX
MOV    -4    1    0   37.00     SS 304 IN END PIECES
ADD -6    1    0    2.10     INCONEL X-750 EXPANSION SPRINGS
PCH    1    1    1
HED    1                              CHARGE
IRF   265.45  -0.13  1  2  4  2  BURNUP= 6,875 MWD/MTIHM
DEC   371.45        2  3  4  0   DECAY FOR 106.0 DAYS
IRF   636.90  -0.13  3  4  4  0  BURNUP=13,750 MWD/MTIHM
DEC   742.90        4  5  4  0   DECAY FOR 106.0 DAYS
IRF  1008.35  -0.13  5  6  4  0  BURNUP=20,625 MWD/MTIHM
DEC  1114.35        6  7  4  0   DECAY FOR 106.0 DAYS
IRF  1379.80  -0.13  7  8  4  0  BURNUP=27,500 MWD/MTIHM
DEC  1485.80        8  9  4  0   DECAY FOR 106.0 DAYS
IRF  1751.25  -0.13  9 10  4  0  BURNUP=34,375 MWD/MTIHM
DEC  1857.25       10 11  4  0   DECAY FOR 106.0 DAYS
IRF  2122.70  -0.13 11 12  4  0  BURNUP=41,250 MWD/MTIHM
DEC  2228.70       12 13  4  0   DECAY FOR 106.0 DAYS
IRF  2373.49  -0.13 13 14  4  0  BURNUP=45,000 MWD/MTIHM
RDA -6 = IRRAD. SS 304 END PIECES & INCONEL SPRINGS AT DISCHARGE
MOV    14   -6   0   1.0
PCH    -6   -6   -6
RDA    IRRADIATION OF SS 302 IN PLENUM SPRINGS AT 0.500 FLUX
TIT    IRRADIATION OF SS 302 IN PLENUM SPRINGS AT 0.500 FLUX
MOV    -5    1    0    6.00     SS302
PCH    1    1    1
HED    1                              CHARGE
IRF   265.45  -0.5  1  2  4  2  BURNUP= 6,875 MWD/MTIHM
DEC   371.45        2  3  4  0   DECAY FOR 106.0 DAYS
IRF   636.90  -0.5  3  4  4  0  BURNUP=13,750 MWD/MTIHM
DEC   742.90        4  5  4  0   DECAY FOR 106.0 DAYS
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 IRF   1008.35  -0.5  5  6  4 0  BURNUP=20,625 MWD/MTIHM
 DEC   1114.35       6  7  4 0   DECAY FOR 106.0 DAYS
 IRF   1379.80  -0.5  7  8  4 0  BURNUP=27,500 MWD/MTIHM
 DEC   1485.80       8  9  4 0   DECAY FOR 106.0 DAYS
 IRF   1751.25  -0.5  9 10  4 0  BURNUP=34,375 MWD/MTIHM
 DEC   1857.25      10 11  4 0   DECAY FOR 106.0 DAYS
 IRF   2122.70  -0.5 11 12  4 0  BURNUP=41,250 MWD/MTIHM
 DEC   2228.70      12 13  4 0   DECAY FOR 106.0 DAYS
 IRF   2373.49  -0.5 13 14  4 0  BURNUP=45,000 MWD/MTIHM
 RDA    -5 = IRRADIATED SS 302 IN PLENUM SPRINGS AT DISCHARGE
 MOV    14   -5  0  1.0
 PCH    -5   -5  -5
 RDA    ***** OUTPUT MODULE *****
 TIT TEST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
 BAS 1 MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE
 OPTL     6*8  7  8  8  8  14*8
 OPTA     6*8  7  8  8  8  14*8
 OPTF     6*8  7  8  8  8  14*8
 MOV    -10   1   0  1.0
 ADD     -9   1   0  1.0
 ADD     -8   1   0  1.0
 ADD     -7   1   0  1.0
 ADD     -6   1   0  1.0
 ADD     -5   1   0  1.0
 HED    1   ASSY DIS
 RDA    ***** DECAY MODULE *****
 DEC    0.5  1  2  5  2
 DEC    1.0  2  3  5  0
 DEC    2.0  3  4  5  0
 DEC    5.0  4  5  5  0
 DEC   10.0  5  6  5  0
 DEC   26.0  6  7  5  0
 OUT     7   1   -1   0
 END
2 922340 247.0 922350 45000. 922380  954753.   0  0.0  FUEL 4.5%
4 030000  1.0   050000 1.0   060000 89.4 070000   25.0 FUEL IMPU
4 080000 134454. 090000 10.7   110000 15.0 120000   2.0 FUEL IMPU
4 130000  16.7   140000 12.1   150000 35.0 170000   5.3 FUEL IMPU
4 200000  2.0   220000 1.0   230000 3.0  240000   4.0 FUEL IMPU
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
4 250000 1.7 260000 18.0 270000 1.0 280000 24.0 FUEL IMPU
4 290000 1.0 300000 40.3 420000 10.0 470000 0.1 FUEL IMPU
4 480000 25.0 490000 2.0 500000 4.0 640000 1573. FUEL IMPU
4 740000 2.0 820000 1.0 830000 0.4 0 0.0 FUEL IMPU
0
4 400000 979.11 500000 16.0 260000 2.25 240000 1.25 ZIRC-4
4 280000 0.02 130000 0.024 050000 0.00033 480000 0.00025 ZIRC-4
4 060000 0.120 270000 0.010 290000 0.020 720000 0.078 ZIRC-4
4 010000 0.013 250000 0.020 070000 0.080 080000 0.950 ZIRC-4
4 160000 0.035 220000 0.020 740000 0.020 230000 0.020 ZIRC-4
5 920000 0.0002 0 0.0 ZIRC-4
0
4 400000 979.63 500000 16.0 260000 1.5 240000 1.00 ZIRC-2
4 280000 0.5 130000 0.024 050000 0.00033 480000 0.00025 ZIRC-2
4 060000 0.120 270000 0.010 290000 0.020 720000 0.078 ZIRC-2
4 010000 0.013 250000 0.020 070000 0.080 080000 0.950 ZIRC-2
4 160000 0.035 220000 0.020 740000 0.020 230000 0.020 ZIRC-2
5 920000 0.0002 0 0.0 ZIRC-2
0
4 260000 688.44 240000 190.0 280000 89.2 250000 20.0 SS-304
4 060000 0.8 150000 0.45 160000 0.3 140000 10.0 SS-304
4 070000 1.3 270000 0.8 0 0.0 SS-304
0
4 260000 697.74 240000 180.0 280000 89.2 250000 20.0 SS-302
4 060000 1.5 150000 0.45 160000 0.3 140000 10.0 SS-302
4 070000 1.3 270000 0.8 0 0.0 SS-302
0
4 260000 67.846 240000 149.66 280000 721.861 130000 7.982 INC-X-750
4 060000 0.399 270000 6.485 290000 0.499 250000 6.984 INC-X-750
4 070000 1.3 410000 8.98 160000 0.07 140000 2.993 INC-X-750
4 220000 24.943 0 0.0 INC-X-750
0

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Attachment 2. Sample Output File from Origen 2.1

```
1
        ********************************************************
        *                                                      *
        * OOOOO RRRR  IIII  GGGGG  EEEEE N   N  22222  *
        * O   O R   R   I   G      E     NN  N 22   22 *
        * O   O RRRR    I   G   GG EEEE  N NN N     22  *
        * O   O R   R   I   G   G E     N  NN  22     *
        * OOOOO R   R IIII  GGGGGG EEEEE N   N 2222222 *
        *                                                      *
        *          Version 2.1 (8-1-91)                        *
        *                                                      *
        *                                                      *
        *          OOOOO   AA   K  K                           *
        *          O   O  A A  K K                             *
        *          O   O  AAAA  KKK                            *
        *          O   O  A A  K K                             *
        *          OOOOO  A A  K  K                            *
        *                                                      *
        *     RRRR  III  DDDDD   GGGGG   EEEEE                 *
        *     R   R  I   D   D  G      E                       *
        *     RRRR   I   D   D  G   GG  EEEE                   *
        *     R   R  I   D   D  G   G  E                       *
        *     R   R III  DDDDD   GGGGGG  EEEEE                 *
        *                                                      *
        * N   N  AA  TTTTT  III OOOOO N   N  AA  L    *
        * NN  N A A   T    I  O   O NN  N A A L    *
        * N NN N AAAA   T    I  O   O N NN N AAAA L    *
        * N  NN A A   T    I  O   O N  NN A A L    *
        * N   N A A   T   III OOOOO N   N A A LLLLL *
        *                                                      *
        *L   AA  BBBB  OOOO RRRR   AA  TTTTT OOOO RRRR  Y   Y *
        *L  A A B   B O   O R   R A A   T   O   O R   R Y Y *
        *L  AAAA BBBB  O   O RRRR  AAAA   T   O   O RRRR   Y  *
        *L  A A B   B O   O R   R A A   T   O   O R   R  Y  *
        *LLLL A  A BBBB  OOOO R   R A A   T   OOOO R   R  Y  *
        *                                                      *
        *       RSIC CODE PACKAGE NUMBER (CCC-371)             *
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
*                                                    *
*   ORIGEN2 VERSION 2.1 (8-1-91) UPDATES THE FOLLOWING:  *
*                                                    *
*       CCC-371(A) - MAINFRAMES                      *
*       CCC-371(E) - IBM PC (80386 W/80387 OR 80486)  *
*                                                    *
*    ORIGEN2 RUN  DATE: Aug 20 1999 TIME 10:07:12      *
*                                                    *
*                                                    *
*******************************************************
```

1 OUTPUT UNIT = 6 PAGE 1
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
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****
********** ORIGEN2: A REVISED AND UPDATED VERSION OF THE ORIGEN COMPUTER CODE **********

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INTRODUCTION

THIS TEXT IS INTENDED TO BE A BRIEF OUTLINE OF THE ORIGEN2 COMPUTER CODE, WHICH IS A REVISED AND UPDATED VERSION OF THE ORIGEN DOCUMENTED IN REPORT ORNL-4628 (MAY 1973). INCLUDED HERE ARE A BRIEF DESCRIPTION OF THE FUNCTIONS OF ORIGEN2, A LISTING OF THE MAJOR DATA SOURCES, A LISTING OF THE PUBLISHED DOCUMENTATION CONCERNING ORIGEN2, AND AN OUTLINE OF THE ORIGEN2 OUTPUT ORGANIZATION. ORIGEN2 IS AVAILABLE FROM THE ORNL RADIATION SHIELDING INFORMATION CENTER (RSIC) AT THE FOLLOWING ADDRESS:

CODES COORDINATOR
RADIATION SHIELDING INFORMATION CENTER

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

BLDG. 6025
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE 37830
PHONE: (615) 574-6176

QUESTIONS CONCERNING ORIGEN2 SHOULD BE ADDRESSED TO RSIC.

-DESCRIPTION

ORIGEN2 IS A REVISION AND UPDATE OF THE ORIGEN COMPUTER CODE. SPECIFICALLY, THE INPUT, OUTPUT, CONTROL, AND DATA BASE ASPECTS OF ORIGEN HAVE BEEN SIGNIFICANTLY REVISED AND UPDATED TO REFLECT CURRENT INFORMATION AND NEEDS. IT SHOULD BE NOTED THAT THE MATHEMATICAL METHODS USED TO SOLVE THE NUCLIDE BUILDUP, DEPLETION, AND DECAY EQUATIONS ARE ESSENTIALLY UNCHANGED FROM THAT IN ORIGEN. ORIGEN2 IS A COMPUTER CODE DESIGNED TO CALCULATE THE COMPOSITION AND CHARACTERISTICS OF NUCLEAR MATERIALS AS A FUNCTION OF DECAY TIME AND THE CHANGES THE MATERIALS UNDERGO DURING VARIOUS FUEL CYCLE OPERATIONS. INPUT AND OUTPUT FEATURES HAVE BEEN DESIGNED TO FACILITATE FLEXIBILITY IN THE TYPE OF CASES THAT CAN BE CONSIDERED AND IN CONTROLLING THE DETAIL OF THE OUTPUT. FOR FURTHER INFORMATION, THE USER IS REFERRED TO THE DOCUMENTATION LISTED BELOW.

-MAJOR DATA SOURCES

VIRTUALLY ALL ASPECTS OF THE DATA INPUT TO ORIGEN2 HAVE BEEN UPDATED OR REVISED TO REFLECT CURRENT INFORMATION. THE PRINCIPAL SOURCES OF CROSS SECTION DATA WERE THE ENDF/B-IV, ENDF/B-V, AND LENDL COMPILATIONS. DECAY AND PHOTON INFORMATION WERE PRIMARILY BASED ON THE EVALUATED NUCLEAR STRUCTURE DATA FILE (ENSDF) AT ORNL AND ENDF/B-IV. DATA CONCERNING REACTOR AND FUEL CHARACTERISTICS WERE OBTAINED FROM REFERENCE SAFETY ANALYSIS REPORTS AND, WHERE POSSIBLE, THE COMMERCIAL REACTOR VENDORS.

-DOCUMENTATION

THE FOLLOWING ITEMS CONSTITUTE THE ORIGEN2 DOCUMENTATION PUBLISHED AS OF THE DATE OF THIS CODE PACKAGE:

A.G. CROFF, "ORIGEN2 - A REVISED AND UPDATED VERSION OF THE OAK RIDGE ISOTOPE GENERATION AND DEPLETION CODE", ORNL-5621 (JULY 1980).

A.G. CROFF, "A USER'S MANUAL FOR THE ORIGEN2 COMPUTER CODE", ORNL/TM-7175 (JULY 1980).

A.G. CROFF, M.A. BJERKE, G.W.MORRISON, AND L.M. PETRIE, "REVISED

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
URANIUM-PLUTONIUM CYCLE PWR AND BWR MODELS FOR THE
ORIGEN COMPUTER CODE", ORNL/TM-6051 (SEPTEMBER 1978).
A.G. CROFF AND M.A. BJERKE, "ALTERNATIVE FUEL CYCLE PWR MODELS FOR THE ORIGEN COMPUTER CODE", ORNL/TM-7005 (FEB 1980).
A.G. CROFF, R.L. HAESE, AND N.B. GOVE, "UPDATED DECAY AND PHOTON LIBRARIES FOR THE ORIGEN CODE", ORNL/TM-6055 (FEB 1979)
A.G. CROFF, "ORIGEN2: A REVISED AND UPDATED VERSION OF ORIGEN", TRANS. AM. NUCL. SOC., VOL. 34, P. 349-50 (JUNE 1980).
1 OUTPUT UNIT = 6 PAGE 2
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0**********
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********** ORIGEN2: A REVISED AND UPDATED VERSION OF THE ORIGEN COMPUTER CODE **********

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ORGANIZATION OF ORIGEN2 OUTPUT
PAST EXPERIENCE HAS INDICATED THAT MANY USERS ENCOUNTER CONSIDERABLE DIFFICULTY IN FINDING THE DESIRED INFORMATION IN A
ORIGEN2 OUT PUT WHICH IS SOMETIMES RATHER MASSIVE. THIS SECTION IS INTENDED AS A BRIEF OUTLINE OF THE ORGANIZATION OF
ORIGEN2 OUTPUT. FOR DETAILS REFER TO THE USER'S MANUAL (ORNL/TM-7175, SECT. 8.2). THE ORIGEN2 OUTPUT IS EXTREMELY
HIERARCHICAL, AND IS ORGANIZED AS FOLLOWS:
0 CARD INPUT ECHO
MISCELLANEOUS INPUT DATA (NEUTRON YIELDS, REPROCESSING LOSSES,ELEMENT CHEMICAL TOXICITIES
LISTING OF ORIGEN2 COMMANDS CURRENTLY BEING EXECUTED
LISTING OF ORIGEN2 DATA LIBRARIES (IF SPECIFIED)
DECAY LIBRARY
ACTIVATION PRODUCTS

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

ACTINIDES
FISSION PRODUCTS
CROSS SECTION/FISSION PRODUCT YIELD LIBRARY
ACTIVATION PRODUCTS, ACTINIDES, AND FISSION PRODUCTS
PHOTON LIBRARY
ACTIVATION PRODUCTS, ACTINIDES, AND FISSION PRODUCTS
OUTPUT 1
REACTIVITY AND BURNUP DATA
ACTIVATION PRODUCT TABLES
GRAM TABLES (NUCLIDE, ELEMENT, NUCLIDE SUMMARY, ELEMENT SUMMARY)
CURIE TABLES (NUCLIDE, ELEMENT, NUCLIDE SUMMARY, ELEMENT SUMMARY)
ETC. (DEPENDING ON THE OUTPUT OPTIONS SPECIFIED, MANY OF THESE TABLES MAY BE OMITTED
.
.
ACTINIDE TABLES
SAME SUBHEADINGS POSSIBLE AS UNDER ACTIVATION PRODUCT TABLES

FISSION PRODUCT TABLES
SAME SUBHEADINGS POSSIBLE AS UNDER ACTIVATION PRODUCT TABLES

NEUTRON PRODUCTION RATE TABLES: (ALPHA,N) AND SPONTANEOUS FISSION

PHOTON TABLES
ACTIVATION PRODUCTS (SUMMATION AND PRINCIPAL CONTRIBUTORS)
ACTINIDES (SUMMATION AND PRINCIPAL CONTRIBUTORS)
FISSION PRODUCTS (SUMMATION AND PRINCIPAL CONTRIBUTORS)
OUTPUT 2
SAME GENERAL CONTENT AND ORDER AS OUTPUT 1
.
.
.
OUTPUT N
SAME GENERAL CONTENT AND ORDER AS OUTPUT 1
TABLE OF CONTENTS (UNIT 12) FOR THE ABOVE (UNIT 6) OUTPUT
VARIABLE CROSS SECTION INFORMATION OUTPUT (UNIT 16)
DEBUGGING AND OTHER INTERNAL INFORMATION OUTPUT (UNIT 15)

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
0 THE SCENARIO LISTED ABOVE CONSTITUTES A TYPICAL ORIGEN2 OUTPUT FOR MANY CASES. ONE POSSIBLE MODIFICATION IS THE USE OF AN
STP COMMAND TO EXECUTE AN ADDITIONAL SET OF INSTRUCTIONS AFTER THE FIRST SET HAS BEEN EXECUTED. IF THIS IS DONE, THE OUTPUT
WILL BEGIN WITH "MISCELLANEOUS INPUT DATA" IF NSTP=1, "ORIGEN2COMMANDS CURRENTLY BEING EXECUTED" IF NSTP=2, OR "OUTPUT 1"

FOR NSTP=3. ANOTHER OFTEN-USED OPTION IS TO EMPLOY BOTH THE PRIMARY (UNIT 6) AND ALTERNATE (UNIT 11) OUTPUT UNITS. IF BOTH
ARE ROUTED TO PAPER, THE TABLE OF CONTENTS FOR UNIT 11, WHICH IS ON UNIT 13, WILL IMMEDIATELY FOLLOW THE DEBUGGING AND
INTERNAL INFORMATION (UNIT 15) OUTPUT. THE "OUTPUT N" TABLES FOR UNIT 11 WILL BE PRINTED FOLLOWING THE TABLE OF CONTENTS.
1 PAGE 3
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
LISTING OF INPUT DATA ON UNIT = 5

INPUT UNIT	WRITE UNIT	CARD NUMBER	CARD IMAGE
5	50	1	-1
5	50	2	-1
5	50	3	-1
5	50	4	RDA * BURNUP OF BWR 4.5% UO2 FUEL & ASSY HDWARE, 45,000 MWD/MT
5	50	5	RDA ** CROSS SECTION LIBRARY = BWRU, 4 CYCLE
5	50	6	RDA *** SCOTT B. LUDWIG, OAK RIDGE NATIONAL LABORATORY
5	50	7	RDA **** (615) 574-7916, FTS 624-7916
5	50	8	RDA -1 = FRESH BWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
5	50	9	RDA -2 = FRESH ZIRCALOY-4 COMPOSITION (1 KG)
5	50	10	RDA -3 = FRESH ZIRCALOY-2 COMPOSITION (1 KG)
5	50	11	RDA -4 = FRESH SS 304 COMPOSITION (1 KG)
5	50	12	RDA -5 = FRESH SS 302 COMPOSITION (1 KG)
5	50	13	RDA -6 = FRESH INCONEL X-750 COMPOSITION (1 KG)

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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5    50    14    RDA    WARNING:  VECTORS ARE CHANGED WITH RESPECT TO
CONTENT.
5    50    15    RDA          THESE CHANGES WILL BE NOTED ON RDA CARDS.

5    50    16    CUT    5 1.0E-10 7 1.0E-14 9 1.0E-10 -1
5    50    17    LIP    0 0 0
5    50    18    RDA      DECAY LIB    XSECT LIB                VAR. XSECT
5    50    19    LIB    0   1 2 3    251 252 253    9   50   0   1      4
5    50    20    RDA    PHOTON LIB
5    50    21    PHO    101 102 103  10
5    50    22    TIT   INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND
STRUCTURAL MAT'LS
5    50    23    RDA    READ FUEL COMPOSITION INCLUDING IMPURITIES (1000
KG)
5    50    24    INP    -1   1  -1  -1  1  1
5    50    25    RDA    READ ZIRCALOY-4 COMPOSITION (1.0 KG)

5    50    26    INP    -2   1  -1  -1  1  1
5    50    27    RDA    READ ZIRCALOY-2 COMPOSITION (1.0 KG)

5    50    28    INP    -3   1  -1  -1  1  1
5    50    29    RDA    READ SS304 COMPOSITION (1.0 KG)
5    50    30    INP    -4   1  -1  -1  1  1
5    50    31    RDA    READ SS302 COMPOSITION (1.0 KG)
5    50    32    INP    -5   1  -1  -1  1  1
5    50    33    RDA    READ INCONEL X-750 COMPOSITION (1.0 KG)

5    50    34    INP    -6   1  -1  -1  1  1
5    50    35    TIT    IRRADIATION OF ONE METRIC TON OF BWRU FUEL

5    50    36    MOV    -1   1   0   1.0
5    50    37    PCH    1   1   1
5    50    38    HED    1                                CHARGE
5    50    39    BUP
5    50    40    IRP    265.45   25.90   1   2   4  2   BURNUP= 6,875 MWD/MTIHM

5    50    41    DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
5    50    42    IRP    636.90   25.90   3   4   4  0   BURNUP=13,750 MWD/MTIHM
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
  5    50      43    DEC    742.90        4  5  4  0   DECAY FOR 106.0 DAYS
  5    50      44    IRP   1008.35  25.90  5  6  4  0   BURNUP=20,625 MWD/MTIHM

  5    50      45    DEC   1114.35        6  7  4  0   DECAY FOR 106.0 DAYS
  5    50      46    IRP   1379.80  25.90  7  8  4  0   BURNUP=27,500 MWD/MTIHM

  5    50      47    DEC   1485.80        8  9  4  0   DECAY FOR 106.0 DAYS
  5    50      48    IRP   1751.25  25.90  9 10  4  0   BURNUP=34,375 MWD/MTIHM

  5    50      49    DEC   1857.25       10 11  4  0   DECAY FOR 106.0 DAYS
1                                                                    PAGE   4
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 LISTING OF INPUT DATA ON UNIT = 5

 INPUT   WRITE    CARD                        CARD IMAGE
 UNIT    UNIT     NUMBER
  5    50      50    IRP   2122.70  25.90 11 12  4  0   BURNUP=41,250 MWD/MTIHM

  5    50      51    DEC   2228.70       12 13  4  0   DECAY FOR 106.0 DAYS
  5    50      52    IRP   2373.49  25.90 13 14  4  0   BURNUP=45,000 MWD/MTIHM

  5    50      53    BUP
  5    50      54    RDA    -10 = IRRADIATED U FUEL AT DISCHARGE

  5    50      55    MOV     14  -10    0    1.0
  5    50      56    PCH    -10  -10  -10
  5    50      57    RDA    IRRADIATION OF ZIRCALOY-2 CLADDING AT 1.000 FLUX

  5    50      58    TIT    IRRADIATION OF ZIRCALOY-2 CLADDING AT 1.000 FLUX

  5    50      59    MOV     -3    1    0  279.50      ZIRCALOY-2 CLAD
  5    50      60    HED     1                                CHARGE
  5    50      61    IRF    265.45  -1.0  1  2  4  2   BURNUP= 6,875 MWD/MTIHM

  5    50      62    DEC    371.45        2  3  4  0   DECAY FOR 106.0 DAYS
  5    50      63    IRF    636.90  -1.0  3  4  4  0   BURNUP=13,750 MWD/MTIHM

  5    50      64    DEC    742.90        4  5  4  0   DECAY FOR 106.0 DAYS
  5    50      65    IRF   1008.35  -1.0  5  6  4  0   BURNUP=20,625 MWD/MTIHM
```

```
5   50   66   DEC   1114.35      6  7  4 0   DECAY FOR 106.0 DAYS
5   50   67   IRF   1379.80  -1.0  7  8  4 0   BURNUP=27,500 MWD/MTIHM

5   50   68   DEC   1485.80      8  9  4 0   DECAY FOR 106.0 DAYS
5   50   69   IRF   1751.25  -1.0  9 10  4 0   BURNUP=34,375 MWD/MTIHM

5   50   70   DEC   1857.25     10 11  4 0   DECAY FOR 106.0 DAYS
5   50   71   IRF   2122.70  -1.0 11 12  4 0   BURNUP=41,250 MWD/MTIHM

5   50   72   DEC   2228.70     12 13  4 0   DECAY FOR 106.0 DAYS
5   50   73   IRF   2373.49  -1.0 13 14  4 0   BURNUP=45,000 MWD/MTIHM

5   50   74   RDA   -9 = IRRADIATED ZIRCALOY-2 CLADDING AT DISCHARGE

5   50   75   MOV   14   -9   0   1.0
5   50   76   RDA   IRRADIATION OF ZIRCALOY CLADDING AT 0.500 FLUX

5   50   77   TIT   IRRADIATION OF ZIRCALOY CLADDING AT 0.500 FLUX

5   50   78   MOV   -3   1   0   25.4   ZIRCALOY-2 CLAD
5   50   79   MOV   -3   2   0   304.90   TOTAL ZIRC-2 CLAD
5   50   80   PCH   2   2   2
5   50   81   HED   1                          CHARGE
5   50   82   IRF   265.45  -0.5  1  2  4 2   BURNUP= 6,875 MWD/MTIHM

5   50   83   DEC   371.45      2  3  4 0   DECAY FOR 106.0 DAYS
5   50   84   IRF   636.90  -0.5  3  4  4 0   BURNUP=13,750 MWD/MTIHM

5   50   85   DEC   742.90      4  5  4 0   DECAY FOR 106.0 DAYS
5   50   86   IRF   1008.35  -0.5  5  6  4 0   BURNUP=20,625 MWD/MTIHM

5   50   87   DEC   1114.35      6  7  4 0   DECAY FOR 106.0 DAYS
5   50   88   IRF   1379.80  -0.5  7  8  4 0   BURNUP=27,500 MWD/MTIHM

5   50   89   DEC   1485.80      8  9  4 0   DECAY FOR 106.0 DAYS
5   50   90   IRF   1751.25  -0.5  9 10  4 0   BURNUP=34,375 MWD/MTIHM

5   50   91   DEC   1857.25     10 11  4 0   DECAY FOR 106.0 DAYS
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
  5    50      92    IRF   2122.70  -0.5  11  12   4  0   BURNUP=41,250 MWD/MTIHM

  5    50      93    DEC    2228.70        12  13   4  0   DECAY FOR 106.0 DAYS
  5    50      94    IRF   2373.49  -0.5  13  14   4  0   BURNUP=45,000 MWD/MTIHM

  5    50      95    RDA     -9 = IRRADIATED ZIRCALOY CLADDING AT DISCHARGE

  5    50      96    ADD     14    -9     0     1.0   TOTAL IRRAD ZIRC-2 CLAD
  5    50      97    PCH     -9    -9    -9
  5    50      98    RDA      IRRADIATION OF ZIRCALOY-4 CHANNEL AT 1.000 FLUX

  5    50      99    TIT      IRRADIATION OF ZIRCALOY-4 CHANNEL AT 1.000 FLUX

1                                                                    PAGE   5
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 LISTING OF INPUT DATA ON UNIT = 5

 INPUT   WRITE    CARD                        CARD IMAGE
 UNIT    UNIT     NUMBER
  5    50      100   MOV     -2     1     0   227.50    ZIRCALOY-4 CHANNEL
  5    50      101   HED     1                              CHARGE
  5    50      102   IRF    265.45  -1.0   1   2   4  2   BURNUP= 6,875 MWD/MTIHM

  5    50      103   DEC     371.45        2   3   4  0   DECAY FOR 106.0 DAYS
  5    50      104   IRF    636.90  -1.0   3   4   4  0   BURNUP=13,750 MWD/MTIHM

  5    50      105   DEC     742.90        4   5   4  0   DECAY FOR 106.0 DAYS
  5    50      106   IRF   1008.35  -1.0   5   6   4  0   BURNUP=20,625 MWD/MTIHM

  5    50      107   DEC    1114.35        6   7   4  0   DECAY FOR 106.0 DAYS
  5    50      108   IRF   1379.80  -1.0   7   8   4  0   BURNUP=27,500 MWD/MTIHM

  5    50      109   DEC    1485.80        8   9   4  0   DECAY FOR 106.0 DAYS
  5    50      110   IRF   1751.25  -1.0   9  10   4  0   BURNUP=34,375 MWD/MTIHM

  5    50      111   DEC    1857.25       10  11   4  0   DECAY FOR 106.0 DAYS
  5    50      112   IRF   2122.70  -1.0  11  12   4  0   BURNUP=41,250 MWD/MTIHM

  5    50      113   DEC    2228.70       12  13   4  0   DECAY FOR 106.0 DAYS
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
5    50    114    IRF    2373.49   -1.0  13  14   4  0   BURNUP=45,000 MWD/MTIHM

5    50    115    RDA     -8 = IRRADIATED ZIRCALOY CHANNEL AT DISCHARGE

5    50    116    MOV     14    -8    0    1.0
5    50    117    RDA     IRRADIATION OF ZIRCALOY-4 CHANNEL AT 0.500 FLUX

5    50    118    TIT     IRRADIATION OF ZIRCALOY-4 CHANNEL AT 0.500 FLUX

5    50    119    MOV     -2    1    0    20.70    ZIRCALOY-4 CHANNEL
5    50    120    MOV     -2    2    0   248.20    TOTAL ZIRCALOY-4 CHANNEL

5    50    121    PCH     2    2    2
5    50    122    HED     1                                CHARGE
5    50    123    IRF    265.45   -0.5   1   2   4  2   BURNUP= 6,875 MWD/MTIHM

5    50    124    DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
5    50    125    IRF    636.90   -0.5   3   4   4  0   BURNUP=13,750 MWD/MTIHM

5    50    126    DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
5    50    127    IRF   1008.35   -0.5   5   6   4  0   BURNUP=20,625 MWD/MTIHM

5    50    128    DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
5    50    129    IRF   1379.80   -0.5   7   8   4  0   BURNUP=27,500 MWD/MTIHM

5    50    130    DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
5    50    131    IRF   1751.25   -0.5   9  10   4  0   BURNUP=34,375 MWD/MTIHM

5    50    132    DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
5    50    133    IRF   2122.70   -0.5  11  12   4  0   BURNUP=41,250 MWD/MTIHM

5    50    134    DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
5    50    135    IRF   2373.49   -0.5  13  14   4  0   BURNUP=45,000 MWD/MTIHM

5    50    136    RDA     -8 = IRRADIATED ZIRCALOY CHANNEL AT DISCHARGE

5    50    137    ADD     14    -8    0    1.0
5    50    138    PCH     -8    -8    -8
5    50    139    RDA     IRRADIATION OF ZIRCALOY GRID SPACERS AND INCONEL
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
SPRINGS
  5    50      140    TIT    IRRADIATION OF ZIRCALOY GRID SPACERS AND INCONEL
SPRINGS
  5    50      141    MOV    -2    1    0    10.60    ZIRCALOY GRIDS
  5    50      142    ADD    -6    1    0     1.80    INCONEL SPRINGS
  5    50      143    PCH    1    1    1
  5    50      144    HED    1                                CHARGE
  5    50      145    IRF    265.45  -1.0  1  2  4  2  BURNUP= 6,875 MWD/MTIHM

  5    50      146    DEC    371.45        2  3  4  0  DECAY FOR 106.0 DAYS
  5    50      147    IRF    636.90  -1.0  3  4  4  0  BURNUP=13,750 MWD/MTIHM

  5    50      148    DEC    742.90        4  5  4  0  DECAY FOR 106.0 DAYS
  5    50      149    IRF   1008.35  -1.0  5  6  4  0  BURNUP=20,625 MWD/MTIHM
```



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ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
LISTING OF INPUT DATA ON UNIT = 5

INPUT  WRITE   CARD                    CARD IMAGE
UNIT   UNIT    NUMBER
  5    50      150    DEC   1114.35        6  7  4  0  DECAY FOR 106.0 DAYS
  5    50      151    IRF   1379.80  -1.0  7  8  4  0  BURNUP=27,500 MWD/MTIHM

  5    50      152    DEC   1485.80        8  9  4  0  DECAY FOR 106.0 DAYS
  5    50      153    IRF   1751.25  -1.0  9 10  4  0  BURNUP=34,375 MWD/MTIHM

  5    50      154    DEC   1857.25       10 11  4  0  DECAY FOR 106.0 DAYS
  5    50      155    IRF   2122.70  -1.0 11 12  4  0  BURNUP=41,250 MWD/MTIHM

  5    50      156    DEC   2228.70       12 13  4  0  DECAY FOR 106.0 DAYS
  5    50      157    IRF   2373.49  -1.0 13 14  4  0  BURNUP=45,000 MWD/MTIHM

  5    50      158    RDA   -7 = IRRADIATED ZIRCALOY GRID SPACERS AND INCONEL
SPRINGS
  5    50      159    RDA        AT DISCHARGE
  5    50      160    MOV    14    -7    0    1.0
  5    50      161    PCH    -7    -7    -7
  5    50      162    RDA IRRAD. OF SS 304 END PIECES & INCONEL SPRINGS AT 0.130
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
FLUX
  5    50      163    TIT IRRAD. OF SS 304 END PIECES & INCONEL SPRINGS AT 0.130
FLUX
  5    50      164    MOV    -4    1    0   37.00     SS 304 IN END PIECES
  5    50      165    ADD -6    1    0    2.10     INCONEL X-750 EXPANSION SPRINGS

  5    50      166    PCH     1    1    1
  5    50      167    HED     1                                  CHARGE
  5    50      168    IRF    265.45   -0.13   1   2   4  2   BURNUP= 6,875 MWD/MTIHM

  5    50      169    DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS
  5    50      170    IRF    636.90   -0.13   3   4   4  0   BURNUP=13,750 MWD/MTIHM

  5    50      171    DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS
  5    50      172    IRF   1008.35   -0.13   5   6   4  0   BURNUP=20,625 MWD/MTIHM

  5    50      173    DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS
  5    50      174    IRF   1379.80   -0.13   7   8   4  0   BURNUP=27,500 MWD/MTIHM

  5    50      175    DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS
  5    50      176    IRF   1751.25   -0.13   9  10   4  0   BURNUP=34,375 MWD/MTIHM

  5    50      177    DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS
  5    50      178    IRF   2122.70   -0.13  11  12   4  0   BURNUP=41,250 MWD/MTIHM

  5    50      179    DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS
  5    50      180    IRF   2373.49   -0.13  13  14   4  0   BURNUP=45,000 MWD/MTIHM

  5    50      181    RDA -6 = IRRAD. SS 304 END PIECES & INCONEL SPRINGS AT
DISCHARGE
  5    50      182    MOV    14   -6    0    1.0
  5    50      183    PCH    -6   -6   -6
  5    50      184    RDA    IRRADIATION OF SS 302 IN PLENUM SPRINGS AT 0.500
FLUX
  5    50      185    TIT    IRRADIATION OF SS 302 IN PLENUM SPRINGS AT 0.500 FLUX

  5    50      186    MOV    -5    1    0    6.00     SS302
  5    50      187    PCH     1    1    1
  5    50      188    HED     1                                  CHARGE
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
  5    50      189    IRF    265.45  -0.5  1  2  4  2  BURNUP= 6,875 MWD/MTIHM

  5    50      190    DEC    371.45        2  3  4  0  DECAY FOR 106.0 DAYS
  5    50      191    IRF    636.90  -0.5  3  4  4  0  BURNUP=13,750 MWD/MTIHM

  5    50      192    DEC    742.90        4  5  4  0  DECAY FOR 106.0 DAYS
  5    50      193    IRF   1008.35  -0.5  5  6  4  0  BURNUP=20,625 MWD/MTIHM

  5    50      194    DEC   1114.35        6  7  4  0  DECAY FOR 106.0 DAYS
  5    50      195    IRF   1379.80  -0.5  7  8  4  0  BURNUP=27,500 MWD/MTIHM

  5    50      196    DEC   1485.80        8  9  4  0  DECAY FOR 106.0 DAYS
  5    50      197    IRF   1751.25  -0.5  9 10  4  0  BURNUP=34,375 MWD/MTIHM

  5    50      198    DEC   1857.25       10 11  4  0  DECAY FOR 106.0 DAYS
  5    50      199    IRF   2122.70  -0.5 11 12  4  0  BURNUP=41,250 MWD/MTIHM

1                                                                    PAGE   7
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 LISTING OF INPUT DATA ON UNIT = 5

 INPUT   WRITE    CARD                        CARD IMAGE
 UNIT    UNIT     NUMBER
  5    50      200    DEC   2228.70       12 13  4  0  DECAY FOR 106.0 DAYS
  5    50      201    IRF   2373.49  -0.5 13 14  4  0  BURNUP=45,000 MWD/MTIHM

  5    50      202    RDA    -5 = IRRADIATED SS 302 IN PLENUM SPRINGS AT
DISCHARGE
  5    50      203    MOV    14   -5  0  1.0
  5    50      204    PCH    -5   -5  -5
  5    50      205    RDA    ***** OUTPUT MODULE *****
  5    50      206    TIT TEST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD
BURNUP (BWRU)
  5    50      207    BAS 1 MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM,
4 CYCLE
  5    50      208    OPTL    6*8  7  8  8  8  14*8
  5    50      209    OPTA    6*8  7  8  8  8  14*8
  5    50      210    OPTF    6*8  7  8  8  8  14*8
  5    50      211    MOV    -10   1   0  1.0
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
5   50   212   ADD   -9   1   0   1.0
5   50   213   ADD   -8   1   0   1.0
5   50   214   ADD   -7   1   0   1.0
5   50   215   ADD   -6   1   0   1.0
5   50   216   ADD   -5   1   0   1.0
5   50   217   HED   1   ASSY DIS
5   50   218   RDA   ***** DECAY MODULE *****
5   50   219   DEC   0.5   1   2   5   2
5   50   220   DEC   1.0   2   3   5   0
5   50   221   DEC   2.0   3   4   5   0
5   50   222   DEC   5.0   4   5   5   0
5   50   223   DEC   10.0   5   6   5   0
5   50   224   DEC   26.0   6   7   5   0
5   50   225   OUT   7   1   -1   0
5   50   226   END
5   50   227   2 922340 247.0 922350 45000. 922380  954753.   0  0.0  FUEL 4.5%

5   50   228   4 030000  1.0   050000 1.0   060000 89.4 070000   25.0 FUEL IMPU

5   50   229   4 080000 134454. 090000 10.7   110000 15.0 120000   2.0 FUEL IMPU

5   50   230   4 130000  16.7   140000 12.1   150000 35.0 170000   5.3 FUEL IMPU

5   50   231   4 200000  2.0   220000 1.0   230000 3.0  240000   4.0 FUEL IMPU

5   50   232   4 250000  1.7   260000 18.0   270000 1.0  280000   24.0 FUEL IMPU

5   50   233   4 290000  1.0   300000 40.3   420000 10.0 470000   0.1  FUEL IMPU

5   50   234   4 480000  25.0   490000 2.0   500000 4.0  640000  1573. FUEL IMPU

5   50   235   4 740000  2.0   820000 1.0   830000 0.4  0       0.0  FUEL IMPU
5   50   236   0
5   50   237   4 400000 979.11 500000 16.0   260000   2.25   240000 1.25   ZIRC-4

5   50   238   4 280000 0.02   130000 0.024 050000 0.00033 480000 0.00025  ZIRC-4

5   50   239   4 060000 0.120  270000 0.010  290000   0.020  720000 0.078  ZIRC-4
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
  5    50      240   4 010000 0.013  250000 0.020  070000   0.080  080000 0.950  ZIRC-4

  5    50      241   4 160000 0.035  220000 0.020  740000   0.020  230000 0.020  ZIRC-4

  5    50      242   5 920000 0.0002      0 0.0                          ZIRC-4
  5    50      243   0
  5    50      244   4 400000 979.63 500000 16.0   260000   1.5    240000   1.00 ZIRC-2

  5    50      245   4 280000 0.5    130000 0.024  050000 0.00033 480000 0.00025 ZIRC-2

  5    50      246   4 060000 0.120  270000 0.010  290000   0.020  720000  0.078 ZIRC-2

  5    50      247   4 010000 0.013  250000 0.020  070000   0.080  080000  0.950 ZIRC-2

  5    50      248   4 160000 0.035  220000 0.020  740000   0.020  230000  0.020 ZIRC-2

  5    50      249   5 920000 0.0002      0 0.0                          ZIRC-2
1                                                                                PAGE    8
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 LISTING OF INPUT DATA ON UNIT = 5

 INPUT   WRITE    CARD                          CARD IMAGE
 UNIT    UNIT     NUMBER
  5    50      250   0
  5    50      251   4 260000 688.44 240000 190.0  280000   89.2   250000   20.0 SS-304

  5    50      252   4 060000 0.8    150000 0.45   160000   0.3    140000   10.0 SS-304
  5    50      253   4 070000 1.3    270000 0.8        0   0.0                SS-304
  5    50      254   0
  5    50      255   4 260000 697.74 240000 180.0  280000   89.2   250000   20.0 SS-302

  5    50      256   4 060000 1.5    150000 0.45   160000   0.3    140000   10.0 SS-302
  5    50      257   4 070000 1.3    270000 0.8        0   0.0                SS-302
  5    50      258   0
  5    50      259   4 260000 67.846 240000 149.66 280000 721.861 130000 7.982 INC-X-750

  5    50      260   4 060000 0.399  270000 6.485  290000  0.499  250000 6.984 INC-X-750

  5    50      261   4 070000 1.3    410000 8.98  160000  0.07   140000  2.993 INC-X-750
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
  5    50      262   4 220000 24.943     0 0.0                    INC-X-750
  5    50      263   0
1                                          OUTPUT UNIT =  6                PAGE   9
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 NEUTRON YIELD PER NEUTRON-INDUCED FISSION

   NUCLIDE    YIELD    NUCLIDE    YIELD    NUCLIDE    YIELD    NUCLIDE    YIELD
  NUCLIDE    YIELD    NUCLIDE    YIELD
0    832090   0.0000    882230   0.0000    882260   0.0000    882280   0.0000    892270
0.0000    902270   0.0000
0    902280   0.0000    902290   2.0490    902300   0.0000    902320   2.4180    902330
0.0000    902340   0.0000
0    912310   0.0000    912320   0.0000    912330   2.6630    912341   0.0000    912340
0.0000    922300   0.0000
0    922310   0.0000    922320   0.0000    922330   2.4990    922340   2.6310    922350
2.4210    922360   2.7340
0    922370   0.0000    922380   2.8010    922390   0.0000    922400   0.0000    932360
0.0000    932370   3.0050
0    932380   0.0000    932390   0.0000    942360   2.8700    942370   0.0000    942380
2.8330    942390   2.8750
0    942400   3.1350    942410   2.9340    942420   3.2800    942430   0.0000    952410
3.2770    952421   3.1620
0    952420   3.3600    952430   3.7320    952441   0.0000    952440   0.0000    962420
3.7460    962430   3.4340
0    962440   3.7250    962450   3.8320    962460   3.8580    962470   3.5920    962480
3.7960    962490   0.0000
0    972490   3.7600    982490   4.0620    982500   3.9700    982510   4.1400    982520
4.1260    982530   4.1500
0    982540   0.0000    992530   0.0000    992541   0.0000    992540   0.0000       0   0.0000
       0   0.0000
1                                          OUTPUT UNIT =  6                PAGE  10
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 SPONTANEOUS FISSION NEUTRON YIELD, NEUT/FISSION

 NUCLIDE          NUCLIDE          NUCLIDE          NUCLIDE          NUCLIDE
NUCLIDE
 922350   1.6950   922360   1.6500   922370   1.8720   922380   2.0000   922390   2.0480
932361   1.7900
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
932360 1.7830 932370 1.8730 932380 1.9630 932390 2.0530 942360 2.2200 942370 1.8860
942380 2.2800 942390 2.2400 942400 2.1600 942410 2.2500 942420 2.1500 942430 2.4300
942440 2.3000 952400 2.2900 952410 2.3830 952420 2.4750 952421 2.5900 952430 2.5200
952440 2.6570 952441 2.6650 962410 2.5000 962420 2.5900 962430 2.6870 962440 2.7600
962450 2.8720 962460 3.0000 962480 3.3200 962500 3.5600 972490 3.7200 982490 3.4400
982500 3.5600 982520 3.7250 982540 3.9000 992530 3.9200 992540 4.0400 992550 4.1600
0THE REMAINING NEUTRON YIELDS ARE CALCULATED FROM THE EQUATION: NEUT/FISS=(2.84+0.1225*(AT WT-244)
1 OUTPUT UNIT = 6 PAGE 11
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
INDIVIDUAL ELEMENT FRACTIONAL RECOVERIES

ELEMENT SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER

	1	2	3	4	5	6	7	8	9	10
1	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.9000000	1.0000000
2	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000
3	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
4	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
5	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
6	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000
7	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000
8	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
9	0.0000000	0.0010000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

10	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000
11	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
12	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
13	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
14	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
15	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
16	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
17	0.0000000	0.0010000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
18	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000
19	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
20	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
21	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
22	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
23	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
24	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
25	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
26	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
27	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
28	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
29	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000			

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
0.0000000 0.0000000 1.0000000
30 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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31 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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32 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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33 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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34 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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35 0.0000000 0.0010000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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36 0.0000000 0.0000000 0.0005000 0.0000000 1.0000000 1.0000000 0.0000000
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37 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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38 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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39 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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40 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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41 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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42 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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43 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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44 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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45 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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46 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
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47 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
48 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

49	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000

1 OUTPUT UNIT = 6 PAGE 12
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
INDIVIDUAL ELEMENT FRACTIONAL RECOVERIES

ELEMENT	SET NUMBER 1	SET NUMBER 2	SET NUMBER 3	SET NUMBER 4	SET NUMBER 5	SET NUMBER 6	SET NUMBER 7	SET NUMBER 8	SET NUMBER 9	SET NUMBER 10
50	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
51	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
52	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
53	0.0000000	0.0010000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
54	0.0000000	0.0000000	0.0005000	0.0000000	1.0000000	1.0000000	0.0000000	0.0000000	0.0000000	1.0000000
55	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
56	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
57	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
58	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
59	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
60	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
61	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
62	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
63	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
64	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

65	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
66	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
67	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
68	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
69	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
70	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
71	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
72	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
73	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
74	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
75	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
76	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
77	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
78	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
79	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
80	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
81	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
82	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
83	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000	0.0000000	0.0000000	1.0000000
84	0.0000000	1.0000000	0.0005000	0.0000000	1.0000000	1.0000000	1.0000000			

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
0.0000000 0.0000000 1.0000000
85 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
86 0.0000000 0.0000000 0.0005000 0.0000000 1.0000000 1.0000000 0.0000000
0.0000000 0.0000000 1.0000000
87 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
88 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
89 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
90 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
91 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000
0.0000000 0.0000000 1.0000000
92 0.9950000 1.0000000 0.0005000 0.9990000 1.0000000 0.2000000 0.6000000
1.0000000 0.0000000 1.0000000
93 0.0000000 1.0000000 0.0005000 0.0000000 0.0500000 0.0500000 0.0000000
0.0000000 0.0000000 1.0000000
94 0.9950000 1.0000000 0.0005000 0.9999000 1.0000000 0.0200000 0.0000000
0.0000000 0.0000000 1.0000000
95 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000
0.0000000 0.0000000 1.0000000
96 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000
0.0000000 0.0000000 1.0000000
97 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000
0.0000000 0.0000000 1.0000000
98 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000
0.0000000 0.0000000 1.0000000
99 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000
0.0000000 0.0000000 1.0000000
1 OUTPUT UNIT = 6 PAGE 13
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
GROUP FRACTIONAL RECOVERIES

GROUP SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER
SET NUMBER SET NUMBER SET NUMBER SET NUMBER SET NUMBER
1 2 3 4 5 6 7 8 9 10
1 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
0.0000000 0.0000000 0.0000000
2 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 0.0000000 0.0000000 0.0000000 0.0000000
3 0.0000000 1.0000000 0.0005000 0.0000000 1.0000000 1.0000000 0.0000000 0.0000000 0.0000000 0.0000000
4 0.9950000 1.0000000 0.0005000 0.9990000 1.0000000 0.2000000 0.6000000 1.0000000 0.0000000 0.0000000
5 0.0000000 1.0000000 0.0005000 0.0000000 0.0500000 0.0500000 0.0000000 0.0000000 0.0000000 0.0000000
6 0.9950000 1.0000000 0.0005000 0.9999000 1.0000000 0.0200000 0.0000000 0.0000000 0.0000000 0.0000000
7 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000 0.0000000 0.0000000 0.0000000
8 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000 0.0000000 0.0000000 0.0000000
9 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000 0.0000000 0.0000000 0.0000000
10 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000 0.0000000 0.0000000 0.0000000
11 0.0000000 1.0000000 0.0005000 0.0000000 0.0010000 0.0010000 0.0000000 0.0000000 0.0000000 0.0000000
12 0.0000000 0.0010000 0.0005000 0.0000000 1.0000000 1.0000000 1.0000000 0.0000000 0.0000000 0.0000000
13 0.0000000 0.0000000 0.0005000 0.0000000 1.0000000 1.0000000 0.0000000 0.0000000 0.0000000 0.0000000
14 0.0000000 0.0000000 0.0005000 0.0000000 1.0000000 1.0000000 0.0000000 0.0000000 0.9000000 0.0000000
15 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
16 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
17 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
18 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
19 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
20 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

1 OUTPUT UNIT = 6 PAGE 14

ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

ELEMENT ASSIGNMENTS TO FRACTIONAL RECOVERY GROUPS

0 ELEM GROUP ELEM GROUP ELEM GROUP ELEM GROUP ELEM GROUP ELEM GROUP ELEM GROUP ELEM GROUP ELEM GROUP

1	14	2	13	3	1	4	1	5	1	6	13	7	13	8	1	9	12		
10	13	11	1	12	1	13	1	14	1	15	1	16	1	17	12	18	13		
19	1	20	1	21	1	22	1	23	1	24	1	25	1	26	1	27	1		
28	1	29	1	30	1	31	1	32	1	33	1	34	1	35	12	36	13		
37	1	38	1	39	1	40	1	41	1	42	1	43	1	44	1	45	1		
46	1	47	1	48	1	49	1	50	1	51	1	52	1	53	12	54	13		
55	1	56	1	57	1	58	1	59	1	60	1	61	1	62	1	63	1		
64	1	65	1	66	1	67	1	68	1	69	1	70	1	71	1	72	1		
73	1	74	1	75	1	76	1	77	1	78	1	79	1	80	1	81	1		
82	1	83	1	84	1	85	1	86	13	87	1	88	1	89	1	90	2		
91	3	92	4	93	5	94	6	95	7	96	8	97	9	98	10	99	11		

1 OUTPUT UNIT = 6 PAGE 15

ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

CHEMICAL TOXICITIES, GRAMS PER M**3 WATER

0NUCLIDE TOXICITY NUCLIDE TOXICITY NUCLIDE TOXICITY NUCLIDE TOXICITY NUCLIDE TOXICITY NUCLIDE TOXICITY

1	3.50E+03	2	2.00E-01	3	5.00E+00	4	1.00E+00	5	1.00E+00	6	4.00E+02						
7	1.00E-02	8	9.45E+05	9	1.00E+00	10	1.00E+00	11	1.00E+03	12	1.00E+01						
13	1.00E-02	14	5.00E+00	15	1.00E-02	16	5.00E+01	17	1.50E-01	18	1.00E+01						
19	1.00E+03	20	3.00E+01	21	5.00E-01	22	1.00E-01	23	1.00E-01	24	2.00E-02						
25	1.00E-02	26	5.00E-02	27	5.00E-02	28	5.00E-02	29	1.00E-02	30	5.00E-02						
31	2.00E-01	32	5.00E-01	33	1.00E-02	34	1.00E-02	35	3.00E+00	36	4.00E+01						
37	5.00E+01	38	1.00E+01	39	1.00E-03	40	1.00E+00	41	2.00E-02	42	5.00E-01						
43	1.00E+02	44	1.00E+00	45	5.00E-02	46	5.00E-02	47	1.00E-03	48	1.00E-02						
49	2.00E-02	50	5.00E-02	51	5.00E-02	52	2.00E-01	53	1.00E+01	54							

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
1.50E+02
55 5.00E+00 56 5.00E-01 57 1.00E+00 58 2.00E+00 59 1.00E+00 60 2.00E-01
61 1.00E+00 62 2.00E-01 63 2.00E-01 64 2.00E-01 65 5.00E-01 66 1.00E+00
67 1.00E+00 68 1.00E-01 69 2.00E-01 70 1.00E-01 71 1.00E-01 72 5.00E-02
73 1.00E+00 74 1.00E+02 75 1.00E+01 76 1.00E+00 77 8.00E-01 78 3.00E-01
79 2.00E-02 80 2.00E-03 81 5.00E-03 82 1.00E-02 83 1.00E-01 84 2.00E-01
85 1.00E+01 86 5.00E+02 87 5.00E+00 88 1.00E-03 89 2.00E-02 90 5.00E-04
91 5.00E-03 92 5.00E-01 93 8.00E-03 94 8.00E-04 95 4.00E-02 96 5.00E-01
97 5.00E-03 98 1.00E-02 99 1.00E-02

```
1                                        OUTPUT UNIT =  6                PAGE  16
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
   1    0 RDA  *  RDA *  BURNUP OF BWR 4.5% UO2 FUEL & ASSY HDWARE, 45,000
MWD/MT            *
   2    0 RDA  *  RDA     **  CROSS SECTION LIBRARY = BWRU, 4 CYCLE
 *
   3    0 RDA  *  RDA     ***  SCOTT B. LUDWIG, OAK RIDGE NATIONAL LABORATORY
          *
   4    0 RDA  *  RDA     ****  (615) 574-7916, FTS 624-7916                    *
   5    0 RDA  *  RDA     -1 = FRESH BWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
      *
   6    0 RDA  *  RDA     -2 = FRESH ZIRCALOY-4 COMPOSITION (1 KG)                *
   7    0 RDA  *  RDA     -3 = FRESH ZIRCALOY-2 COMPOSITION (1 KG)                *
   8    0 RDA  *  RDA     -4 = FRESH SS 304 COMPOSITION (1 KG)                  *
   9    0 RDA  *  RDA     -5 = FRESH SS 302 COMPOSITION (1 KG)                  *
  10    0 RDA  *  RDA     -6 = FRESH INCONEL X-750 COMPOSITION (1 KG)
 *
  11    0 RDA  *  RDA      WARNING:  VECTORS ARE CHANGED WITH RESPECT TO
CONTENT.            *
  12    0 RDA  *  RDA            THESE CHANGES WILL BE NOTED ON RDA CARDS.
      *
  13    0 CUT  *  CUT     5 1.0E-10 7 1.0E-14 9 1.0E-10 -1                     *
  14    0 LIP  *  LIP     0 0 0                                          *
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 15   0 RDA  *  RDA       DECAY LIB    XSECT LIB                    VAR. XSECT          *
 16   0 LIB  *  LIB    0    1 2 3    251 252 253    9   50   0   1      4              *
 17   0 RDA  *  RDA      PHOTON LIB                                                     *
 18   0 PHO  *  PHO    101 102 103  10                                                  *
 19   0 TIT  *  TIT  INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL
MAT'LS          *
 20   0 RDA  *  RDA    READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
        *
 21   0 INP  *  INP    -1   1  -1  -1  1  1                                             *
 22   0 RDA  *  RDA    READ ZIRCALOY-4 COMPOSITION (1.0 KG)                                  *
 23   0 INP  *  INP    -2   1  -1  -1  1  1                                             *
 24   0 RDA  *  RDA    READ ZIRCALOY-2 COMPOSITION (1.0 KG)                                  *
 25   0 INP  *  INP    -3   1  -1  -1  1  1                                             *
 26   0 RDA  *  RDA    READ SS304 COMPOSITION (1.0 KG)                                   *
 27   0 INP  *  INP    -4   1  -1  -1  1  1                                             *
 28   0 RDA  *  RDA    READ SS302 COMPOSITION (1.0 KG)                                   *
 29   0 INP  *  INP    -5   1  -1  -1  1  1                                             *
 30   0 RDA  *  RDA    READ INCONEL X-750 COMPOSITION (1.0 KG)
*
 31   0 INP  *  INP    -6   1  -1  -1  1  1                                             *
 32   0 TIT  *  TIT    IRRADIATION OF ONE METRIC TON OF BWRU FUEL
  *
 33   0 MOV  *  MOV    -1   1   0   1.0                                                 *
 34   0 PCH  *  PCH     1   1   1                                                       *
 35   0 HED  *  HED     1                                   CHARGE          *
 36   0 BUP  *  BUP                                                                     *
 37   0 IRP  *  IRP    265.45   25.90   1   2   4  2   BURNUP= 6,875 MWD/MTIHM          *
 38   0 DEC  *  DEC    371.45          2   3   4  0   DECAY FOR 106.0 DAYS            *
 39   0 IRP  *  IRP    636.90   25.90   3   4   4  0   BURNUP=13,750 MWD/MTIHM          *
 40   0 DEC  *  DEC    742.90          4   5   4  0   DECAY FOR 106.0 DAYS            *
 41   0 IRP  *  IRP   1008.35   25.90   5   6   4  0   BURNUP=20,625 MWD/MTIHM          *
 42   0 DEC  *  DEC   1114.35          6   7   4  0   DECAY FOR 106.0 DAYS            *
 43   0 IRP  *  IRP   1379.80   25.90   7   8   4  0   BURNUP=27,500 MWD/MTIHM          *
 44   0 DEC  *  DEC   1485.80          8   9   4  0   DECAY FOR 106.0 DAYS            *
 45   0 IRP  *  IRP   1751.25   25.90   9  10   4  0   BURNUP=34,375 MWD/MTIHM          *
 46   0 DEC  *  DEC   1857.25         10  11   4  0   DECAY FOR 106.0 DAYS            *
 47   0 IRP  *  IRP   2122.70   25.90  11  12   4  0   BURNUP=41,250 MWD/MTIHM          *
 48   0 DEC  *  DEC   2228.70         12  13   4  0   DECAY FOR 106.0 DAYS            *
 49   0 IRP  *  IRP   2373.49   25.90  13  14   4  0   BURNUP=45,000 MWD/MTIHM          *
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
1                                                OUTPUT UNIT =  6                    PAGE   17
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
  50   0 BUP  *  BUP                                                    *
  51   0 RDA  *  RDA    -10 = IRRADIATED U FUEL AT DISCHARGE                                  *
  52   0 MOV  *  MOV      14   -10     0     1.0                                  *
  53   0 PCH  *  PCH     -10   -10   -10                                        *
  54   0 RDA  *  RDA     IRRADIATION OF ZIRCALOY-2 CLADDING AT 1.000 FLUX
       *
  55   0 TIT  *  TIT     IRRADIATION OF ZIRCALOY-2 CLADDING AT 1.000 FLUX
    *
  56   0 MOV  *  MOV      -3     1     0   279.50      ZIRCALOY-2 CLAD                  *
  57   0 HED  *  HED      1                                   CHARGE            *
  58   0 IRF  *  IRF     265.45   -1.0   1   2   4  2   BURNUP= 6,875 MWD/MTIHM            *
  59   0 DEC  *  DEC     371.45          2   3   4  0    DECAY FOR 106.0 DAYS              *
  60   0 IRF  *  IRF     636.90   -1.0   3   4   4  0   BURNUP=13,750 MWD/MTIHM            *
  61   0 DEC  *  DEC     742.90          4   5   4  0    DECAY FOR 106.0 DAYS              *
  62   0 IRF  *  IRF    1008.35   -1.0   5   6   4  0   BURNUP=20,625 MWD/MTIHM            *
  63   0 DEC  *  DEC    1114.35          6   7   4  0    DECAY FOR 106.0 DAYS              *
  64   0 IRF  *  IRF    1379.80   -1.0   7   8   4  0   BURNUP=27,500 MWD/MTIHM            *
  65   0 DEC  *  DEC    1485.80          8   9   4  0    DECAY FOR 106.0 DAYS              *
  66   0 IRF  *  IRF    1751.25   -1.0   9  10   4  0   BURNUP=34,375 MWD/MTIHM            *
  67   0 DEC  *  DEC    1857.25         10  11   4  0    DECAY FOR 106.0 DAYS              *
  68   0 IRF  *  IRF    2122.70   -1.0  11  12   4  0   BURNUP=41,250 MWD/MTIHM            *
  69   0 DEC  *  DEC    2228.70         12  13   4  0    DECAY FOR 106.0 DAYS              *
  70   0 IRF  *  IRF    2373.49   -1.0  13  14   4  0   BURNUP=45,000 MWD/MTIHM            *
  71   0 RDA  *  RDA      -9 = IRRADIATED ZIRCALOY-2 CLADDING AT DISCHARGE
       *
  72   0 MOV  *  MOV      14     -9     0     1.0                                  *
  73   0 RDA  *  RDA     IRRADIATION OF ZIRCALOY CLADDING AT 0.500 FLUX
       *
  74   0 TIT  *  TIT     IRRADIATION OF ZIRCALOY CLADDING AT 0.500 FLUX
    *
  75   0 MOV  *  MOV      -3     1     0    25.4     ZIRCALOY-2 CLAD                  *
  76   0 MOV  *  MOV      -3     2     0   304.90    TOTAL ZIRC-2 CLAD                  *
  77   0 PCH  *  PCH       2     2     2                                        *
  78   0 HED  *  HED      1                                   CHARGE            *
  79   0 IRF  *  IRF     265.45   -0.5   1   2   4  2   BURNUP= 6,875 MWD/MTIHM            *
  80   0 DEC  *  DEC     371.45          2   3   4  0    DECAY FOR 106.0 DAYS              *
  81   0 IRF  *  IRF     636.90   -0.5   3   4   4  0   BURNUP=13,750 MWD/MTIHM            *
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 82   0 DEC  *  DEC     742.90        4  5  4  0   DECAY FOR 106.0 DAYS              *
 83   0 IRF  *  IRF    1008.35  -0.5  5  6  4  0  BURNUP=20,625 MWD/MTIHM            *
 84   0 DEC  *  DEC    1114.35        6  7  4  0   DECAY FOR 106.0 DAYS              *
 85   0 IRF  *  IRF    1379.80  -0.5  7  8  4  0  BURNUP=27,500 MWD/MTIHM            *
 86   0 DEC  *  DEC    1485.80        8  9  4  0   DECAY FOR 106.0 DAYS              *
 87   0 IRF  *  IRF    1751.25  -0.5  9 10  4  0  BURNUP=34,375 MWD/MTIHM            *
 88   0 DEC  *  DEC    1857.25       10 11  4  0   DECAY FOR 106.0 DAYS              *
 89   0 IRF  *  IRF    2122.70  -0.5 11 12  4  0  BURNUP=41,250 MWD/MTIHM            *
 90   0 DEC  *  DEC    2228.70       12 13  4  0   DECAY FOR 106.0 DAYS              *
 91   0 IRF  *  IRF    2373.49  -0.5 13 14  4  0  BURNUP=45,000 MWD/MTIHM            *
 92   0 RDA  *  RDA      -9 = IRRADIATED ZIRCALOY CLADDING AT DISCHARGE
        *
 93   0 ADD  *  ADD     14    -9     0     1.0   TOTAL IRRAD ZIRC-2 CLAD            *
 94   0 PCH  *  PCH     -9    -9    -9                                   *
 95   0 RDA  *  RDA      IRRADIATION OF ZIRCALOY-4 CHANNEL AT 1.000 FLUX
       *
 96   0 TIT  *  TIT      IRRADIATION OF ZIRCALOY-4 CHANNEL AT 1.000 FLUX
    *
 97   0 MOV  *  MOV     -2     1     0   227.50    ZIRCALOY-4 CHANNEL              *
 98   0 HED  *  HED     1                                CHARGE          *
 99   0 IRF  *  IRF     265.45  -1.0  1  2  4  2  BURNUP= 6,875 MWD/MTIHM           *
1                                                OUTPUT UNIT =  6                PAGE   18
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
100   0 DEC  *  DEC     371.45        2  3  4  0   DECAY FOR 106.0 DAYS              *
101   0 IRF  *  IRF     636.90  -1.0  3  4  4  0  BURNUP=13,750 MWD/MTIHM            *
102   0 DEC  *  DEC     742.90        4  5  4  0   DECAY FOR 106.0 DAYS              *
103   0 IRF  *  IRF    1008.35  -1.0  5  6  4  0  BURNUP=20,625 MWD/MTIHM            *
104   0 DEC  *  DEC    1114.35        6  7  4  0   DECAY FOR 106.0 DAYS              *
105   0 IRF  *  IRF    1379.80  -1.0  7  8  4  0  BURNUP=27,500 MWD/MTIHM            *
106   0 DEC  *  DEC    1485.80        8  9  4  0   DECAY FOR 106.0 DAYS              *
107   0 IRF  *  IRF    1751.25  -1.0  9 10  4  0  BURNUP=34,375 MWD/MTIHM            *
108   0 DEC  *  DEC    1857.25       10 11  4  0   DECAY FOR 106.0 DAYS              *
109   0 IRF  *  IRF    2122.70  -1.0 11 12  4  0  BURNUP=41,250 MWD/MTIHM            *
110   0 DEC  *  DEC    2228.70       12 13  4  0   DECAY FOR 106.0 DAYS              *
111   0 IRF  *  IRF    2373.49  -1.0 13 14  4  0  BURNUP=45,000 MWD/MTIHM            *
112   0 RDA  *  RDA      -8 = IRRADIATED ZIRCALOY CHANNEL AT DISCHARGE
        *
113   0 MOV  *  MOV     14    -8     0     1.0                                  *
114   0 RDA  *  RDA      IRRADIATION OF ZIRCALOY-4 CHANNEL AT 0.500 FLUX
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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        *
 115   0 TIT  *  TIT      IRRADIATION OF ZIRCALOY-4 CHANNEL AT 0.500 FLUX
     *
 116   0 MOV  *  MOV     -2     1   0    20.70    ZIRCALOY-4 CHANNEL                *
 117   0 MOV  *  MOV     -2     2   0   248.20    TOTAL ZIRCALOY-4 CHANNEL
*
 118   0 PCH  *  PCH      2     2   2                                    *
 119   0 HED  *  HED      1                                CHARGE          *
 120   0 IRF  *  IRF    265.45  -0.5  1  2  4  2  BURNUP= 6,875 MWD/MTIHM          *
 121   0 DEC  *  DEC    371.45        2  3  4  0   DECAY FOR 106.0 DAYS            *
 122   0 IRF  *  IRF    636.90  -0.5  3  4  4  0  BURNUP=13,750 MWD/MTIHM          *
 123   0 DEC  *  DEC    742.90        4  5  4  0   DECAY FOR 106.0 DAYS            *
 124   0 IRF  *  IRF   1008.35  -0.5  5  6  4  0  BURNUP=20,625 MWD/MTIHM          *
 125   0 DEC  *  DEC   1114.35        6  7  4  0   DECAY FOR 106.0 DAYS            *
 126   0 IRF  *  IRF   1379.80  -0.5  7  8  4  0  BURNUP=27,500 MWD/MTIHM          *
 127   0 DEC  *  DEC   1485.80        8  9  4  0   DECAY FOR 106.0 DAYS            *
 128   0 IRF  *  IRF   1751.25  -0.5  9 10  4  0  BURNUP=34,375 MWD/MTIHM          *
 129   0 DEC  *  DEC   1857.25       10 11  4  0   DECAY FOR 106.0 DAYS            *
 130   0 IRF  *  IRF   2122.70  -0.5 11 12  4  0  BURNUP=41,250 MWD/MTIHM          *
 131   0 DEC  *  DEC   2228.70       12 13  4  0   DECAY FOR 106.0 DAYS            *
 132   0 IRF  *  IRF   2373.49  -0.5 13 14  4  0  BURNUP=45,000 MWD/MTIHM          *
 133   0 RDA  *  RDA     -8 = IRRADIATED ZIRCALOY CHANNEL AT DISCHARGE
        *
 134   0 ADD  *  ADD     14    -8    0     1.0                                  *
 135   0 PCH  *  PCH     -8    -8   -8                                    *
 136   0 RDA  *  RDA     IRRADIATION OF ZIRCALOY GRID SPACERS AND INCONEL
SPRINGS          *
 137   0 TIT  *  TIT     IRRADIATION OF ZIRCALOY GRID SPACERS AND INCONEL
SPRINGS          *
 138   0 MOV  *  MOV     -2     1     0    10.60    ZIRCALOY GRIDS                *
 139   0 ADD  *  ADD     -6     1     0     1.80    INCONEL SPRINGS               *
 140   0 PCH  *  PCH      1     1     1                                    *
 141   0 HED  *  HED      1                                CHARGE          *
 142   0 IRF  *  IRF    265.45  -1.0  1  2  4  2  BURNUP= 6,875 MWD/MTIHM          *
 143   0 DEC  *  DEC    371.45        2  3  4  0   DECAY FOR 106.0 DAYS            *
 144   0 IRF  *  IRF    636.90  -1.0  3  4  4  0  BURNUP=13,750 MWD/MTIHM          *
 145   0 DEC  *  DEC    742.90        4  5  4  0   DECAY FOR 106.0 DAYS            *
 146   0 IRF  *  IRF   1008.35  -1.0  5  6  4  0  BURNUP=20,625 MWD/MTIHM          *
 147   0 DEC  *  DEC   1114.35        6  7  4  0   DECAY FOR 106.0 DAYS            *
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 148   0 IRF  *  IRF    1379.80   -1.0   7   8   4  0   BURNUP=27,500 MWD/MTIHM            *
 149   0 DEC  *  DEC    1485.80         8   9   4  0   DECAY FOR 106.0 DAYS              *
1                                                  OUTPUT UNIT =  6                    PAGE   19
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 150   0 IRF  *  IRF    1751.25   -1.0   9  10   4  0   BURNUP=34,375 MWD/MTIHM            *
 151   0 DEC  *  DEC    1857.25        10  11   4  0   DECAY FOR 106.0 DAYS              *
 152   0 IRF  *  IRF    2122.70   -1.0  11  12   4  0   BURNUP=41,250 MWD/MTIHM            *
 153   0 DEC  *  DEC    2228.70        12  13   4  0   DECAY FOR 106.0 DAYS              *
 154   0 IRF  *  IRF    2373.49   -1.0  13  14   4  0   BURNUP=45,000 MWD/MTIHM            *
 155    0 RDA  *  RDA    -7 = IRRADIATED ZIRCALOY GRID SPACERS AND INCONEL
SPRINGS          *
 156   0 RDA  *  RDA          AT DISCHARGE                                    *
 157   0 MOV  *  MOV      14     -7     0     1.0                                *
 158   0 PCH  *  PCH      -7     -7     -7                                     *
 159   0 RDA  *  RDA IRRAD. OF SS 304 END PIECES & INCONEL SPRINGS AT 0.130 FLUX
        *
 160   0 TIT  *  TIT IRRAD. OF SS 304 END PIECES & INCONEL SPRINGS AT 0.130 FLUX
        *
 161   0 MOV  *  MOV      -4     1     0    37.00      SS 304 IN END PIECES              *
 162   0 ADD  *  ADD -6     1     0     2.10      INCONEL X-750 EXPANSION SPRINGS
 *
 163   0 PCH  *  PCH      1     1     1                                          *
 164   0 HED  *  HED      1                                   CHARGE          *
 165   0 IRF  *  IRF     265.45   -0.13   1   2   4  2   BURNUP= 6,875 MWD/MTIHM            *
 166   0 DEC  *  DEC     371.45          2   3   4  0   DECAY FOR 106.0 DAYS              *
 167   0 IRF  *  IRF     636.90   -0.13   3   4   4  0   BURNUP=13,750 MWD/MTIHM            *
 168   0 DEC  *  DEC     742.90          4   5   4  0   DECAY FOR 106.0 DAYS              *
 169   0 IRF  *  IRF    1008.35   -0.13   5   6   4  0   BURNUP=20,625 MWD/MTIHM            *
 170   0 DEC  *  DEC    1114.35          6   7   4  0   DECAY FOR 106.0 DAYS              *
 171   0 IRF  *  IRF    1379.80   -0.13   7   8   4  0   BURNUP=27,500 MWD/MTIHM            *
 172   0 DEC  *  DEC    1485.80          8   9   4  0   DECAY FOR 106.0 DAYS              *
 173   0 IRF  *  IRF    1751.25   -0.13   9  10   4  0   BURNUP=34,375 MWD/MTIHM            *
 174   0 DEC  *  DEC    1857.25         10  11   4  0   DECAY FOR 106.0 DAYS              *
 175   0 IRF  *  IRF    2122.70   -0.13  11  12   4  0   BURNUP=41,250 MWD/MTIHM
*
 176   0 DEC  *  DEC    2228.70         12  13   4  0   DECAY FOR 106.0 DAYS              *
 177   0 IRF  *  IRF    2373.49   -0.13  13  14   4  0   BURNUP=45,000 MWD/MTIHM
*
  178     0 RDA   *   RDA -6 = IRRAD. SS 304 END PIECES & INCONEL SPRINGS AT
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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DISCHARGE          *
 179   0 MOV  *  MOV     14   -6   0   1.0                                  *
 180   0 PCH  *  PCH     -6   -6   -6                                    *
 181   0 RDA  *  RDA     IRRADIATION OF SS 302 IN PLENUM SPRINGS AT 0.500 FLUX
        *
 182   0 TIT  *  TIT     IRRADIATION OF SS 302 IN PLENUM SPRINGS AT 0.500 FLUX
      *
 183   0 MOV  *  MOV     -5    1    0    6.00      SS302                    *
 184   0 PCH  *  PCH      1    1    1                                    *
 185   0 HED  *  HED      1                                CHARGE          *
 186   0 IRF  *  IRF    265.45   -0.5   1   2   4  2   BURNUP= 6,875 MWD/MTIHM          *
 187   0 DEC  *  DEC    371.45        2   3   4  0   DECAY FOR 106.0 DAYS            *
 188   0 IRF  *  IRF    636.90   -0.5   3   4   4  0   BURNUP=13,750 MWD/MTIHM          *
 189   0 DEC  *  DEC    742.90        4   5   4  0   DECAY FOR 106.0 DAYS            *
 190   0 IRF  *  IRF   1008.35   -0.5   5   6   4  0   BURNUP=20,625 MWD/MTIHM          *
 191   0 DEC  *  DEC   1114.35        6   7   4  0   DECAY FOR 106.0 DAYS            *
 192   0 IRF  *  IRF   1379.80   -0.5   7   8   4  0   BURNUP=27,500 MWD/MTIHM          *
 193   0 DEC  *  DEC   1485.80        8   9   4  0   DECAY FOR 106.0 DAYS            *
 194   0 IRF  *  IRF   1751.25   -0.5   9  10   4  0   BURNUP=34,375 MWD/MTIHM          *
 195   0 DEC  *  DEC   1857.25       10  11   4  0   DECAY FOR 106.0 DAYS            *
 196   0 IRF  *  IRF   2122.70   -0.5  11  12   4  0   BURNUP=41,250 MWD/MTIHM          *
 197   0 DEC  *  DEC   2228.70       12  13   4  0   DECAY FOR 106.0 DAYS            *
 198   0 IRF  *  IRF   2373.49   -0.5  13  14   4  0   BURNUP=45,000 MWD/MTIHM          *
 199   0 RDA  *  RDA    -5 = IRRADIATED SS 302 IN PLENUM SPRINGS AT DISCHARGE
        *
1                                                OUTPUT UNIT =  6                PAGE   20
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 200   0 MOV  *  MOV     14   -5   0   1.0                                  *
 201   0 PCH  *  PCH     -5   -5   -5                                    *
 202   0 RDA  *  RDA     ***** OUTPUT MODULE *****                          *
 203    0 TIT  *  TIT TEST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP
(BWRU)          *
 204   0 BAS  *  BAS 1 MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4
CYCLE           *
 205   0 OPTL *  OPTL     6*8  7  8  8  8  14*8                            *
 206   0 OPTA *  OPTA     6*8  7  8  8  8  14*8                            *
 207   0 OPTF *  OPTF     6*8  7  8  8  8  14*8                            *
 208   0 MOV  *  MOV    -10    1    0   1.0                                  *
 209   0 ADD  *  ADD     -9    1    0   1.0                                  *
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 210   0 ADD  *  ADD     -8   1   0  1.0                                  *
 211   0 ADD  *  ADD     -7   1   0  1.0                                  *
 212   0 ADD  *  ADD     -6   1   0  1.0                                  *
 213   0 ADD  *  ADD     -5   1   0  1.0                                  *
 214   0 HED  *  HED    1   ASSY DIS                                        *
 215   0 RDA  *  RDA    ***** DECAY MODULE *****                                    *
 216   0 DEC  *  DEC    0.5  1  2  5  2                                   *
 217   0 DEC  *  DEC    1.0  2  3  5  0                                   *
 218   0 DEC  *  DEC    2.0  3  4  5  0                                   *
 219   0 DEC  *  DEC    5.0  4  5  5  0                                   *
 220   0 DEC  *  DEC   10.0  5  6  5  0                                    *
 221   0 DEC  *  DEC   26.0  6  7  5  0                                    *
 222   0 OUT  *  OUT     7   1    -1   0                                  *
 223   0 END  *  END                                                     *
```

0SUM OF YIELDS FOR EACH FISSILE ISOTOPE: 0.0000E+00 0.0000E+00 2.0003E+00 1.9997E+00 2.0006E+00 2.0001E+00

0ISOTOPES FOR WHICH YIELDS ARE EXPLICITLY ACCOUNTED FOR: 922350 922380 942390 942410

1 OUTPUT UNIT = 6 PAGE 21

ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)

POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC

0 REACTIVITY AND BURNUP DATA

BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
TIME, SEC	0.00E+00	1.58E+07	3.16E+07	6.31E+07	1.58E+08	3.16E+08	8.20E+08
NEUT. FLUX	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SP POW,MW	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BURNUP,MWD	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
K INFINITY	0.00000	0.87373	0.87064	0.86466	0.84837	0.82636	0.78554
NEUT PRODN	0.00E+00	8.45E+03	8.42E+03	8.37E+03	8.22E+03	8.01E+03	7.60E+03
NEUT DESTN	0.00E+00	9.67E+03	9.68E+03	9.68E+03	9.69E+03	9.69E+03	9.68E+03
TOT BURNUP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AVG N FLUX	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
AVG SP POW 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

SIZE OF MMAX(I): MMAX= 1 #= 876 MMAX= 2 #= 432 MMAX= 3 #= 142 MMAX= 4 #= 50 MMAX= 5 #= 85 MMAX= 6 #= 58
MMAX= 7 #= 46 MMAX= 8 #= 0 MMAX= 9 #= 0 MMAX=10 #= 0 MMAX=11 #= 0 MMAX=12 #= 0

THE NUMBER OF NON-ZERO TERMS IN A=6466
THE NUMBER OF NON-ZERO FISSION PRODUCT YIELDS=3242
ILITE= 688 IACT= 129 IFP= 879 ITOT=1696
THE NUMBER OF NON-ZERO NATURAL ABUNDANCES= 437
THE NUMBER OF NON-ZERO PHOTON YIELDS= 7903
THE MAXIMUM NUMBER OF TERMS IN AP= 396
1 OUTPUT UNIT = 6 PAGE 22
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTIVATION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
H 3	2.734E+02	2.659E+02	2.585E+02	2.444E+02	2.065E+02	1.560E+02	6.354E+01
H 4	3.761E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HE 6	1.588E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LI 8	2.031E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE 8	2.051E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE 10	1.493E-06	1.493E-06	1.493E-06	1.493E-06	1.493E-06	1.493E-06	1.493E-06
BE 11	2.495E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
B 12	1.763E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C 14	1.964E+00	1.964E+00	1.964E+00	1.964E+00	1.963E+00	1.962E+00	1.958E+00
C 15	2.421E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
N 16	1.516E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
O 19	3.176E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

F 20	3.131E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE 23	9.322E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA 24	2.460E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA 24M	1.025E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA 25	1.541E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MG 27	5.128E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AL 28	1.745E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AL 29	4.078E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AL 30	3.944E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SI 31	4.116E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SI 32	1.602E-08	1.601E-08	1.600E-08	1.598E-08	1.593E-08	1.585E-08	1.558E-08
P 32	1.210E+02	1.732E-02	2.494E-06	1.598E-08	1.593E-08	1.585E-08	1.558E-08
P 33	4.311E-03	2.727E-05	1.724E-07	6.896E-12	4.410E-25	0.000E+00	0.000E+00
P 34	5.747E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S 35	1.970E+01	4.674E+00	1.109E+00	6.245E-02	1.115E-05	6.310E-12	6.845E-32
S 37	1.469E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CL 36	1.395E-02	1.395E-02	1.395E-02	1.395E-02	1.395E-02	1.395E-02	1.395E-02
CL 38	6.339E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CL 38M	7.546E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AR 37	3.323E-01	8.949E-03	2.410E-04	1.749E-07	6.677E-17	2.282E-32	0.000E+00
AR 39	7.207E-05	7.198E-05	7.188E-05	7.170E-05	7.115E-05	7.024E-05	6.740E-05
AR 41	6.769E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
K 40	3.928E-09	3.928E-09	3.928E-09	3.928E-09	3.928E-09	3.928E-09	3.928E-09
K 42	6.699E-03	2.867E-13	2.837E-13	2.778E-13	2.608E-13	2.348E-13	1.678E-13
K 43	2.060E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
K 44	7.826E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CA 41	2.237E-04	2.237E-04	2.237E-04	2.237E-04	2.237E-04	2.237E-04	2.237E-04
CA 45	3.027E-01	1.392E-01	6.402E-02	1.354E-02	1.281E-04	5.421E-08	8.687E-19
CA 47	5.925E-04	4.493E-16	3.407E-28	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CA 49	3.946E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SC 46	1.078E+00	2.379E-01	5.252E-02	2.560E-03	2.964E-07	8.151E-14	0.000E+00
SC 46M	8.778E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SC 47	2.035E+00	1.799E-15	1.304E-27	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SC 48	1.900E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SC 49	2.319E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SC 50	3.255E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TI 51	5.065E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
V 52	6.451E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
V 53	4.082E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

1 OUTPUT UNIT = 6 PAGE 23

ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)

+ ACTIVATION PRODUCTS

POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC

0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES

MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
V 54	4.455E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR 51	1.152E+04	1.195E+02	1.240E+00	1.334E-04	1.663E-16	0.000E+00	0.000E+00
CR 55	1.681E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	2.791E+02	1.862E+02	1.242E+02	5.522E+01	4.860E+00	8.460E-02	1.986E-07
MN 56	2.138E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 57	1.069E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 58	3.317E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE 55	2.960E+03	2.591E+03	2.268E+03	1.737E+03	7.806E+02	2.058E+02	2.891E+00
FE 59	1.630E+02	9.781E+00	5.871E-01	2.115E-03	9.891E-11	6.004E-23	0.000E+00
CO 58	1.161E+03	1.941E+02	3.245E+01	9.072E-01	1.982E-05	3.385E-13	0.000E+00
CO 60	2.746E+03	2.571E+03	2.407E+03	2.111E+03	1.423E+03	7.370E+02	8.984E+01
CO 60M	4.350E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 61	3.453E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 62	1.414E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 59	1.335E+00	1.335E+00	1.335E+00	1.335E+00	1.335E+00	1.335E+00	1.335E+00
NI 63	1.996E+02	1.989E+02	1.981E+02	1.966E+02	1.923E+02	1.851E+02	1.641E+02
NI 65	2.244E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 66	1.188E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 64	2.780E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 66	6.167E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 67	8.332E-05	3.909E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 65	8.289E+01	4.933E+01	2.935E+01	1.039E+01	4.615E-01	2.569E-03	1.570E-10
ZN 69	8.058E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 69M	5.417E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 71	1.203E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 71M	1.261E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 70	1.191E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

GA 72	4.412E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 72M	1.363E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 71	5.714E-03	1.253E-07	2.748E-12	1.322E-21	0.000E+00	0.000E+00	0.000E+00
GE 71M	4.663E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	6.159E+01	5.021E+00	4.094E-01	2.721E-03	7.993E-10	1.037E-20	0.000E+00
SR 90	3.346E-03	3.307E-03	3.268E-03	3.191E-03	2.971E-03	2.638E-03	1.802E-03
SR 91	1.324E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 93	4.553E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 89M	4.496E-04	6.810E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 90	2.521E+03	3.308E-03	3.269E-03	3.192E-03	2.972E-03	2.638E-03	1.803E-03
Y 90M	1.828E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 91	1.517E+02	1.744E+01	2.004E+00	2.646E-02	6.091E-08	2.445E-17	0.000E+00
Y 92	3.118E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 93	4.553E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	9.471E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	6.060E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 89	4.503E-04	6.820E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	3.860E-01	3.860E-01	3.860E-01	3.860E-01	3.860E-01	3.860E-01	3.860E-01
ZR 95	6.888E+04	9.525E+03	1.317E+03	2.518E+01	1.761E-04	4.500E-13	0.000E+00
ZR 97	1.172E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 92	1.324E-01	5.139E-07	1.995E-12	3.006E-23	0.000E+00	0.000E+00	0.000E+00
NB 93M	5.003E-02	5.800E-02	6.577E-02	8.072E-02	1.213E-01	1.765E-01	2.825E-01
NB 94	3.969E-02	3.968E-02	3.968E-02	3.968E-02	3.968E-02	3.967E-02	3.965E-02
NB 95	5.911E+04	1.858E+04	2.853E+03	5.781E+01	3.909E-04	9.991E-13	0.000E+00

1 OUTPUT UNIT = 6 PAGE 24
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTIVATION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
NB 95M	4.841E+02	7.066E+01	9.771E+00	1.868E-01	1.306E-06	3.339E-15	0.000E+00
NB 96	5.486E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	1.172E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NB 97M	1.109E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	2.411E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB100	9.326E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93M	3.511E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	7.669E-04	7.669E-04	7.668E-04	7.666E-04	7.662E-04	7.654E-04	7.630E-04
MO 99	1.440E+02	1.469E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	6.111E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 98	5.111E-11	5.111E-11	5.111E-11	5.111E-11	5.111E-11	5.111E-11	5.111E-11
TC 99	1.563E-04	1.569E-04	1.569E-04	1.569E-04	1.569E-04	1.569E-04	1.569E-04
TC100	3.461E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC101	6.111E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU103	1.602E-03	6.387E-05	2.545E-06	4.043E-09	1.621E-17	1.597E-31	0.000E+00
RU105	1.154E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104	7.505E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104M	3.477E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH105	1.082E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	9.204E-06	4.699E-15	3.332E-15	1.675E-15	2.129E-16	6.851E-18	1.142E-22
PD107	1.145E-11	1.145E-11	1.145E-11	1.145E-11	1.145E-11	1.145E-11	1.145E-11
PD107M	1.277E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD109	5.120E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD109M	8.327E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD111	1.043E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD111M	1.452E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG106	5.710E-04	1.945E-10	6.625E-17	7.689E-30	0.000E+00	0.000E+00	0.000E+00
AG108	1.027E+01	1.331E-03	1.328E-03	1.320E-03	1.299E-03	1.264E-03	1.158E-03
AG108M	1.500E-02	1.496E-02	1.492E-02	1.484E-02	1.459E-02	1.420E-02	1.301E-02
AG109M	9.704E-01	6.998E-01	5.327E-01	3.087E-01	6.007E-02	3.925E-03	6.345E-07
AG110	2.310E+01	7.797E-03	4.698E-03	1.706E-03	8.164E-05	5.151E-07	4.696E-14
AG110M	9.729E-01	5.862E-01	3.532E-01	1.283E-01	6.138E-03	3.873E-05	3.531E-12
AG111	1.180E-01	4.932E-09	2.061E-16	3.651E-31	0.000E+00	0.000E+00	0.000E+00
AG111M	5.905E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG112	9.672E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD107	1.100E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD109	9.193E-01	6.998E-01	5.327E-01	3.087E-01	6.007E-02	3.925E-03	6.345E-07
CD111M	1.874E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115	2.424E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	1.899E+01	1.111E+00	6.502E-02	2.226E-04	8.929E-12	4.198E-24	0.000E+00
CD117	7.318E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD117M	2.766E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

CD119	1.257E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD121	3.786E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN113M	1.193E+03	3.975E+02	1.323E+02	1.467E+01	2.007E-02	3.360E-07	1.748E-22
IN114	5.944E+02	1.765E+01	1.369E+00	8.240E-03	1.795E-09	1.416E-20	0.000E+00
IN114M	2.378E+02	1.845E+01	1.431E+00	8.610E-03	1.876E-09	1.479E-20	0.000E+00
IN116	6.093E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN116M	4.863E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN117	4.405E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN117M	6.927E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 25
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTIVATION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
IN118	1.654E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN119	1.207E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN119M	1.257E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN121	3.105E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN113	1.193E+03	3.972E+02	1.323E+02	1.466E+01	2.006E-02	3.358E-07	1.747E-22
SN113M	6.836E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN117M	1.194E+04	1.417E+00	1.683E-04	2.371E-12	0.000E+00	0.000E+00	0.000E+00
SN119M	8.741E+03	5.215E+03	3.111E+03	1.107E+03	4.988E+01	2.845E-01	1.881E-08
SN121	5.698E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN121M	1.596E+00	1.585E+00	1.574E+00	1.552E+00	1.489E+00	1.389E+00	1.112E+00
SN123	4.300E+02	1.614E+02	6.057E+01	8.532E+00	2.382E-02	1.321E-06	3.170E-20
SN123M	2.244E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN125	3.715E+03	7.365E-03	1.460E-08	5.736E-20	0.000E+00	0.000E+00	0.000E+00
SN125M	2.942E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB122	8.037E+02	3.512E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB122M	7.087E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB124	3.793E+01	4.631E+00	5.655E-01	8.432E-03	2.795E-08	2.059E-17	0.000E+00
SB124M	1.315E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

SB125	3.118E+03	2.783E+03	2.456E+03	1.912E+03	9.024E+02	2.582E+02	4.711E+00
SB126	6.920E+01	2.542E-03	9.335E-08	1.259E-16	0.000E+00	0.000E+00	0.000E+00
SB126M	6.902E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE123M	6.109E+00	2.121E+00	7.366E-01	8.882E-02	1.553E-04	3.958E-09	7.900E-24
TE125M	6.846E+02	6.694E+02	5.980E+02	4.665E+02	2.202E+02	6.301E+01	1.149E+00
TE127	9.462E-01	1.818E-02	5.692E-03	5.580E-04	5.255E-07	4.755E-12	3.453E-28
TE127M	5.929E-02	1.856E-02	5.811E-03	5.696E-04	5.365E-07	4.854E-12	3.525E-28
TE129	2.450E-06	1.020E-09	2.357E-11	1.259E-14	1.917E-24	0.000E+00	0.000E+00
TE129M	6.780E-08	1.567E-09	3.621E-11	1.934E-14	2.946E-24	0.000E+00	0.000E+00
I128	4.229E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I130	6.735E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I130M	2.854E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE127	8.465E-08	2.617E-09	8.091E-11	7.733E-14	6.752E-23	0.000E+00	0.000E+00
XE129M	1.382E-05	1.856E-12	2.493E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM149	7.734E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM151	7.999E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM152	4.499E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM151	6.023E-06	6.029E-06	6.006E-06	5.960E-06	5.823E-06	5.603E-06	4.954E-06
SM153	5.095E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM155	8.907E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU152	1.210E-03	1.179E-03	1.150E-03	1.092E-03	9.375E-04	7.266E-04	3.215E-04
EU152M	2.164E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	1.458E+02	1.401E+02	1.345E+02	1.241E+02	9.747E+01	6.514E+01	1.794E+01
EU155	8.869E+01	8.270E+01	7.712E+01	6.706E+01	4.409E+01	2.192E+01	2.342E+00
EU156	1.729E+03	4.145E-01	9.934E-05	5.707E-12	0.000E+00	0.000E+00	0.000E+00
GD153	2.690E+02	1.594E+02	9.449E+01	3.320E+01	1.439E+00	7.704E-03	4.146E-10
GD155M	4.243E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD159	3.240E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD161	3.294E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD162	7.630E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	7.555E+03	1.312E+03	2.278E+02	6.868E+00	1.883E-04	4.691E-12	0.000E+00
TB161	4.454E+03	5.065E-05	5.759E-13	7.443E-29	0.000E+00	0.000E+00	0.000E+00
TB162	7.478E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 26
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTIVATION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
DY165	9.257E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY165M	4.047E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY166	2.467E+00	1.596E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO166	1.583E+02	2.378E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO166M	3.232E-03	3.231E-03	3.230E-03	3.228E-03	3.223E-03	3.213E-03	3.184E-03
ER167M	2.098E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER169	2.063E-02	2.924E-08	4.145E-14	8.329E-26	0.000E+00	0.000E+00	0.000E+00
ER171	7.485E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TM170	1.411E-03	5.271E-04	1.969E-04	2.750E-05	7.470E-08	3.963E-12	8.260E-26
TM170M	2.246E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TM171	1.201E-05	1.002E-05	8.369E-06	5.833E-06	1.975E-06	3.248E-07	1.006E-09
TM172	4.930E-06	8.858E-27	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TM173	4.487E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
YB175	3.751E-08	2.837E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
YB175M	2.654E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LU176	7.235E-11	7.235E-11	7.235E-11	7.235E-11	7.235E-11	7.235E-11	7.235E-11
LU176M	1.215E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LU177	4.938E+00	1.110E-03	4.904E-04	9.577E-05	7.131E-07	2.024E-10	9.047E-22
LU177M	1.092E-02	4.826E-03	2.133E-03	4.165E-04	3.101E-06	8.803E-10	3.934E-21
HF175	1.819E+01	2.981E+00	4.887E-01	1.313E-02	2.547E-07	3.568E-15	0.000E+00
HF178M	2.481E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HF179M	4.082E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HF180M	4.750E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HF181	8.724E+02	4.405E+01	2.225E+00	5.673E-03	9.408E-11	1.015E-23	0.000E+00
HF182	6.681E-07	6.681E-07	6.681E-07	6.681E-07	6.681E-07	6.681E-07	6.681E-07
TA182	9.061E+01	3.014E+01	1.003E+01	1.109E+00	1.503E-03	6.930E-07	6.681E-07
TA182M	1.617E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TA183	2.237E+02	3.717E-09	6.175E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W181	1.297E+00	4.564E-01	1.606E-01	1.988E-02	3.768E-05	1.095E-09	3.328E-24
W183M	2.256E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W185	4.037E+01	7.482E+00	1.387E+00	4.763E-02	1.931E-06	9.234E-14	0.000E+00
W185M	5.438E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W187	8.248E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

W188	1.574E+00	2.540E-01	4.099E-02	1.068E-03	1.885E-08	2.257E-16	0.000E+00
RE186	3.383E+01	9.390E-14	2.606E-28	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RE187	4.186E-08	4.191E-08	4.191E-08	4.191E-08	4.191E-08	4.191E-08	4.191E-08
RE188	3.190E+02	2.567E-01	4.142E-02	1.079E-03	1.904E-08	2.280E-16	0.000E+00
RE188M	3.106E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RE189	1.298E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OS190M	3.693E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OS191	4.226E-02	1.172E-05	3.165E-09	2.307E-16	0.000E+00	0.000E+00	0.000E+00
OS191M	3.163E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OS193	1.115E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
OS194	3.788E-10	3.575E-10	3.375E-10	3.007E-10	2.126E-10	1.193E-10	1.879E-11
IR192	1.307E-02	2.363E-03	4.273E-04	1.399E-05	1.855E-08	1.780E-08	1.700E-08
IR192M	1.830E-08	1.828E-08	1.825E-08	1.820E-08	1.804E-08	1.778E-08	1.698E-08
IR194	4.843E-04	3.577E-10	3.376E-10	3.008E-10	2.127E-10	1.194E-10	1.880E-11
IR194M	2.552E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PT193	1.903E-07	1.910E-07	1.909E-07	1.906E-07	1.898E-07	1.885E-07	1.844E-07
PT193M	3.752E-05	6.155E-18	1.004E-30	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PT195M	3.237E-08	1.005E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 27
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTIVATION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
TL206	2.029E-08	2.029E-08	2.029E-08	2.029E-08	2.029E-08	2.029E-08	2.029E-08
PB205	2.192E-09	2.192E-09	2.192E-09	2.192E-09	2.192E-09	2.192E-09	2.192E-09
PB209	4.784E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BI208	2.282E-08	2.282E-08	2.282E-08	2.282E-08	2.282E-08	2.282E-08	2.282E-08
BI210	3.358E-02	3.600E-13	3.860E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BI210M	2.037E-08	2.037E-08	2.037E-08	2.037E-08	2.037E-08	2.037E-08	2.037E-08
BI211	2.643E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PO210	2.419E-02	1.020E-02	4.088E-03	6.564E-04	2.717E-06	3.716E-10	8.147E-11
PO211	2.923E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
SUMTOT 6.253E+05 4.584E+04 1.655E+04 8.200E+03 3.928E+03 1.698E+03 3.517E+02
0TOTAL 6.253E+05 4.584E+04 1.655E+04 8.200E+03 3.928E+03 1.698E+03 3.517E+02
1 OUTPUT UNIT = 6 PAGE 28
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTIVATION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
H	2.772E+02	2.659E+02	2.585E+02	2.444E+02	2.065E+02	1.560E+02	6.354E+01
HE	1.588E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LI	2.031E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE	2.051E+00	1.493E-06	1.493E-06	1.493E-06	1.493E-06	1.493E-06	1.493E-06
B	1.763E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C	2.618E+01	1.964E+00	1.964E+00	1.964E+00	1.963E+00	1.962E+00	1.958E+00
N	1.516E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
O	3.176E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
F	3.131E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	9.322E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NA	3.485E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MG	5.128E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AL	1.749E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SI	4.116E+01	1.601E-08	1.600E-08	1.598E-08	1.593E-08	1.585E-08	1.558E-08
P	1.211E+02	1.735E-02	2.666E-06	1.599E-08	1.593E-08	1.585E-08	1.558E-08
S	1.971E+01	4.674E+00	1.109E+00	6.245E-02	1.115E-05	6.310E-12	6.845E-32
CL	6.428E+00	1.395E-02	1.395E-02	1.395E-02	1.395E-02	1.395E-02	1.395E-02
AR	3.324E-01	9.021E-03	3.129E-04	7.187E-05	7.115E-05	7.024E-05	6.740E-05
K	6.984E-03	3.928E-09	3.928E-09	3.928E-09	3.928E-09	3.928E-09	3.928E-09
CA	3.430E-01	1.394E-01	6.425E-02	1.376E-02	3.518E-04	2.238E-04	2.237E-04
SC	3.547E+00	2.379E-01	5.252E-02	2.560E-03	2.964E-07	8.151E-14	0.000E+00
TI	5.065E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
V	6.455E+02	7.841E-15	7.841E-15	7.841E-15	7.841E-15	7.841E-15	7.841E-15
CR	1.169E+04	1.195E+02	1.240E+00	1.334E-04	1.663E-16	0.000E+00	0.000E+00
MN	2.166E+04	1.862E+02	1.242E+02	5.522E+01	4.860E+00	8.460E-02	1.986E-07

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

FE	3.123E+03	2.601E+03	2.268E+03	1.737E+03	7.806E+02	2.058E+02	2.891E+00
CO	8.291E+03	2.765E+03	2.440E+03	2.112E+03	1.423E+03	7.370E+02	8.984E+01
NI	4.254E+02	2.002E+02	1.995E+02	1.980E+02	1.936E+02	1.865E+02	1.655E+02
CU	3.396E+02	3.909E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN	1.690E+02	4.933E+01	2.935E+01	1.039E+01	4.615E-01	2.569E-03	1.570E-10
GA	1.196E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE	6.180E-03	1.253E-07	2.748E-12	1.322E-21	0.000E+00	0.000E+00	0.000E+00
SR	7.488E+01	5.025E+00	4.127E-01	5.912E-03	2.971E-03	2.638E-03	1.802E-03
Y	2.994E+03	1.744E+01	2.007E+00	2.965E-02	2.972E-03	2.638E-03	1.803E-03
ZR	1.860E+05	9.525E+03	1.317E+03	2.557E+01	3.861E-01	3.860E-01	3.860E-01
NB	2.877E+05	1.865E+04	2.863E+03	5.812E+01	1.613E-01	2.161E-01	3.222E-01
MO	1.501E+02	7.669E-04	7.668E-04	7.666E-04	7.662E-04	7.654E-04	7.630E-04
TC	9.573E+00	1.569E-04	1.569E-04	1.569E-04	1.569E-04	1.569E-04	1.569E-04
RU	1.602E-03	6.387E-05	2.545E-06	4.043E-09	2.290E-16	6.851E-18	1.142E-22
RH	8.775E-05	3.170E-11	2.813E-11	2.215E-11	1.081E-11	3.272E-12	7.145E-14
PD	5.322E-02	1.145E-11	1.145E-11	1.145E-11	1.145E-11	1.145E-11	1.145E-11
AG	3.551E+01	1.310E+00	9.069E-01	4.548E-01	8.218E-02	1.943E-02	1.417E-02
CD	2.728E+02	1.811E+00	5.977E-01	3.089E-01	6.007E-02	3.925E-03	6.345E-07
IN	2.147E+03	4.336E+02	1.351E+02	1.469E+01	2.007E-02	3.360E-07	1.150E-13
SN	3.535E+04	5.776E+03	3.305E+03	1.132E+03	5.141E+01	1.673E+00	1.112E+00
SB	4.043E+03	2.787E+03	2.456E+03	1.912E+03	9.024E+02	2.582E+02	4.711E+00
TE	6.917E+02	6.716E+02	5.988E+02	4.666E+02	2.202E+02	6.301E+01	1.149E+00
I	4.229E-02	7.731E-14	7.732E-14	7.732E-14	7.732E-14	7.732E-14	7.732E-14
XE	1.391E-05	2.619E-09	8.091E-11	7.733E-14	6.752E-23	0.000E+00	0.000E+00
PM	8.044E-04	7.097E-14	6.152E-14	4.721E-14	2.137E-14	5.702E-15	8.319E-17
SM	5.190E-03	6.029E-06	6.006E-06	5.960E-06	5.823E-06	5.603E-06	4.954E-06
EU	1.964E+03	2.232E+02	2.117E+02	1.912E+02	1.416E+02	8.706E+01	2.028E+01
GD	3.597E+04	1.594E+02	9.449E+01	3.320E+01	1.439E+00	7.704E-03	4.152E-10
TB	1.201E+04	1.312E+03	2.278E+02	6.868E+00	1.883E-04	4.691E-12	0.000E+00
DY	1.333E+03	1.596E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO	1.583E+02	3.231E-03	3.230E-03	3.228E-03	3.223E-03	3.213E-03	3.184E-03
ER	2.119E+00	2.924E-08	4.145E-14	8.329E-26	0.000E+00	0.000E+00	0.000E+00
TM	1.657E-03	5.371E-04	2.053E-04	3.333E-05	2.049E-06	3.248E-07	1.006E-09
YB	6.405E-08	2.837E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LU	1.710E+01	5.936E-03	2.623E-03	5.122E-04	3.814E-06	1.155E-09	7.235E-11
HF	5.022E+03	4.703E+01	2.713E+00	1.880E-02	9.229E-07	6.681E-07	6.681E-07
TA	3.145E+02	3.014E+01	1.003E+01	1.109E+00	1.503E-03	6.930E-07	6.681E-07
W	8.704E+02	8.192E+00	1.588E+00	6.858E-02	3.963E-05	1.095E-09	3.328E-24
RE	6.634E+02	2.567E-01	4.142E-02	1.079E-03	6.095E-08	4.191E-08	4.191E-08

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

OS	7.393E-02	1.172E-05	3.502E-09	3.007E-10	2.126E-10	1.193E-10	1.879E-11
IR	1.358E-02	2.363E-03	4.273E-04	1.401E-05	3.680E-08	3.570E-08	3.400E-08
PT	3.774E-05	1.910E-07	1.909E-07	1.906E-07	1.898E-07	1.885E-07	1.844E-07
TL	2.029E-08	2.029E-08	2.029E-08	2.029E-08	2.029E-08	2.029E-08	2.029E-08
PB	4.784E-04	2.192E-09	2.192E-09	2.192E-09	2.192E-09	2.192E-09	2.192E-09
BI	3.358E-02	4.319E-08	4.319E-08	4.319E-08	4.319E-08	4.319E-08	4.319E-08
PO	2.419E-02	1.020E-02	4.088E-03	6.564E-04	2.717E-06	3.716E-10	8.147E-11
SUMTOT	6.253E+05	4.584E+04	1.655E+04	8.200E+03	3.928E+03	1.698E+03	3.517E+02
0TOTAL	6.253E+05	4.584E+04	1.655E+04	8.200E+03	3.928E+03	1.698E+03	3.517E+02

0 CUMULATIVE TABLE TOTALS

AP+FP	6.253E+05	4.584E+04	1.655E+04	8.200E+03	3.928E+03	1.698E+03	3.517E+02
ACT+FP	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AP+ACT+FP	6.253E+05	4.584E+04	1.655E+04	8.200E+03	3.928E+03	1.698E+03	3.517E+02

1 OUTPUT UNIT = 6 PAGE 29
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTINIDES+DAUGHTERS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
TL207	1.704E-06	2.117E-06	2.560E-06	3.499E-06	6.026E-06	9.969E-06	2.079E-05
TL208	2.628E-03	3.540E-03	4.482E-03	6.332E-03	1.086E-02	1.453E-02	1.444E-02
TL209	2.845E-08	9.983E-09	9.985E-09	1.001E-08	1.013E-08	1.041E-08	1.208E-08
PB209	1.321E-06	4.622E-07	4.623E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
PB210	9.788E-09	1.125E-08	1.258E-08	1.574E-08	3.011E-08	7.525E-08	5.012E-07
PB211	1.708E-06	2.123E-06	2.568E-06	3.508E-06	6.043E-06	9.997E-06	2.085E-05
PB212	7.316E-03	9.852E-03	1.247E-02	1.762E-02	3.023E-02	4.043E-02	4.019E-02
PB214	8.094E-08	9.174E-08	1.035E-07	1.295E-07	2.290E-07	4.689E-07	1.919E-06
BI210	9.846E-09	1.126E-08	1.259E-08	1.575E-08	3.012E-08	7.526E-08	5.012E-07
BI211	1.708E-06	2.123E-06	2.568E-06	3.508E-06	6.043E-06	9.997E-06	2.085E-05
BI212	7.316E-03	9.852E-03	1.247E-02	1.762E-02	3.023E-02	4.043E-02	4.019E-02
BI213	1.317E-06	4.622E-07	4.623E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
BI214	8.094E-08	9.174E-08	1.035E-07	1.295E-07	2.290E-07	4.689E-07	1.919E-06

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

PO210	7.498E-09	9.326E-09	1.083E-08	1.382E-08	2.686E-08	7.527E-08	5.012E-07
PO211	4.784E-09	5.945E-09	7.189E-09	9.824E-09	1.692E-08	2.799E-08	5.837E-08
PO212	4.687E-03	6.312E-03	7.992E-03	1.129E-02	1.937E-02	2.590E-02	2.575E-02
PO213	1.289E-06	4.522E-07	4.523E-07	4.534E-07	4.587E-07	4.717E-07	5.473E-07
PO214	1.946E-07	9.198E-08	1.034E-07	1.295E-07	2.290E-07	4.688E-07	1.918E-06
PO215	1.708E-06	2.123E-06	2.568E-06	3.508E-06	6.043E-06	9.997E-06	2.085E-05
PO216	7.316E-03	9.852E-03	1.247E-02	1.762E-02	3.023E-02	4.043E-02	4.019E-02
PO218	8.096E-08	9.176E-08	1.035E-07	1.296E-07	2.291E-07	4.690E-07	1.919E-06
AT217	1.317E-06	4.622E-07	4.623E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
RN219	1.708E-06	2.123E-06	2.568E-06	3.508E-06	6.043E-06	9.997E-06	2.085E-05
RN220	7.316E-03	9.852E-03	1.247E-02	1.762E-02	3.023E-02	4.043E-02	4.019E-02
RN222	8.096E-08	9.176E-08	1.035E-07	1.296E-07	2.291E-07	4.690E-07	1.919E-06
FR221	1.317E-06	4.622E-07	4.623E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
FR223	2.399E-08	3.016E-08	3.627E-08	4.833E-08	8.329E-08	1.378E-07	2.875E-07
RA223	1.708E-06	2.123E-06	2.568E-06	3.508E-06	6.043E-06	9.997E-06	2.085E-05
RA224	7.316E-03	9.852E-03	1.247E-02	1.762E-02	3.023E-02	4.043E-02	4.019E-02
RA225	1.316E-06	4.616E-07	4.621E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
RA226	8.090E-08	9.176E-08	1.035E-07	1.296E-07	2.291E-07	4.690E-07	1.919E-06
AC225	1.317E-06	4.622E-07	4.623E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
AC227	1.738E-06	2.185E-06	2.628E-06	3.502E-06	6.036E-06	9.985E-06	2.083E-05
AC228	2.071E-05	1.845E-11	2.193E-11	2.976E-11	5.922E-11	1.230E-10	3.862E-10
TH227	1.680E-06	2.090E-06	2.528E-06	3.460E-06	5.960E-06	9.859E-06	2.056E-05
TH228	7.271E-03	9.820E-03	1.243E-02	1.758E-02	3.020E-02	4.040E-02	4.019E-02
TH229	4.608E-07	4.614E-07	4.620E-07	4.634E-07	4.688E-07	4.821E-07	5.594E-07
TH230	4.824E-05	5.222E-05	5.623E-05	6.434E-05	8.935E-05	1.333E-04	2.917E-04
TH231	1.032E+00	1.827E-02	1.827E-02	1.827E-02	1.827E-02	1.828E-02	1.828E-02
TH232	7.353E-11	8.284E-11	9.216E-11	1.108E-10	1.667E-10	2.598E-10	5.581E-10
TH233	3.696E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TH234	3.126E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01
PA231	2.986E-05	3.014E-05	3.034E-05	3.072E-05	3.188E-05	3.381E-05	3.999E-05
PA232	7.613E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PA233	5.021E-01	4.965E-01	4.965E-01	4.967E-01	4.976E-01	5.002E-01	5.148E-01
PA234M	3.179E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01
PA234	5.712E-03	4.061E-04	4.061E-04	4.061E-04	4.061E-04	4.061E-04	4.061E-04
U231	2.532E-05	2.064E-18	1.597E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U232	2.097E-02	2.413E-02	2.688E-02	3.138E-02	3.935E-02	4.323E-02	3.922E-02
U233	1.166E-05	1.275E-05	1.383E-05	1.623E-05	2.299E-05	3.389E-05	6.935E-05
U234	8.816E-01	8.878E-01	8.941E-01	9.070E-01	9.452E-01	1.007E+00	1.189E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTINIDES+DAUGHTERS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
U235	1.827E-02	1.827E-02	1.827E-02	1.827E-02	1.827E-02	1.828E-02	1.828E-02
U236	3.776E-01	3.776E-01	3.776E-01	3.776E-01	3.777E-01	3.777E-01	3.780E-01
U237	8.707E+05	3.312E+00	3.227E+00	3.076E+00	2.662E+00	2.093E+00	9.687E-01
U238	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01	3.124E-01
U239	1.428E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U240	2.763E+01	5.311E-07	5.311E-07	5.311E-07	5.311E-07	5.311E-07	5.311E-07
U241	2.824E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP235	6.568E-03	4.771E-03	3.466E-03	1.829E-03	2.688E-04	1.100E-05	3.977E-10
NP236M	7.073E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP236	6.687E-06	6.687E-06	6.687E-06	6.687E-06	6.687E-06	6.686E-06	6.686E-06
NP237	4.889E-01	4.964E-01	4.965E-01	4.967E-01	4.976E-01	5.002E-01	5.148E-01
NP238	3.937E+05	7.794E-02	7.777E-02	7.741E-02	7.636E-02	7.464E-02	6.939E-02
NP239	1.426E+07	2.442E+01	2.442E+01	2.441E+01	2.441E+01	2.440E+01	2.436E+01
NP240M	3.056E+03	5.311E-07	5.311E-07	5.311E-07	5.311E-07	5.311E-07	5.311E-07
NP240	1.213E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP241	2.824E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU236	7.110E-01	6.324E-01	5.600E-01	4.391E-01	2.117E-01	6.279E-02	1.284E-03
PU237	5.905E-01	3.680E-02	2.293E-03	8.890E-06	5.191E-13	4.563E-25	0.000E+00
PU238	4.249E+03	4.446E+03	4.515E+03	4.537E+03	4.446E+03	4.275E+03	3.769E+03
PU239	2.994E+02	3.032E+02	3.032E+02	3.032E+02	3.032E+02	3.032E+02	3.031E+02
PU240	5.522E+02	5.524E+02	5.525E+02	5.528E+02	5.534E+02	5.544E+02	5.562E+02
PU241	1.380E+05	1.348E+05	1.316E+05	1.254E+05	1.085E+05	8.530E+04	3.949E+04
PU242	2.153E+00	2.154E+00	2.154E+00	2.154E+00	2.154E+00	2.154E+00	2.154E+00
PU243	3.074E+05	2.112E-07	2.112E-07	2.112E-07	2.112E-07	2.112E-07	2.112E-07
PU244	5.317E-07	5.318E-07	5.318E-07	5.318E-07	5.318E-07	5.318E-07	5.318E-07
PU245	6.108E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU246	1.499E-04	1.285E-09	2.268E-14	1.166E-14	1.166E-14	1.166E-14	1.165E-14
AM239	1.388E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

AM240	3.808E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM241	2.445E+02	3.536E+02	4.601E+02	6.651E+02	1.222E+03	1.983E+03	3.437E+03
AM242M	1.562E+01	1.559E+01	1.555E+01	1.548E+01	1.527E+01	1.493E+01	1.388E+01
AM242	1.274E+05	1.551E+01	1.547E+01	1.540E+01	1.520E+01	1.485E+01	1.381E+01
AM243	2.439E+01	2.442E+01	2.442E+01	2.441E+01	2.441E+01	2.440E+01	2.436E+01
AM244M	9.931E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM244	5.215E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM245	6.108E-01	2.030E-08	1.367E-08	6.198E-09	5.774E-10	1.106E-11	3.520E-17
AM246	1.499E-04	1.287E-09	2.270E-14	1.166E-14	1.166E-14	1.166E-14	1.165E-14
CM241	1.482E-02	4.404E-04	1.308E-05	1.155E-08	7.942E-18	0.000E+00	0.000E+00
CM242	6.797E+04	3.150E+04	1.451E+04	3.085E+03	4.185E+01	1.230E+01	1.142E+01
CM243	3.243E+01	3.204E+01	3.165E+01	3.089E+01	2.871E+01	2.543E+01	1.723E+01
CM244	3.140E+03	3.082E+03	3.023E+03	2.910E+03	2.594E+03	2.142E+03	1.161E+03
CM245	2.610E-01	2.610E-01	2.610E-01	2.610E-01	2.609E-01	2.608E-01	2.605E-01
CM246	6.608E-02	6.608E-02	6.607E-02	6.606E-02	6.603E-02	6.598E-02	6.583E-02
CM247	2.112E-07	2.112E-07	2.112E-07	2.112E-07	2.112E-07	2.112E-07	2.112E-07
CM248	5.648E-07	5.649E-07	5.649E-07	5.650E-07	5.650E-07	5.651E-07	5.651E-07
CM249	1.414E-02	6.682E-12	5.477E-15	3.680E-21	0.000E+00	0.000E+00	0.000E+00
BK249	2.076E-03	1.400E-03	9.426E-04	4.273E-04	3.981E-05	7.624E-07	2.427E-12
BK250	4.826E-03	1.281E-08	8.097E-09	3.232E-09	2.056E-10	2.092E-12	6.527E-15
BK251	1.809E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CF249	1.177E-06	2.873E-06	4.012E-06	5.291E-06	6.225E-06	6.260E-06	6.067E-06
CF250	3.097E-05	3.029E-05	2.950E-05	2.798E-05	2.387E-05	1.831E-05	7.843E-06

1 OUTPUT UNIT = 6 PAGE 31
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ ACTINIDES+DAUGHTERS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
CF251	1.796E-07	1.796E-07	1.795E-07	1.794E-07	1.789E-07	1.782E-07	1.761E-07
CF252	3.859E-05	3.383E-05	2.967E-05	2.281E-05	1.037E-05	2.788E-06	4.164E-08
CF253	2.623E-06	2.150E-09	1.762E-12	1.184E-18	0.000E+00	0.000E+00	0.000E+00
CF254	3.039E-08	3.750E-09	4.627E-10	7.046E-12	2.488E-17	2.037E-26	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 ES253      1.869E-06 2.564E-08 7.084E-11 3.435E-16 2.282E-32 0.000E+00 0.000E+00
 ES254      2.027E-08 1.281E-08 8.093E-09 3.231E-09 2.055E-10 2.084E-12 8.669E-19
 SUMTOT     3.057E+07 1.751E+05 1.550E+05 1.375E+05 1.178E+05 9.468E+04 4.883E+04
0TOTAL      3.057E+07 1.751E+05 1.550E+05 1.375E+05 1.178E+05 9.468E+04 4.883E+04
1                                                OUTPUT UNIT =  6                PAGE   32
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

    *ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+                                                        ACTINIDES+DAUGHTERS
        POWER= 1.00000E+00 MW,   BURNUP= 1.00000E+00 MWD,   FLUX= 1.00E+00
N/CM**2-SEC
0              7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                  MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

         ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 TL        2.630E-03 3.542E-03 4.484E-03 6.336E-03 1.087E-02 1.454E-02 1.446E-02
 PB        7.319E-03 9.854E-03 1.248E-02 1.763E-02 3.023E-02 4.044E-02 4.022E-02
 BI        7.319E-03 9.854E-03 1.248E-02 1.763E-02 3.023E-02 4.044E-02 4.022E-02
 PO        1.201E-02 1.617E-02 2.047E-02 2.892E-02 4.960E-02 6.634E-02 6.597E-02
 AT        1.317E-06 4.622E-07 4.623E-07 4.634E-07 4.688E-07 4.821E-07 5.594E-07
 RN        7.317E-03 9.854E-03 1.248E-02 1.763E-02 3.023E-02 4.044E-02 4.022E-02
 FR        1.341E-06 4.923E-07 4.985E-07 5.117E-07 5.521E-07 6.199E-07 8.469E-07
 RA        7.319E-03 9.854E-03 1.248E-02 1.763E-02 3.023E-02 4.044E-02 4.022E-02
 AC        2.376E-05 2.647E-06 3.090E-06 3.966E-06 6.505E-06 1.047E-05 2.139E-05
 TH        1.389E+00 3.406E-01 3.432E-01 3.483E-01 3.610E-01 3.712E-01 3.712E-01
 PA        1.587E+00 8.093E-01 8.093E-01 8.096E-01 8.105E-01 8.131E-01 8.277E-01
  U        1.515E+07 4.932E+00 4.857E+00 4.722E+00 4.355E+00 3.851E+00 2.906E+00
 NP        1.467E+07 2.500E+01 2.499E+01 2.499E+01 2.498E+01 2.497E+01 2.494E+01
 PU        4.506E+05 1.401E+05 1.369E+05 1.308E+05 1.138E+05 9.044E+04 4.412E+04
 AM        2.322E+05 4.091E+02 5.155E+02 7.204E+02 1.277E+03 2.037E+03 3.489E+03
 CM        7.114E+04 3.461E+04 1.756E+04 6.026E+03 2.665E+03 2.180E+03 1.190E+03
 BK        6.904E-03 1.400E-03 9.426E-04 4.273E-04 3.981E-05 7.624E-07 2.433E-12
 CF        7.356E-05 6.718E-05 6.336E-05 5.626E-05 4.064E-05 2.754E-05 1.413E-05
 ES        1.999E-06 3.848E-08 8.165E-09 3.231E-09 2.055E-10 2.084E-12 8.669E-19
 SUMTOT     3.057E+07 1.751E+05 1.550E+05 1.375E+05 1.178E+05 9.468E+04 4.883E+04
0TOTAL      3.057E+07 1.751E+05 1.550E+05 1.375E+05 1.178E+05 9.468E+04 4.883E+04
0                              CUMULATIVE TABLE TOTALS
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

AP+FP	6.253E+05	4.584E+04	1.655E+04	8.200E+03	3.928E+03	1.698E+03	3.517E+02
ACT+FP	3.057E+07	1.751E+05	1.550E+05	1.375E+05	1.178E+05	9.468E+04	4.883E+04
AP+ACT+FP	3.119E+07	2.210E+05	1.716E+05	1.457E+05	1.217E+05	9.638E+04	4.918E+04

1 OUTPUT UNIT = 6 PAGE 33
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
H 3	6.497E+02	6.317E+02	6.142E+02	5.807E+02	4.907E+02	3.706E+02	1.510E+02
BE 10	3.952E-06	3.952E-06	3.952E-06	3.952E-06	3.952E-06	3.952E-06	3.952E-06
C 14	1.593E-04	1.593E-04	1.593E-04	1.593E-04	1.592E-04	1.591E-04	1.588E-04
CU 66	4.574E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 72	8.647E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 72	1.724E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 72	3.543E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 72	4.257E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 72	4.273E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 73	2.736E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 73	1.382E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 73	4.518E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 73	8.038E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 73	8.526E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 73M	8.533E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 74	5.424E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 74	8.670E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 74	6.274E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 74	1.560E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 74	1.680E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 75	7.191E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 75	3.512E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 75	6.207E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 75	2.890E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

GA 75	3.526E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 75	3.575E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 75M	1.645E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 76	9.190E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 76	4.754E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 76	4.997E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 76	7.733E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 76	2.950E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 77	1.537E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 77	2.156E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 77	5.462E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 77	1.400E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 77	6.459E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 77M	1.400E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 77	1.759E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 77M	5.220E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 78	1.791E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 78	7.781E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 78	5.397E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 78	2.470E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 78	3.981E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 78	4.102E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 79	2.094E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 79	3.240E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 79	2.668E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 79	8.209E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 79	9.674E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 34
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS 0.5YR 1.0YR 2.0YR 5.0YR 10.0YR 26.0YR

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

SE 79	5.517E-01	5.517E-01	5.517E-01	5.517E-01	5.516E-01	5.516E-01	5.515E-01
SE 79M	9.711E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 79M	1.335E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 80	2.248E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 80	1.192E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 80	2.682E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 80	1.613E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 80	2.111E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 80	6.761E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 80M	4.149E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 81	1.633E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 81	2.637E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 81	1.527E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 81	1.885E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 81	3.275E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 81	3.533E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 81M	9.753E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 81	6.208E-07	6.208E-07	6.208E-07	6.208E-07	6.208E-07	6.208E-07	6.208E-07
KR 81M	2.817E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 82	3.385E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 82	5.546E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 82	1.600E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 82	2.791E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 82M	1.187E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 82	5.005E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 82M	2.084E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 83	3.103E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 83	1.502E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 83	1.132E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 83	4.939E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 83	3.114E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 83M	4.603E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 83	7.899E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 83M	7.928E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 84	1.820E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 84	3.446E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 84	3.944E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 84	1.298E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 84	1.350E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 BR 84M    5.274E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 GE 85     8.658E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AS 85     2.284E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SE 85     7.438E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SE 85M    5.565E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BR 85     1.621E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR 85     1.166E+04 1.129E+04 1.093E+04 1.024E+04 8.439E+03 6.107E+03 2.171E+03
 KR 85M    1.645E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 GE 86     1.611E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AS 86     1.203E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SE 86     1.442E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BR 86     1.152E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1                                        OUTPUT UNIT =  6                PAGE   35
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

   *ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+                                                  FISSION PRODUCTS
      POWER= 1.00000E+00 MW,   BURNUP= 1.00000E+00 MWD,   FLUX= 1.00E+00
N/CM**2-SEC
0              7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                 MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 BR 86M    1.157E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 86     1.958E+03 2.221E+00 2.494E-03 3.190E-09 6.672E-27 0.000E+00 0.000E+00
 RB 86M    2.154E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 GE 87     2.241E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AS 87     5.943E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SE 87     1.165E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BR 87     2.622E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR 87     3.119E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 87     3.039E-05 3.039E-05 3.039E-05 3.039E-05 3.039E-05 3.039E-05 3.039E-05
 SR 87M    6.971E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 GE 88     7.974E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 AS 88     4.479E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SE 88     4.266E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BR 88     2.747E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR 88     4.380E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

RB 88	4.461E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 89	4.585E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 89	1.195E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 89	1.881E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 89	5.290E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 89	5.696E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	5.312E+05	4.332E+04	3.532E+03	2.348E+01	6.897E-06	8.952E-17	0.000E+00
Y 89M	3.757E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 90	3.615E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 90	1.177E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 90	5.213E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90	5.500E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90M	1.329E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	9.915E+04	9.797E+04	9.681E+04	9.454E+04	8.802E+04	7.815E+04	5.340E+04
Y 90	1.030E+05	9.800E+04	9.684E+04	9.456E+04	8.804E+04	7.816E+04	5.341E+04
Y 90M	1.337E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 90M	3.413E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 91	5.058E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 91	4.003E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 91	3.852E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 91	6.926E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 91	7.486E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 91	6.760E+05	7.830E+04	8.997E+03	1.188E+02	2.735E-04	1.098E-13	0.000E+00
Y 91M	4.345E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 92	2.582E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 92	4.243E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 92	1.899E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 92	6.097E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 92	8.210E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 92	8.250E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 93	7.651E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 93	6.948E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 93	4.640E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 93	9.441E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 93	9.698E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	2.518E+00	2.519E+00	2.519E+00	2.519E+00	2.519E+00	2.519E+00	2.519E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
NB 93M	3.862E-01	4.367E-01	4.859E-01	5.806E-01	8.376E-01	1.187E+00	1.860E+00
BR 94	6.322E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 94	2.450E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	2.444E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 94	8.990E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	9.902E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 94	1.682E-04	1.682E-04	1.682E-04	1.682E-04	1.682E-04	1.682E-04	1.681E-04
NB 94M	8.393E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 95	4.732E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 95	3.018E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 95	1.187E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 95	8.313E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 95	1.072E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	9.575E+05	1.324E+05	1.831E+04	3.501E+02	2.448E-03	6.257E-12	0.000E+00
NB 95	8.371E+05	2.587E+05	3.968E+04	8.037E+02	5.434E-03	1.389E-11	0.000E+00
NB 95M	6.805E+03	9.823E+02	1.358E+02	2.597E+00	1.816E-05	4.642E-14	0.000E+00
BR 96	2.475E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 96	4.590E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 96	3.388E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 96	5.761E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	1.022E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 96	1.569E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 97	2.655E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 97	6.454E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 97	3.014E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 97	8.805E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 97	1.126E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	1.136E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97M	1.068E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 98	2.982E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

RB 98	1.345E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 98	1.162E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 98	6.228E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 98	1.140E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	1.161E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98M	1.211E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 98	6.701E-06	6.701E-06	6.701E-06	6.701E-06	6.701E-06	6.701E-06	6.701E-06
RB 99	1.319E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 99	3.096E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 99	3.528E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 99	1.131E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	1.180E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99M	4.963E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 99	1.282E+06	1.309E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 99	1.753E+01	1.758E+01	1.758E+01	1.758E+01	1.758E+01	1.758E+01	1.758E+01
TC 99M	1.122E+06	1.261E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB100	1.102E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR100	5.905E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y100	1.566E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR100	1.040E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB100	6.590E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 37
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY	DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
NB100M	6.590E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC100	3.884E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR101	8.168E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y101	4.975E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	6.609E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB101	1.089E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

MO101	1.169E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC101	1.170E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR102	7.370E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y102	1.210E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR102	3.719E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB102	9.266E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO102	1.120E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	1.122E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102M	1.368E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH102	1.155E+00	1.025E+00	9.094E-01	7.161E-01	3.496E-01	1.058E-01	2.310E-03
SR103	2.490E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y103	1.730E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR103	1.368E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB103	6.463E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO103	1.091E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC103	1.108E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU103	1.051E+06	4.187E+04	1.669E+03	2.650E+00	1.062E-08	1.075E-22	0.000E+00
RH103M	9.461E+05	3.775E+04	1.505E+03	2.390E+00	9.575E-09	9.687E-23	0.000E+00
SR104	1.029E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y104	1.567E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR104	3.234E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB104	3.131E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO104	8.825E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	9.448E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104	7.976E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104M	5.930E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y105	8.105E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR105	4.394E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB105	1.066E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO105	6.329E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC105	7.818E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU105	7.968E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH105	7.458E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH105M	2.231E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR106	5.165E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB106	2.876E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO106	3.471E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC106	5.598E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	3.846E+05	2.727E+05	1.934E+05	9.722E+04	1.236E+04	3.969E+02	6.613E-03

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

RH106 4.189E+05 2.727E+05 1.934E+05 9.722E+04 1.236E+04 3.969E+02 6.613E-03
RH106M 1.725E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
Y107 4.908E-03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZR107 2.321E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NB107 4.470E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
MO107 1.300E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1 OUTPUT UNIT = 6 PAGE 38
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS 0.5YR 1.0YR 2.0YR 5.0YR 10.0YR 26.0YR

TC107 3.162E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RU107 4.770E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH107 4.793E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
PD107 1.340E-01 1.340E-01 1.340E-01 1.340E-01 1.340E-01 1.340E-01 1.340E-01
PD107M 8.721E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZR108 5.145E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NB108 7.310E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
MO108 3.426E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
TC108 1.815E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RU108 3.312E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH108 3.343E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH108M 3.120E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AG108 1.218E+00 3.437E-06 3.427E-06 3.409E-06 3.353E-06 3.263E-06 2.990E-06
AG108M 3.872E-05 3.862E-05 3.851E-05 3.830E-05 3.768E-05 3.667E-05 3.360E-05
ZR109 3.741E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NB109 1.354E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
MO109 9.935E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
TC109 8.087E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RU109 2.023E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH109 2.111E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH109M 1.055E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

PD109	2.605E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD109M	1.064E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG109M	2.604E+05	8.269E-04	6.295E-04	3.648E-04	7.098E-05	4.638E-06	7.498E-10
CD109	1.086E-03	8.269E-04	6.295E-04	3.648E-04	7.098E-05	4.638E-06	7.498E-10
NB110	1.471E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO110	1.736E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC110	1.889E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU110	8.748E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH110	9.450E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH110M	7.025E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG110	1.265E+05	2.915E+01	1.757E+01	6.378E+00	3.052E-01	1.926E-03	1.756E-10
AG110M	3.638E+03	2.192E+03	1.321E+03	4.795E+02	2.295E+01	1.448E-01	1.320E-08
NB111	1.246E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO111	3.382E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC111	5.470E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU111	3.670E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH111	5.102E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD111	5.249E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD111M	8.270E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG111	5.315E+04	2.227E-03	9.302E-11	1.624E-25	0.000E+00	0.000E+00	0.000E+00
AG111M	5.255E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD111M	2.812E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO112	6.101E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC112	1.693E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU112	1.455E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH112	2.432E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD112	2.620E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG112	2.626E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO113	4.328E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC113	4.353E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 39
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
RU113	7.238E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH113	1.638E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD113	2.012E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG113	1.814E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG113M	2.043E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	6.072E+01	5.931E+01	5.791E+01	5.523E+01	4.789E+01	3.776E+01	1.766E+01
IN113M	3.344E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO114	4.408E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC114	9.544E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU114	3.027E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH114	8.859E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD114	1.338E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG114	1.359E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	1.266E+01	3.704E-01	2.873E-02	1.729E-04	3.765E-11	2.970E-22	0.000E+00
IN114M	4.989E+00	3.870E-01	3.002E-02	1.806E-04	3.935E-11	3.103E-22	0.000E+00
MO115	2.935E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC115	2.001E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU115	1.357E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH115	6.213E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD115	1.215E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG115	9.145E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG115M	3.545E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115	1.213E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	1.084E+03	6.345E+01	3.712E+00	1.272E-02	5.103E-10	2.399E-22	0.000E+00
IN115M	1.215E+04	4.459E-03	2.609E-04	8.940E-07	3.586E-14	1.686E-26	0.000E+00
TC116	1.233E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU116	3.011E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH116	2.888E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD116	9.095E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG116	5.153E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG116M	5.154E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN116	7.003E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN116M	5.634E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC117	5.251E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU117	4.493E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH117	1.618E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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PD117     7.868E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AG117     5.004E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AG117M    5.003E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CD117     6.656E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CD117M    3.620E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
IN117     6.152E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
IN117M    7.783E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
SN117M    7.749E+01 9.198E-03 1.092E-06 1.539E-14 0.000E+00 0.000E+00 0.000E+00
RU118     2.893E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH118     2.281E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
PD118     6.220E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AG118     6.627E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AG118M    4.547E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CD118     1.017E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
IN118     1.018E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1                                        OUTPUT UNIT =  6                PAGE   40
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

   *ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+                                                FISSION PRODUCTS
      POWER= 1.00000E+00 MW,   BURNUP= 1.00000E+00 MWD,   FLUX= 1.00E+00
N/CM**2-SEC
0              7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                 MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

IN118M    4.923E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH119     2.054E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
PD119     4.806E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AG119     9.207E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CD119     5.063E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CD119M    5.063E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
IN119     2.916E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
IN119M    7.598E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
SN119M    1.343E+02 8.014E+01 4.781E+01 1.701E+01 7.665E-01 4.372E-03 2.890E-10
RU120     6.085E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH120     2.805E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
PD120     1.644E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

AG120	6.049E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD120	9.939E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN120	5.088E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN120M	5.088E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH121	4.401E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD121	6.351E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG121	4.110E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD121	9.770E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN121	8.358E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN121M	2.115E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN121	1.050E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN121M	2.497E-01	2.479E-01	2.462E-01	2.428E-01	2.329E-01	2.173E-01	1.741E-01
RH122	5.322E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD122	1.922E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG122	2.492E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD122	9.236E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN122	1.004E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN122M	8.039E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB122	1.638E+03	7.156E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB122M	1.453E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH123	4.538E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD123	4.342E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG123	1.292E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD123	8.707E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN123	8.289E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN123M	3.581E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN123	1.913E+03	7.178E+02	2.694E+02	3.795E+01	1.061E-01	5.881E-06	1.411E-19
SN123M	9.851E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE123M	1.295E+01	4.496E+00	1.561E+00	1.882E-01	3.293E-04	8.392E-09	1.675E-23
PD124	8.252E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG124	5.949E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD124	7.920E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN124	1.352E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB124	1.003E+03	1.225E+02	1.496E+01	2.230E-01	7.391E-07	5.446E-16	0.000E+00
SB124M	8.457E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG125	1.892E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD125	5.780E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN125	8.848E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN125M	6.562E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
1 OUTPUT UNIT = 6 PAGE 41
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
SN125	9.039E+03	1.792E-02	3.552E-08	1.396E-19	0.000E+00	0.000E+00	0.000E+00
SN125M	1.465E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	1.162E+04	1.033E+04	9.115E+03	7.097E+03	3.350E+03	9.585E+02	1.749E+01
TE125M	2.557E+03	2.486E+03	2.220E+03	1.731E+03	8.173E+02	2.339E+02	4.267E+00
PD126	1.290E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG126	5.988E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD126	4.349E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN126	2.008E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	9.186E-01	9.186E-01	9.186E-01	9.185E-01	9.185E-01	9.185E-01	9.184E-01
SB126	7.436E+02	1.559E-01	1.286E-01	1.286E-01	1.286E-01	1.286E-01	1.286E-01
SB126M	3.569E+02	9.186E-01	9.186E-01	9.185E-01	9.185E-01	9.185E-01	9.184E-01
CD127	2.591E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN127	1.226E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN127M	1.227E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN127	4.757E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN127M	2.304E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB127	7.556E+04	4.014E-10	2.102E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE127	7.297E+04	2.586E+03	8.098E+02	7.937E+01	7.475E-02	6.764E-07	4.912E-23
TE127M	8.044E+03	2.641E+03	8.267E+02	8.103E+01	7.632E-02	6.906E-07	5.015E-23
XE127	4.539E-02	1.403E-03	4.338E-05	4.146E-08	3.620E-17	2.282E-32	0.000E+00
AG128	2.674E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD128	9.945E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN128	2.009E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN128	1.120E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB128	1.057E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB128M	1.223E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I128	1.032E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

CD129	3.796E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN129	1.648E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN129	7.617E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN129M	8.554E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB129	2.250E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129	2.207E+05	4.825E+02	1.115E+01	5.956E-03	9.072E-13	3.941E-29	0.000E+00
TE129M	3.192E+04	7.413E+02	1.713E+01	9.149E-03	1.394E-12	6.056E-29	0.000E+00
I129	3.982E-02	4.002E-02	4.002E-02	4.002E-02	4.002E-02	4.002E-02	4.002E-02
XE129M	6.940E+00	9.320E-07	1.252E-13	2.257E-27	0.000E+00	0.000E+00	0.000E+00
CD130	3.246E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN130	1.757E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN130	2.420E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB130	7.454E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB130M	3.225E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I130	3.545E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I130M	1.493E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD131	5.013E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN131	6.205E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN131	2.093E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB131	5.696E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE131	6.091E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE131M	1.009E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I131	6.891E+05	1.033E-01	1.502E-08	3.177E-22	0.000E+00	0.000E+00	0.000E+00
XE131M	7.683E+03	5.748E-01	1.383E-05	7.939E-15	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 42
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY	DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
CD132	4.472E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN132	1.511E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN132	1.091E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

SB132	3.319E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132M	2.221E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE132	9.744E+05	1.304E-11	1.745E-28	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I132	9.909E+05	1.344E-11	1.798E-28	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS132	2.087E+02	6.738E-07	2.175E-15	2.282E-32	0.000E+00	0.000E+00	0.000E+00
IN133	1.628E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN133	3.166E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB133	3.799E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133	8.117E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133M	4.957E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I133	1.385E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I133M	4.414E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	1.389E+06	5.642E-05	1.865E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133M	4.365E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN134	8.905E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN134	4.193E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB134	6.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB134M	5.911E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	1.116E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	1.519E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134M	1.559E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE134M	1.093E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	1.838E+05	1.554E+05	1.314E+05	9.385E+04	3.423E+04	6.375E+03	2.941E+01
CS134M	4.994E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN135	4.519E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB135	3.383E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE135	5.880E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I135	1.300E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE135	3.774E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE135M	2.775E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS135	7.004E-01	7.010E-01	7.010E-01	7.010E-01	7.010E-01	7.010E-01	7.010E-01
CS135M	2.767E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA135M	2.007E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN136	3.812E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB136	6.388E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE136	3.038E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	6.102E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	3.619E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS136	5.585E+04	3.556E+00	2.265E-04	9.182E-13	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 BA136M    9.204E+03 5.861E-01 3.732E-05 1.513E-13 0.000E+00 0.000E+00 0.000E+00
 SB137     8.897E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TE137     8.310E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  I137     5.887E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE137     1.211E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS137     1.351E+05 1.336E+05 1.320E+05 1.290E+05 1.204E+05 1.072E+05 7.410E+04
 BA137M    1.280E+05 1.264E+05 1.249E+05 1.220E+05 1.139E+05 1.015E+05 7.010E+04
 SB138     1.061E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TE138     1.953E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1                                          OUTPUT UNIT =  6                PAGE   43
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

   *ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+                                                   FISSION PRODUCTS
      POWER= 1.00000E+00 MW,   BURNUP= 1.00000E+00 MWD,   FLUX= 1.00E+00
N/CM**2-SEC
0              7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                 MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

  I138     2.866E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE138     1.126E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS138     1.253E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS138M    6.136E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SB139     7.700E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TE139     3.650E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  I139     1.243E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE139     8.740E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS139     1.186E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BA139     1.227E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TE140     4.312E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  I140     3.381E+04 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE140     5.620E+05 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS140     1.067E+06 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BA140     1.183E+06 5.947E+01 2.991E-03 7.563E-12 0.000E+00 0.000E+00 0.000E+00
 LA140     1.235E+06 6.844E+01 3.442E-03 8.703E-12 0.000E+00 0.000E+00 0.000E+00
 PR140     1.881E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TE141     1.918E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

I141	5.397E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE141	1.952E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS141	7.856E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	1.110E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA141	1.115E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	1.087E+06	2.227E+04	4.537E+02	1.883E-01	1.346E-11	1.658E-28	0.000E+00
TE142	1.975E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I142	7.356E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE142	6.446E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS142	4.695E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA142	1.047E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	1.073E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	3.713E-05	3.714E-05	3.714E-05	3.714E-05	3.714E-05	3.714E-05	3.714E-05
PR142	8.181E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR142M	1.784E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I143	4.778E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE143	1.074E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS143	2.265E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA143	9.109E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA143	1.017E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE143	1.025E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR143	1.020E+06	1.006E+02	8.907E-03	6.984E-11	0.000E+00	0.000E+00	0.000E+00
I144	3.750E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE144	1.786E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS144	6.467E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA144	6.808E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA144	8.940E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144	7.021E+05	4.498E+05	2.881E+05	1.182E+05	8.173E+03	9.515E+01	6.161E-05
PR144	7.073E+05	4.498E+05	2.881E+05	1.182E+05	8.173E+03	9.515E+01	6.161E-05
PR144M	8.435E+03	5.397E+03	3.458E+03	1.419E+03	9.808E+01	1.142E+00	7.393E-07
XE145	1.828E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS145	1.586E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA145	3.484E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 44
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
LA145	6.473E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE145	6.972E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR145	6.975E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE146	1.153E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS146	2.236E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA146	1.272E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA146	4.223E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE146	5.598E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR146	5.621E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM146	2.518E+00	2.365E+00	2.220E+00	1.957E+00	1.341E+00	7.142E-01	9.508E-02
SM146	4.437E-07	4.482E-07	4.524E-07	4.600E-07	4.779E-07	4.962E-07	5.142E-07
XE147	9.836E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS147	3.368E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA147	2.843E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA147	2.054E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE147	4.346E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR147	4.470E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND147	4.503E+05	4.823E+00	5.161E-05	5.909E-15	0.000E+00	0.000E+00	0.000E+00
PM147	1.161E+05	1.063E+05	9.318E+04	7.155E+04	3.239E+04	8.642E+03	1.261E+02
SM147	3.336E-06	3.704E-06	4.027E-06	4.557E-06	5.517E-06	6.100E-06	6.308E-06
CS148	2.119E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA148	4.766E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA148	7.615E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE148	3.190E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR148	3.563E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.823E+05	6.582E+01	3.070E+00	6.686E-03	6.883E-11	3.352E-24	0.000E+00
PM148M	2.505E+04	1.169E+03	5.450E+01	1.187E-01	1.222E-09	5.951E-23	0.000E+00
BA149	5.159E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA149	1.857E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE149	1.772E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR149	2.506E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND149	2.672E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM149	3.909E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

CS150	1.949E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA150	3.761E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA150	3.465E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE150	8.194E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR150	1.690E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM150	3.678E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU150	3.145E-05	3.115E-05	3.085E-05	3.026E-05	2.856E-05	2.594E-05	1.906E-05
LA151	4.262E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE151	2.432E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR151	9.441E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND151	1.416E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM151	1.419E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM151	4.049E+02	4.085E+02	4.069E+02	4.038E+02	3.946E+02	3.797E+02	3.357E+02
BA152	9.540E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA152	4.509E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE152	5.179E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR152	4.188E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND152	9.855E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 45
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
PM152	1.010E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM152M	1.911E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU152	1.379E+01	1.344E+01	1.310E+01	1.245E+01	1.069E+01	8.282E+00	3.664E+00
EU152M	1.309E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA153	4.445E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE153	8.502E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR153	1.312E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND153	5.836E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM153	6.644E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

SM153	3.877E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	8.905E+01	5.278E+01	3.128E+01	1.099E+01	4.765E-01	2.551E-03	1.373E-10
LA154	2.033E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE154	9.477E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR154	3.123E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND154	3.083E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM154	3.803E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM154M	6.547E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	1.468E+04	1.410E+04	1.354E+04	1.249E+04	9.811E+03	6.557E+03	1.806E+03
CE155	1.040E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR155	6.011E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND155	1.193E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM155	2.425E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM155	2.898E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU155	8.732E+03	8.143E+03	7.593E+03	6.603E+03	4.341E+03	2.158E+03	2.306E+02
GD155M	1.616E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE156	9.652E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR156	1.093E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND156	4.306E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM156	1.370E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM156	1.829E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU156	1.829E+05	4.395E+01	1.054E-02	6.053E-10	0.000E+00	0.000E+00	0.000E+00
CE157	7.332E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR157	1.576E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND157	1.186E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM157	6.680E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM157	1.220E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU157	1.873E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR158	1.111E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND158	1.789E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM158	2.189E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM158	6.722E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU158	7.193E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR159	4.204E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND159	1.685E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM159	4.974E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM159	3.187E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU159	3.863E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD159	5.087E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

ND160	1.193E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM160	7.975E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM160	1.142E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 46
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
EU160	1.750E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	8.205E+02	1.425E+02	2.474E+01	7.459E-01	2.045E-05	5.095E-13	0.000E+00
ND161	7.609E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM161	8.805E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM161	3.073E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU161	7.525E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD161	8.794E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB161	1.006E+03	1.145E-05	1.301E-13	1.682E-29	0.000E+00	0.000E+00	0.000E+00
PM162	3.465E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM162	3.642E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU162	2.100E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD162	3.880E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB162	3.843E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB162M	1.184E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM163	3.810E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU163	4.711E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD163	1.526E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB163	1.650E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM164	3.073E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU164	8.865E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD164	5.836E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB164	7.309E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM165	1.800E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU165	1.303E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

GD165	1.872E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB165	3.134E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY165	4.521E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY165M	1.988E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY166	2.215E+01	1.433E-15	9.127E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO166	1.338E+02	2.135E-15	1.369E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO166M	3.608E-03	3.607E-03	3.606E-03	3.604E-03	3.597E-03	3.587E-03	3.554E-03
ER167M	3.219E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER169	2.451E-01	3.474E-07	4.925E-13	9.895E-25	0.000E+00	0.000E+00	0.000E+00
TM170	4.873E-02	1.821E-02	6.803E-03	9.498E-04	2.582E-06	1.370E-10	2.855E-24
TM170M	5.781E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TM171	7.627E-04	6.367E-04	5.316E-04	3.705E-04	1.254E-04	2.063E-05	6.394E-08
TM172	5.576E-05	1.002E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SUMTOT	1.185E+08	2.842E+06	1.764E+06	1.079E+06	5.458E+05	3.978E+05	2.559E+05
0TOTAL	1.185E+08	2.842E+06	1.764E+06	1.079E+06	5.458E+05	3.978E+05	2.559E+05

1 OUTPUT UNIT = 6 PAGE 47
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

*ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
+ FISSION PRODUCTS
POWER= 1.00000E+00 MW, BURNUP= 1.00000E+00 MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 7 SUMMARY TABLE: RADIOACTIVITY, CURIES
MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
H	6.497E+02	6.317E+02	6.142E+02	5.807E+02	4.907E+02	3.706E+02	1.510E+02
BE	3.952E-06	3.952E-06	3.952E-06	3.952E-06	3.952E-06	3.952E-06	3.952E-06
C	1.593E-04	1.593E-04	1.593E-04	1.593E-04	1.592E-04	1.591E-04	1.588E-04
CO	1.200E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI	4.434E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU	2.846E+02	2.282E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN	2.627E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA	1.289E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE	8.150E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS	2.393E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	7.026E+05	5.517E-01	5.517E-01	5.517E-01	5.516E-01	5.516E-01	5.515E-01
BR	1.507E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

KR	2.728E+06	1.129E+04	1.093E+04	1.024E+04	8.439E+03	6.107E+03	2.171E+03
RB	3.872E+06	2.221E+00	2.524E-03	3.040E-05	3.039E-05	3.039E-05	3.039E-05
SR	5.906E+06	1.413E+05	1.003E+05	9.456E+04	8.802E+04	7.815E+04	5.340E+04
Y	8.169E+06	1.763E+05	1.058E+05	9.468E+04	8.804E+04	7.816E+04	5.341E+04
ZR	6.601E+06	1.324E+05	1.831E+04	3.526E+02	2.521E+00	2.519E+00	2.519E+00
NB	9.885E+06	2.597E+05	3.981E+04	8.069E+02	8.432E-01	1.188E+00	1.860E+00
MO	6.701E+06	1.309E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC	7.803E+06	1.758E+01	1.758E+01	1.758E+01	1.758E+01	1.758E+01	1.758E+01
RU	3.393E+06	3.146E+05	1.950E+05	9.723E+04	1.236E+04	3.969E+02	6.613E-03
RH	4.557E+06	3.105E+05	1.949E+05	9.723E+04	1.236E+04	3.970E+02	8.923E-03
PD	5.226E+05	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.340E-01	1.340E-01
AG	6.244E+05	2.221E+03	1.338E+03	4.859E+02	2.326E+01	1.468E-01	3.660E-05
CD	1.039E+05	1.228E+02	6.163E+01	5.524E+01	4.789E+01	3.776E+01	1.766E+01
IN	2.384E+05	7.618E-01	5.901E-02	3.544E-04	9.025E-11	1.321E-11	1.321E-11
SN	9.872E+05	7.992E+02	3.184E+02	5.612E+01	2.024E+00	1.140E+00	1.092E+00
SB	2.513E+06	1.045E+04	9.131E+03	7.098E+03	3.351E+03	9.596E+02	1.853E+01
TE	5.442E+06	8.942E+03	3.886E+03	1.892E+03	8.174E+02	2.339E+02	4.267E+00
I	8.157E+06	1.433E-01	4.002E-02	4.002E-02	4.002E-02	4.002E-02	4.002E-02
XE	6.151E+06	5.762E-01	5.721E-05	4.146E-08	3.620E-17	2.282E-32	0.000E+00
CS	5.584E+06	2.890E+05	2.634E+05	2.229E+05	1.546E+05	1.136E+05	7.413E+04
BA	6.804E+06	1.264E+05	1.249E+05	1.220E+05	1.139E+05	1.015E+05	7.010E+04
LA	6.708E+06	6.844E+01	3.442E-03	1.571E-10	1.484E-10	1.484E-10	1.484E-10
CE	5.114E+06	4.720E+05	2.886E+05	1.182E+05	8.173E+03	9.515E+01	9.874E-05
PR	4.471E+06	4.553E+05	2.916E+05	1.197E+05	8.271E+03	9.629E+01	6.235E-05
ND	1.065E+06	4.823E+00	5.161E-05	2.207E-09	2.247E-09	2.250E-09	2.250E-09
PM	1.121E+06	1.076E+05	9.324E+04	7.155E+04	3.239E+04	8.643E+03	1.262E+02
SM	4.590E+05	4.085E+02	4.069E+02	4.038E+02	3.946E+02	3.797E+02	3.357E+02
EU	2.390E+05	2.230E+04	2.115E+04	1.911E+04	1.416E+04	8.723E+03	2.040E+03
GD	6.675E+03	5.278E+01	3.128E+01	1.099E+01	4.765E-01	2.551E-03	1.383E-10
TB	2.492E+03	1.425E+02	2.474E+01	7.459E-01	2.045E-05	5.095E-13	0.000E+00
DY	6.731E+02	1.433E-15	9.127E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO	1.338E+02	3.607E-03	3.606E-03	3.604E-03	3.597E-03	3.587E-03	3.554E-03
ER	3.464E+00	3.474E-07	4.925E-13	9.895E-25	0.000E+00	0.000E+00	0.000E+00
TM	5.532E-02	1.884E-02	7.334E-03	1.320E-03	1.280E-04	2.063E-05	6.394E-08
SUMTOT	1.185E+08	2.842E+06	1.764E+06	1.079E+06	5.458E+05	3.978E+05	2.559E+05
0TOTAL	1.185E+08	2.842E+06	1.764E+06	1.079E+06	5.458E+05	3.978E+05	2.559E+05

0 CUMULATIVE TABLE TOTALS

AP+FP	1.191E+08	2.888E+06	1.780E+06	1.087E+06	5.498E+05	3.995E+05	2.563E+05

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

ACT+FP	1.490E+08	3.018E+06	1.919E+06	1.217E+06	6.636E+05	4.925E+05	3.047E+05
AP+ACT+FP	1.497E+08	3.063E+06	1.935E+06	1.225E+06	6.676E+05	4.942E+05	3.051E+05

1 OUTPUT UNIT = 6 PAGE 48
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)

(ALPHA,N) NEUTRON SOURCE, NEUTRONS/SEC
BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
PU238	4.043E+06	4.230E+06	4.295E+06	4.317E+06	4.230E+06	4.067E+06	3.586E+06
PU239	2.181E+05	2.209E+05	2.209E+05	2.209E+05	2.209E+05	2.208E+05	2.207E+05
PU240	4.184E+05	4.185E+05	4.186E+05	4.188E+05	4.194E+05	4.201E+05	4.214E+05
AM241	2.345E+05	3.392E+05	4.413E+05	6.380E+05	1.172E+06	1.902E+06	3.296E+06
AM243	2.081E+04	2.083E+04	2.083E+04	2.083E+04	2.082E+04	2.081E+04	2.078E+04
CM242	9.124E+07	4.228E+07	1.948E+07	4.142E+06	5.618E+04	1.651E+04	1.533E+04
CM243	4.317E+04	4.265E+04	4.214E+04	4.112E+04	3.823E+04	3.385E+04	2.294E+04
CM244	3.584E+06	3.517E+06	3.450E+06	3.320E+06	2.960E+06	2.445E+06	1.325E+06

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TOTALS							
TABLE	9.980E+07	5.107E+07	2.837E+07	1.312E+07	9.122E+06	9.129E+06	8.912E+06
ACTUAL	9.980E+07	5.107E+07	2.837E+07	1.312E+07	9.122E+06	9.129E+06	8.912E+06

1 OUTPUT UNIT = 6 PAGE 49
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)

SPONTANEOUS FISSION NEUTRON SOURCE, NEUTRONS/SEC
BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
PU238	6.593E+05	6.898E+05	7.005E+05	7.040E+05	6.899E+05	6.633E+05	5.847E+05
PU240	2.206E+06	2.206E+06	2.207E+06	2.208E+06	2.211E+06	2.214E+06	2.222E+06
PU242	9.504E+05	9.504E+05	9.504E+05	9.504E+05	9.504E+05	9.504E+05	9.504E+05
CM242	4.427E+08	2.052E+08	9.450E+07	2.010E+07	2.726E+05	8.013E+04	7.438E+04
CM244	4.315E+08	4.234E+08	4.154E+08	3.998E+08	3.564E+08	2.943E+08	1.595E+08
CM246	1.914E+06	1.913E+06	1.913E+06	1.913E+06	1.912E+06	1.911E+06	1.906E+06

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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TOTALS
TABLE 8.801E+08 6.345E+08 5.158E+08 4.258E+08 3.625E+08 3.002E+08 1.653E+08
ACTUAL 8.801E+08 6.345E+08 5.158E+08 4.258E+08 3.625E+08 3.002E+08 1.653E+08

0----------

OVERALL
TOTALS
TABLE 9.799E+08 6.856E+08 5.442E+08 4.389E+08 3.716E+08 3.093E+08 1.742E+08
ACTUAL 9.799E+08 6.856E+08 5.442E+08 4.389E+08 3.716E+08 3.093E+08 1.742E+08

1 OUTPUT UNIT = 6 PAGE 50
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
PHOTON SPECTRUM FOR ACTIVATION PRODUCTS
0 ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
POWER= 1.00 MW, BURNUP= 1. MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE
EMEAN

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
1.000E-02	4.482E+15	7.899E+13	2.790E+13	1.343E+13	6.402E+12	2.754E+12	3.563E+11
2.500E-02	1.422E+15	1.733E+14	1.174E+14	6.693E+13	2.391E+13	6.769E+12	1.690E+11
3.750E-02	6.044E+14	3.107E+13	2.259E+13	1.574E+13	7.392E+12	2.579E+12	2.317E+11
5.750E-02	8.829E+14	1.811E+13	5.064E+12	1.748E+12	8.563E+11	4.272E+11	7.061E+10
8.500E-02	5.289E+14	1.236E+13	4.136E+12	1.679E+12	7.862E+11	3.746E+11	4.410E+10
1.250E-01	3.346E+14	6.384E+12	3.957E+12	2.954E+12	1.974E+12	1.194E+12	2.890E+11
2.250E-01	9.057E+14	3.043E+13	1.018E+13	4.860E+12	2.348E+12	7.915E+11	6.751E+10
3.750E-01	4.616E+14	3.916E+13	3.312E+13	2.561E+13	1.210E+13	3.483E+12	7.260E+10
5.750E-01	5.417E+15	5.206E+13	4.314E+13	3.328E+13	1.583E+13	4.661E+12	1.442E+11
8.500E-01	8.894E+15	9.766E+14	1.516E+14	7.160E+12	1.900E+12	1.155E+12	3.193E+11
1.250E+00	6.716E+14	2.095E+14	1.841E+14	1.589E+14	1.071E+14	5.579E+13	6.996E+12
1.750E+00	3.182E+14	2.035E+11	9.620E+10	7.345E+10	5.699E+10	3.807E+10	1.048E+10
2.250E+00	1.203E+14	1.286E+10	2.095E+09	8.448E+08	5.578E+08	2.890E+08	3.522E+07
2.750E+00	2.413E+13	1.001E+07	3.762E+06	2.573E+06	1.726E+06	8.941E+05	1.090E+05
3.500E+00	1.355E+12	6.641E-02	2.661E-02	4.274E-03	1.792E-05	2.237E-07	1.963E-07

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 5.000E+00  2.524E+10 1.977E-02 7.923E-03 1.272E-03 5.306E-06 4.005E-08 3.949E-08
 7.000E+00  3.680E+12 1.283E-03 5.141E-04 8.256E-05 3.442E-07 2.593E-09 2.557E-09
 9.500E+00  3.853E+09 8.112E-05 3.251E-05 5.221E-06 2.177E-08 1.642E-10 1.619E-10
0  TOTAL    2.507E+16 1.628E+15 6.033E+14 3.323E+14 1.807E+14 8.002E+13 8.771E+12
0MEV/SEC    1.306E+16 1.153E+15 4.039E+14 2.376E+14 1.511E+14 7.545E+13 9.220E+12
0                          18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                       BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM,
4 CYCLE
 EMEAN
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 1.000E-02  4.482E+07 7.899E+05 2.790E+05 1.343E+05 6.402E+04 2.754E+04 3.563E+03
 2.500E-02  3.556E+07 4.333E+06 2.935E+06 1.673E+06 5.978E+05 1.692E+05 4.226E+03
 3.750E-02  2.267E+07 1.165E+06 8.470E+05 5.903E+05 2.772E+05 9.670E+04 8.690E+03
 5.750E-02  5.076E+07 1.041E+06 2.912E+05 1.005E+05 4.923E+04 2.456E+04 4.060E+03
 8.500E-02  4.495E+07 1.051E+06 3.516E+05 1.427E+05 6.683E+04 3.184E+04 3.748E+03
 1.250E-01  4.183E+07 7.980E+05 4.946E+05 3.692E+05 2.467E+05 1.492E+05 3.612E+04
 2.250E-01  2.038E+08 6.847E+06 2.289E+06 1.094E+06 5.284E+05 1.781E+05 1.519E+04
 3.750E-01  1.731E+08 1.469E+07 1.242E+07 9.603E+06 4.539E+06 1.306E+06 2.723E+04
 5.750E-01  3.115E+09 2.993E+07 2.481E+07 1.914E+07 9.103E+06 2.680E+06 8.292E+04
 8.500E-01  7.560E+09 8.301E+08 1.288E+08 6.086E+06 1.615E+06 9.820E+05 2.714E+05
 1.250E+00  8.395E+08 2.619E+08 2.302E+08 1.986E+08 1.339E+08 6.974E+07 8.745E+06
 1.750E+00  5.568E+08 3.561E+05 1.683E+05 1.285E+05 9.973E+04 6.662E+04 1.835E+04
 2.250E+00  2.707E+08 2.893E+04 4.714E+03 1.901E+03 1.255E+03 6.501E+02 7.925E+01
 2.750E+00  6.637E+07 2.752E+01 1.035E+01 7.077E+00 4.746E+00 2.459E+00 2.997E-01
 3.500E+00  4.744E+06 2.324E-07 9.314E-08 1.496E-08 6.272E-11 7.831E-13 6.871E-13
 5.000E+00  1.262E+05 9.886E-08 3.962E-08 6.362E-09 2.653E-11 2.003E-13 1.974E-13
 7.000E+00  2.576E+07 8.980E-09 3.599E-09 5.779E-10 2.410E-12 1.815E-14 1.790E-14
 9.500E+00  3.661E+04 7.707E-10 3.088E-10 4.960E-11 2.068E-13 1.560E-15 1.538E-15
0  TOTAL    1.306E+10 1.153E+09 4.039E+08 2.376E+08 1.511E+08 7.545E+07 9.220E+06
0 GAM POW   2.093E+03 1.848E+02 6.474E+01 3.809E+01 2.422E+01 1.209E+01 1.478E+00
1                                          OUTPUT UNIT =  6                PAGE   51
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP  1,PHOTONS/SEC
               MEAN ENERGY= 0.010MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

CR 51	4.774E+13	4.953E+11	5.138E+09	5.528E+05	6.888E-07	9.935E-27	0.000E+00
MN 54	1.425E+12	9.503E+11	6.338E+11	2.819E+11	2.481E+10	4.318E+08	1.014E+03
MN 56	3.882E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 58	9.704E+12	1.622E+12	2.713E+11	7.584E+09	1.657E+05	2.830E-03	0.000E+00
CO 60	5.383E+12	5.041E+12	4.720E+12	4.138E+12	2.789E+12	1.445E+12	1.761E+11
NI 63	4.084E+10	4.068E+10	4.053E+10	4.022E+10	3.933E+10	3.787E+10	3.357E+10
ZN 65	9.843E+11	5.857E+11	3.485E+11	1.234E+11	5.480E+09	3.051E+07	1.864E+00
Y 90	5.250E+13	6.888E+07	6.807E+07	6.647E+07	6.189E+07	5.494E+07	3.754E+07
ZR 95	1.661E+14	2.297E+13	3.176E+12	6.074E+10	4.246E+05	1.085E-03	0.000E+00
ZR 97	1.798E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95	4.592E+13	1.443E+13	2.216E+12	4.490E+10	3.036E+05	7.761E-04	0.000E+00
NB 95M	1.331E+13	1.942E+12	2.685E+11	5.135E+09	3.590E+04	9.175E-05	0.000E+00
NB 97	1.209E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97M	9.063E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.329E+13	7.927E+12	4.729E+12	1.683E+12	7.582E+10	4.326E+08	2.859E+01
SN123	5.011E+12	1.881E+12	7.058E+11	9.941E+10	2.775E+08	1.539E+04	3.693E-10
SN125	6.665E+13	1.321E+08	2.619E+02	1.029E-09	0.000E+00	0.000E+00	0.000E+00
SN125M	5.049E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	7.647E+12	6.825E+12	6.022E+12	4.689E+12	2.213E+12	6.333E+11	1.155E+10
TE125M	1.441E+12	1.409E+12	1.259E+12	9.818E+11	4.634E+11	1.326E+11	2.419E+09
EU154	9.872E+11	9.482E+11	9.107E+11	8.402E+11	6.597E+11	4.409E+11	1.214E+11
EU155	2.369E+11	2.209E+11	2.060E+11	1.791E+11	1.178E+11	5.854E+10	6.255E+09
GD153	1.403E+12	8.315E+11	4.928E+11	1.731E+11	7.506E+09	4.018E+07	2.162E+00
GD159	2.097E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	5.282E+13	9.171E+12	1.593E+12	4.802E+10	1.316E+06	3.280E-02	0.000E+00

0 PRINCIPAL PHOTON SOURCES IN GROUP 2,PHOTONS/SEC
MEAN ENERGY= 0.025MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
MN 56	8.302E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	9.304E+11	8.712E+11	8.157E+11	7.152E+11	4.820E+11	2.497E+11	3.044E+10
NI 63	2.488E+09	2.479E+09	2.470E+09	2.451E+09	2.396E+09	2.308E+09	2.046E+09
ZR 95	2.955E+13	4.087E+12	5.651E+11	1.081E+10	7.555E+04	1.931E-04	0.000E+00
ZR 97	3.792E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95	6.275E+12	1.972E+12	3.029E+11	6.137E+09	4.150E+04	1.061E-04	0.000E+00
NB 97	2.470E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN113	3.169E+13	1.055E+13	3.513E+12	3.894E+11	5.326E+08	8.918E+03	4.640E-12

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 SN117M    2.995E+14 3.555E+10 4.220E+06 5.946E-02 0.000E+00 0.000E+00 0.000E+00
 SN119M    1.416E+14 8.448E+13 5.040E+13 1.793E+13 8.081E+11 4.610E+09 3.047E+02
 SN125     1.429E+13 2.833E+07 5.616E+01 2.207E-10 0.000E+00 0.000E+00 0.000E+00
 SB125     4.879E+13 4.354E+13 3.842E+13 2.991E+13 1.412E+13 4.041E+12 7.371E+10
 TE125M    2.608E+13 2.550E+13 2.278E+13 1.777E+13 8.389E+12 2.400E+12 4.379E+10
 EU154     1.456E+11 1.399E+11 1.344E+11 1.240E+11 9.734E+10 6.505E+10 1.792E+10
 GD159     4.170E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1                                          OUTPUT UNIT =  6                PAGE   52
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP  3,PHOTONS/SEC
               MEAN ENERGY= 0.038MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 MN 56     5.519E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CO 60     5.312E+11 4.974E+11 4.657E+11 4.083E+11 2.752E+11 1.426E+11 1.738E+10
  Y 90     7.479E+12 9.812E+06 9.696E+06 9.468E+06 8.816E+06 7.827E+06 5.348E+06
 ZR 95     1.735E+13 2.399E+12 3.318E+11 6.344E+09 4.435E+04 1.134E-04 0.000E+00
 ZR 97     2.487E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NB 95     2.974E+12 9.346E+11 1.435E+11 2.908E+09 1.966E+04 5.026E-05 0.000E+00
 NB 97     1.595E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SN125     9.455E+12 1.874E+07 3.715E+01 1.460E-10 0.000E+00 0.000E+00 0.000E+00
 SN125M    7.084E+12 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SB125     1.338E+13 1.194E+13 1.054E+13 8.204E+12 3.872E+12 1.108E+12 2.021E+10
 TE125M    6.052E+12 5.918E+12 5.287E+12 4.124E+12 1.947E+12 5.570E+11 1.016E+10
 EU154     1.343E+12 1.290E+12 1.239E+12 1.143E+12 8.977E+11 5.999E+11 1.652E+11
 EU155     6.889E+11 6.424E+11 5.990E+11 5.209E+11 3.425E+11 1.703E+11 1.819E+10
 EU156     9.658E+12 2.315E+09 5.549E+05 3.188E-02 0.000E+00 0.000E+00 0.000E+00
 GD153     1.065E+13 6.310E+12 3.740E+12 1.314E+12 5.696E+10 3.049E+08 1.641E+01
 GD159     2.636E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TB160     3.996E+12 6.939E+11 1.205E+11 3.633E+09 9.958E+04 2.481E-03 0.000E+00
0              PRINCIPAL PHOTON SOURCES IN GROUP  4,PHOTONS/SEC
               MEAN ENERGY= 0.058MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 MN 56     8.065E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

CO 60	5.993E+11	5.611E+11	5.254E+11	4.606E+11	3.105E+11	1.608E+11	1.961E+10
Y 90	1.100E+13	1.444E+07	1.427E+07	1.393E+07	1.297E+07	1.152E+07	7.868E+06
ZR 95	2.056E+13	2.843E+12	3.932E+11	7.518E+09	5.256E+04	1.343E-04	0.000E+00
ZR 97	3.597E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95	2.296E+12	7.216E+11	1.108E+11	2.245E+09	1.518E+04	3.881E-05	0.000E+00
NB 97	2.245E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	2.215E+11	1.321E+11	7.882E+10	2.805E+10	1.264E+09	7.209E+06	4.765E-01
SN123	9.576E+11	3.594E+11	1.349E+11	1.900E+10	5.304E+07	2.941E+03	7.058E-11
SN125	1.388E+13	2.751E+07	5.454E+01	2.143E-10	0.000E+00	0.000E+00	0.000E+00
SN125M	1.031E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	6.493E+11	5.795E+11	5.114E+11	3.982E+11	1.879E+11	5.378E+10	9.811E+08
EU154	3.603E+11	3.461E+11	3.324E+11	3.067E+11	2.408E+11	1.609E+11	4.432E+10
EU155	2.077E+11	1.936E+11	1.806E+11	1.570E+11	1.032E+11	5.132E+10	5.484E+09
GD153	2.278E+12	1.350E+12	8.004E+11	2.812E+11	1.219E+10	6.525E+07	3.512E+00
GD159	3.583E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	5.310E+13	9.220E+12	1.601E+12	4.827E+10	1.323E+06	3.297E-02	0.000E+00
HF181	1.113E+13	5.622E+11	2.839E+10	7.240E+07	1.201E+00	1.295E-13	0.000E+00
TA182	3.030E+12	1.008E+12	3.352E+11	3.709E+10	5.024E+07	2.317E+04	2.234E+04
W187	9.641E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 53
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 5,PHOTONS/SEC
MEAN ENERGY= 0.085MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
MN 56	5.045E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	2.356E+11	2.206E+11	2.066E+11	1.811E+11	1.221E+11	6.324E+10	7.709E+09
Y 90	6.836E+12	8.968E+06	8.862E+06	8.654E+06	8.057E+06	7.153E+06	4.888E+06
ZR 95	8.892E+12	1.230E+12	1.700E+11	3.251E+09	2.273E+04	5.810E-05	0.000E+00
ZR 97	2.193E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	1.309E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN123	5.663E+11	2.125E+11	7.976E+10	1.123E+10	3.137E+07	1.739E+03	4.174E-11
SN125	8.589E+12	1.703E+07	3.375E+01	1.326E-10	0.000E+00	0.000E+00	0.000E+00
SN125M	6.344E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	2.906E+11	2.594E+11	2.289E+11	1.782E+11	8.412E+10	2.407E+10	4.391E+08
EU154	6.905E+10	6.632E+10	6.370E+10	5.877E+10	4.615E+10	3.084E+10	8.493E+09
EU155	1.037E+12	9.667E+11	9.014E+11	7.838E+11	5.154E+11	2.562E+11	2.738E+10

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

EU156	7.611E+12	1.824E+09	4.373E+05	2.512E-02	0.000E+00	0.000E+00	0.000E+00
GD153	3.403E+12	2.017E+12	1.195E+12	4.199E+11	1.821E+10	9.745E+07	5.245E+00
GD159	1.977E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	4.052E+13	7.036E+12	1.222E+12	3.684E+10	1.010E+06	2.516E-02	0.000E+00

0 PRINCIPAL PHOTON SOURCES IN GROUP 6,PHOTONS/SEC
MEAN ENERGY= 0.125MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
MN 56	3.384E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	9.050E+10	8.474E+10	7.934E+10	6.957E+10	4.688E+10	2.429E+10	2.961E+09
Y 90	4.579E+12	6.007E+06	5.936E+06	5.797E+06	5.397E+06	4.792E+06	3.274E+06
ZR 95	3.898E+12	5.390E+11	7.454E+10	1.425E+09	9.964E+03	2.547E-05	0.000E+00
ZR 97	1.456E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	8.234E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN123	3.611E+11	1.355E+11	5.086E+10	7.164E+09	2.000E+07	1.109E+03	2.661E-11
SN125	5.744E+12	1.139E+07	2.257E+01	8.869E-11	0.000E+00	0.000E+00	0.000E+00
SN125M	4.201E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	5.052E+11	4.509E+11	3.978E+11	3.098E+11	1.462E+11	4.184E+10	7.633E+08
TE125M	6.255E+10	6.116E+10	5.464E+10	4.262E+10	2.012E+10	5.757E+09	1.050E+08
EU154	2.196E+12	2.109E+12	2.026E+12	1.869E+12	1.467E+12	9.806E+11	2.701E+11
EU155	5.708E+11	5.323E+11	4.963E+11	4.316E+11	2.838E+11	1.411E+11	1.507E+10
GD153	1.731E+12	1.026E+12	6.082E+11	2.137E+11	9.263E+09	4.958E+07	2.668E+00
GD159	1.168E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	1.503E+12	2.611E+11	4.533E+10	1.367E+09	3.746E+04	9.336E-04	0.000E+00
HF181	1.759E+13	8.881E+11	4.485E+10	1.144E+08	1.897E+00	2.045E-13	0.000E+00
TA182	6.100E+11	2.029E+11	6.749E+10	7.467E+09	1.012E+07	4.665E+03	4.498E+03
W187	3.387E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 54
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

0 PRINCIPAL PHOTON SOURCES IN GROUP 7,PHOTONS/SEC
MEAN ENERGY= 0.225MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
MN 56	4.792E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	2.976E+10	2.787E+10	2.609E+10	2.288E+10	1.542E+10	7.987E+09	9.736E+08

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 ZR 97      2.826E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NB 95M     4.871E+12 7.109E+11 9.830E+10 1.880E+09 1.314E+04 3.359E-05 0.000E+00
 NB 97      1.031E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SN113      1.059E+12 3.527E+11 1.174E+11 1.302E+10 1.780E+07 2.981E+02 1.551E-13
 SN117M     2.752E+14 3.267E+10 3.878E+06 5.464E-02 0.000E+00 0.000E+00 0.000E+00
 SB125      7.012E+12 6.258E+12 5.522E+12 4.300E+12 2.030E+12 5.808E+11 1.060E+10
 EU154      4.537E+11 4.357E+11 4.185E+11 3.861E+11 3.032E+11 2.026E+11 5.580E+10
 GD159      1.222E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TB160      1.246E+14 2.164E+13 3.758E+12 1.133E+11 3.106E+06 7.739E-02 0.000E+00
0               PRINCIPAL PHOTON SOURCES IN GROUP  8,PHOTONS/SEC
                MEAN ENERGY= 0.375MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 CR 51      3.564E+13 3.697E+11 3.835E+09 4.127E+05 5.142E-07 7.416E-27 0.000E+00
 MN 56      2.253E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 ZR 97      1.933E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NB 97      3.328E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SN125      5.662E+12 1.122E+07 2.225E+01 8.742E-11 0.000E+00 0.000E+00 0.000E+00
 SN125M     9.903E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SB125      4.163E+13 3.716E+13 3.279E+13 2.553E+13 1.205E+13 3.448E+12 6.291E+10
 EU154      7.228E+10 6.943E+10 6.669E+10 6.152E+10 4.831E+10 3.229E+10 8.891E+09
 TB160      7.070E+12 1.228E+12 2.132E+11 6.428E+09 1.762E+05 4.390E-03 0.000E+00
0               PRINCIPAL PHOTON SOURCES IN GROUP  9,PHOTONS/SEC
                MEAN ENERGY= 0.575MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 CO 58      1.146E+13 1.917E+12 3.205E+11 8.960E+09 1.958E+05 3.343E-03 0.000E+00
 ZR 97      3.346E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NB 97      4.897E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SB125      5.351E+13 4.776E+13 4.214E+13 3.281E+13 1.549E+13 4.432E+12 8.086E+10
 EU154      5.108E+11 4.907E+11 4.713E+11 4.348E+11 3.414E+11 2.282E+11 6.284E+10
 HF181      2.346E+13 1.185E+12 5.982E+10 1.526E+08 2.530E+00 2.728E-13 0.000E+00
1                                          OUTPUT UNIT =  6                PAGE   55
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0               PRINCIPAL PHOTON SOURCES IN GROUP 10,PHOTONS/SEC
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

MEAN ENERGY= 0.850MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
MN 54	1.014E+13	6.762E+12	4.510E+12	2.006E+12	1.765E+11	3.073E+09	7.212E+03
MN 56	7.836E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	2.214E+15	3.062E+14	4.234E+13	8.095E+11	5.659E+06	1.447E-02	0.000E+00
ZR 97	1.070E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95	1.970E+15	6.192E+14	9.509E+13	1.927E+12	1.303E+07	3.330E-02	0.000E+00
NB 97M	3.514E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	2.568E+12	2.466E+12	2.369E+12	2.185E+12	1.716E+12	1.147E+12	3.158E+11
TB160	2.015E+14	3.499E+13	6.075E+12	1.832E+11	5.021E+06	1.251E-01	0.000E+00

0 PRINCIPAL PHOTON SOURCES IN GROUP 11,PHOTONS/SEC
MEAN ENERGY= 1.250MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
NA 24	9.917E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
V 52	2.768E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	2.031E+14	1.902E+14	1.781E+14	1.562E+14	1.052E+14	5.452E+13	6.646E+12
ZR 97	2.656E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	1.231E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN125	1.869E+13	3.705E+07	7.344E+01	2.886E-10	0.000E+00	0.000E+00	0.000E+00
EU154	2.843E+12	2.731E+12	2.623E+12	2.420E+12	1.900E+12	1.270E+12	3.497E+11
EU156	2.731E+13	6.546E+09	1.569E+06	9.015E-02	0.000E+00	0.000E+00	0.000E+00
TB160	8.440E+13	1.465E+13	2.545E+12	7.672E+10	2.103E+06	5.240E-02	0.000E+00

0 PRINCIPAL PHOTON SOURCES IN GROUP 12,PHOTONS/SEC
MEAN ENERGY= 1.750MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
AL 28	6.583E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 56	2.230E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 58	2.125E+11	3.554E+10	5.942E+09	1.661E+08	3.629E+03	6.198E-05	0.000E+00
ZR 97	7.454E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	5.634E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 AG110M    4.463E+09 2.689E+09 1.620E+09 5.883E+08 2.815E+07 1.776E+05 1.620E-02
 SB124     6.706E+11 8.189E+10 9.999E+09 1.491E+08 4.941E+02 3.641E-07 0.000E+00
 EU154     8.523E+10 8.186E+10 7.863E+10 7.254E+10 5.696E+10 3.807E+10 1.048E+10
 EU156     6.121E+12 1.467E+09 3.517E+05 2.020E-02 0.000E+00 0.000E+00 0.000E+00
1                                          OUTPUT UNIT =  6                PAGE   56
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP 13,PHOTONS/SEC
               MEAN ENERGY= 2.250MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 MN 56     1.067E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CO 60     1.077E+09 1.008E+09 9.439E+08 8.276E+08 5.578E+08 2.890E+08 3.522E+07
 SN125     2.927E+12 5.802E+06 1.150E+01 4.520E-11 0.000E+00 0.000E+00 0.000E+00
 SB124     7.716E+10 9.422E+09 1.150E+09 1.715E+07 5.686E+01 4.189E-08 0.000E+00
 EU156     1.011E+13 2.422E+09 5.806E+05 3.336E-02 0.000E+00 0.000E+00 0.000E+00
0              PRINCIPAL PHOTON SOURCES IN GROUP 14,PHOTONS/SEC
               MEAN ENERGY= 2.750MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 NA 24     9.098E+12 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 MN 56     1.494E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CO 60     3.331E+06 3.119E+06 2.921E+06 2.561E+06 1.726E+06 8.941E+05 1.090E+05
 SB124     5.640E+07 6.887E+06 8.409E+05 1.254E+04 4.156E-02 3.062E-11 0.000E+00
0              PRINCIPAL PHOTON SOURCES IN GROUP 15,PHOTONS/SEC
               MEAN ENERGY= 3.500MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

  N 16     5.401E+10 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  K 42     2.552E+03 1.092E-07 1.081E-07 1.058E-07 9.938E-08 8.947E-08 6.393E-08
 MN 56     1.281E+12 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BI210M    1.318E-07 1.318E-07 1.318E-07 1.318E-07 1.318E-07 1.318E-07 1.318E-07
 PO210     1.575E-01 6.641E-02 2.661E-02 4.273E-03 1.769E-05 2.419E-09 5.304E-10
0              PRINCIPAL PHOTON SOURCES IN GROUP 16,PHOTONS/SEC
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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                MEAN ENERGY= 5.000MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 LI  8     2.276E+09 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  C 15     2.696E+09 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  N 16     2.019E+10 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BI210M     3.933E-08 3.933E-08 3.933E-08 3.933E-08 3.933E-08 3.933E-08 3.933E-08
 PO210      4.689E-02 1.977E-02 7.923E-03 1.272E-03 5.266E-06 7.203E-10 1.579E-10
0               PRINCIPAL PHOTON SOURCES IN GROUP 17,PHOTONS/SEC
                MEAN ENERGY= 7.000MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

  N 16     3.679E+12 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BI210M     2.547E-09 2.547E-09 2.547E-09 2.547E-09 2.547E-09 2.547E-09 2.547E-09
 PO210      3.043E-03 1.283E-03 5.141E-04 8.256E-05 3.417E-07 4.674E-11 1.025E-11
1                                                OUTPUT UNIT =  6                PAGE   57
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0               PRINCIPAL PHOTON SOURCES IN GROUP 18,PHOTONS/SEC
                MEAN ENERGY= 9.500MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 LI  8     8.112E+07 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  N 16     3.769E+09 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BI210M     1.612E-10 1.612E-10 1.612E-10 1.612E-10 1.612E-10 1.612E-10 1.612E-10
 PO210      1.924E-04 8.112E-05 3.251E-05 5.220E-06 2.161E-08 2.955E-12 6.479E-13
1                                                OUTPUT UNIT =  6                PAGE   58
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
          PHOTON SPECTRUM FOR ACTINIDES + DAUGHTERS
0                     ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP
(BWRU)
                          POWER=   1.00 MW, BURNUP=      1. MWD, FLUX= 1.00E+00
N/CM**2-SEC
0                     18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM,
4 CYCLE
EMEAN

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
1.000E-02	7.712E+17	2.442E+14	1.426E+14	7.483E+13	5.843E+13	6.050E+13	6.303E+13
2.500E-02	3.395E+16	3.577E+11	4.572E+11	6.489E+11	1.170E+12	1.880E+12	3.239E+12
3.750E-02	4.895E+16	6.559E+11	4.245E+11	2.778E+11	2.723E+11	3.218E+11	4.128E+11
5.750E-02	4.805E+16	4.959E+12	6.422E+12	9.242E+12	1.690E+13	2.735E+13	4.734E+13
8.500E-02	3.417E+17	9.559E+11	9.540E+11	9.501E+11	9.382E+11	9.195E+11	8.698E+11
1.250E-01	2.710E+17	9.042E+11	8.869E+11	8.698E+11	8.430E+11	8.058E+11	7.121E+11
2.250E-01	1.920E+17	7.273E+11	7.155E+11	7.009E+11	6.705E+11	6.265E+11	5.187E+11
3.750E-01	2.083E+16	3.984E+10	3.984E+10	3.985E+10	3.987E+10	3.989E+10	3.997E+10
5.750E-01	3.568E+15	3.628E+09	2.046E+09	1.066E+09	1.097E+09	1.436E+09	1.803E+09
8.500E-01	9.808E+15	2.528E+09	2.191E+09	1.979E+09	1.963E+09	1.972E+09	1.805E+09
1.250E+00	3.136E+15	1.172E+09	1.063E+09	9.823E+08	9.304E+08	8.777E+08	7.431E+08
1.750E+00	1.210E+12	2.449E+08	2.049E+08	1.788E+08	1.726E+08	1.642E+08	1.182E+08
2.250E+00	1.803E+08	1.282E+08	1.031E+08	8.427E+07	7.154E+07	5.930E+07	3.281E+07
2.750E+00	1.965E+08	1.985E+08	2.170E+08	2.711E+08	4.227E+08	5.442E+08	5.259E+08
3.500E+00	9.377E+07	6.676E+07	5.375E+07	4.395E+07	3.732E+07	3.093E+07	1.710E+07
5.000E+00	4.011E+07	2.856E+07	2.299E+07	1.880E+07	1.596E+07	1.323E+07	7.308E+06
7.000E+00	4.615E+06	3.288E+06	2.649E+06	2.167E+06	1.840E+06	1.525E+06	8.420E+05
9.500E+00	5.315E+05	3.783E+05	3.046E+05	2.490E+05	2.114E+05	1.751E+05	9.670E+04
0 TOTAL	1.744E+18	2.528E+14	1.525E+14	8.756E+13	7.927E+13	9.246E+13	1.162E+14
0MEV/SEC	1.414E+17	3.141E+12	2.197E+12	1.673E+12	1.952E+12	2.577E+12	3.749E+12

0 18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC

BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM,
4 CYCLE
EMEAN

ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
1.000E-02	7.712E+09	2.442E+06	1.426E+06	7.483E+05	5.843E+05	6.050E+05	6.303E+05
2.500E-02	8.487E+08	8.943E+03	1.143E+04	1.622E+04	2.924E+04	4.701E+04	8.099E+04
3.750E-02	1.836E+09	2.460E+04	1.592E+04	1.042E+04	1.021E+04	1.207E+04	1.548E+04
5.750E-02	2.763E+09	2.851E+05	3.693E+05	5.314E+05	9.718E+05	1.573E+06	2.722E+06
8.500E-02	2.905E+10	8.125E+04	8.109E+04	8.076E+04	7.974E+04	7.816E+04	7.394E+04
1.250E-01	3.388E+10	1.130E+05	1.109E+05	1.087E+05	1.054E+05	1.007E+05	8.901E+04
2.250E-01	4.319E+10	1.637E+05	1.610E+05	1.577E+05	1.509E+05	1.410E+05	1.167E+05
3.750E-01	7.811E+09	1.494E+04	1.494E+04	1.494E+04	1.495E+04	1.496E+04	1.499E+04

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

5.750E-01	2.052E+09	2.086E+03	1.177E+03	6.132E+02	6.306E+02	8.256E+02	1.037E+03
8.500E-01	8.337E+09	2.149E+03	1.862E+03	1.682E+03	1.669E+03	1.676E+03	1.534E+03
1.250E+00	3.920E+09	1.465E+03	1.329E+03	1.228E+03	1.163E+03	1.097E+03	9.289E+02
1.750E+00	2.117E+06	4.285E+02	3.585E+02	3.129E+02	3.020E+02	2.874E+02	2.069E+02
2.250E+00	4.056E+02	2.885E+02	2.321E+02	1.896E+02	1.610E+02	1.334E+02	7.382E+01
2.750E+00	5.405E+02	5.458E+02	5.969E+02	7.455E+02	1.162E+03	1.497E+03	1.446E+03
3.500E+00	3.282E+02	2.337E+02	1.881E+02	1.538E+02	1.306E+02	1.082E+02	5.983E+01
5.000E+00	2.006E+02	1.428E+02	1.150E+02	9.399E+01	7.980E+01	6.613E+01	3.654E+01
7.000E+00	3.231E+01	2.302E+01	1.854E+01	1.517E+01	1.288E+01	1.067E+01	5.894E+00
9.500E+00	5.049E+00	3.594E+00	2.893E+00	2.366E+00	2.008E+00	1.664E+00	9.186E-01
0 TOTAL	1.414E+11	3.141E+06	2.197E+06	1.673E+06	1.952E+06	2.577E+06	3.749E+06
0 GAM POW	2.267E+04	5.035E-01	3.521E-01	2.683E-01	3.129E-01	4.132E-01	6.010E-01

1 OUTPUT UNIT = 6 PAGE 59
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 1,PHOTONS/SEC
MEAN ENERGY= 0.010MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
U237	2.689E+16	1.023E+11	9.968E+10	9.499E+10	8.222E+10	6.463E+10	2.992E+10
U239	2.376E+17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP238	9.741E+15	1.929E+09	1.924E+09	1.916E+09	1.890E+09	1.847E+09	1.717E+09
NP239	4.884E+17	8.363E+11	8.363E+11	8.362E+11	8.360E+11	8.356E+11	8.343E+11
PU238	2.468E+13	2.582E+13	2.622E+13	2.635E+13	2.582E+13	2.483E+13	2.189E+13
PU239	6.324E+11	6.405E+11	6.405E+11	6.404E+11	6.404E+11	6.403E+11	6.401E+11
PU240	3.064E+12	3.065E+12	3.065E+12	3.067E+12	3.071E+12	3.076E+12	3.086E+12
PU241	1.940E+12	1.894E+12	1.849E+12	1.762E+12	1.525E+12	1.199E+12	5.550E+11
AM241	1.999E+12	2.891E+12	3.761E+12	5.437E+12	9.991E+12	1.621E+13	2.809E+13
CM242	4.098E+14	1.899E+14	8.747E+13	1.860E+13	2.523E+11	7.417E+10	6.885E+10
CM243	1.050E+12	1.037E+12	1.024E+12	9.997E+11	9.294E+11	8.230E+11	5.577E+11
CM244	1.742E+13	1.710E+13	1.677E+13	1.614E+13	1.439E+13	1.189E+13	6.443E+12

0 PRINCIPAL PHOTON SOURCES IN GROUP 2,PHOTONS/SEC
MEAN ENERGY= 0.025MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
U237	9.984E+14	3.798E+09	3.701E+09	3.527E+09	3.052E+09	2.400E+09	1.111E+09

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

U239	2.566E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP238	3.800E+14	7.525E+07	7.508E+07	7.474E+07	7.372E+07	7.206E+07	6.699E+07
NP239	6.383E+15	1.093E+10	1.093E+10	1.093E+10	1.092E+10	1.092E+10	1.090E+10
AM241	2.288E+11	3.309E+11	4.305E+11	6.225E+11	1.144E+12	1.855E+12	3.216E+12
AM242	6.881E+13	8.376E+09	8.357E+09	8.319E+09	8.206E+09	8.021E+09	7.457E+09

0 PRINCIPAL PHOTON SOURCES IN GROUP 3,PHOTONS/SEC
MEAN ENERGY= 0.038MEV

NUCLIDE
ASSY DIS 0.5YR 1.0YR 2.0YR 5.0YR 10.0YR 26.0YR

U239	4.377E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP239	4.336E+15	7.424E+09	7.424E+09	7.423E+09	7.421E+09	7.417E+09	7.406E+09
PU238	7.104E+10	7.433E+10	7.548E+10	7.586E+10	7.434E+10	7.147E+10	6.301E+10
AM241	1.872E+10	2.708E+10	3.523E+10	5.093E+10	9.358E+10	1.518E+11	2.631E+11
AM242	4.571E+13	5.565E+09	5.552E+09	5.527E+09	5.452E+09	5.329E+09	4.954E+09
AM243	5.865E+10	5.871E+10	5.870E+10	5.870E+10	5.868E+10	5.865E+10	5.857E+10
CM242	9.603E+11	4.450E+11	2.050E+11	4.359E+10	5.914E+08	1.738E+08	1.613E+08
CM244	3.450E+10	3.385E+10	3.321E+10	3.196E+10	2.850E+10	2.353E+10	1.276E+10

1 OUTPUT UNIT = 6 PAGE 60
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

0 PRINCIPAL PHOTON SOURCES IN GROUP 4,PHOTONS/SEC
MEAN ENERGY= 0.058MEV

NUCLIDE
ASSY DIS 0.5YR 1.0YR 2.0YR 5.0YR 10.0YR 26.0YR

U237	1.262E+16	4.803E+10	4.680E+10	4.460E+10	3.860E+10	3.034E+10	1.405E+10
U239	2.292E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP239	1.171E+16	2.005E+10	2.005E+10	2.005E+10	2.004E+10	2.003E+10	2.000E+10
AM241	3.364E+12	4.866E+12	6.331E+12	9.152E+12	1.682E+13	2.728E+13	4.729E+13

0 PRINCIPAL PHOTON SOURCES IN GROUP 5,PHOTONS/SEC
MEAN ENERGY= 0.085MEV

NUCLIDE
ASSY DIS 0.5YR 1.0YR 2.0YR 5.0YR 10.0YR 26.0YR

U237	5.861E+15	2.230E+10	2.173E+10	2.071E+10	1.792E+10	1.409E+10	6.521E+09
U239	2.455E+17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 NP239     8.703E+16 1.490E+11 1.490E+11 1.490E+11 1.490E+11 1.489E+11 1.487E+11
 PU238     1.366E+10 1.429E+10 1.451E+10 1.458E+10 1.429E+10 1.374E+10 1.211E+10
 AM241      2.207E+09 3.192E+09 4.152E+09 6.003E+09 1.103E+10 1.789E+10 3.102E+10
 AM242      2.300E+14 2.800E+10 2.793E+10 2.781E+10 2.743E+10 2.681E+10 2.492E+10
 AM243      5.261E+11 5.266E+11 5.265E+11 5.265E+11 5.263E+11 5.261E+11 5.253E+11
 CM243      2.015E+11 1.991E+11 1.967E+11 1.919E+11 1.784E+11 1.580E+11 1.071E+11
0              PRINCIPAL PHOTON SOURCES IN GROUP  6,PHOTONS/SEC
               MEAN ENERGY= 0.125MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

  U237     1.021E+16 3.884E+10 3.784E+10 3.606E+10 3.121E+10 2.454E+10 1.136E+10
  U239     8.924E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NP239      2.511E+17 4.299E+11 4.299E+11 4.299E+11 4.297E+11 4.295E+11 4.289E+11
 AM241      2.107E+09 3.048E+09 3.965E+09 5.733E+09 1.053E+10 1.709E+10 2.962E+10
 AM242      3.676E+14 4.475E+10 4.465E+10 4.444E+10 4.384E+10 4.285E+10 3.984E+10
 CM242      5.129E+10 2.377E+10 1.095E+10 2.328E+09 3.158E+07 9.282E+06 8.617E+06
 CM243      3.538E+11 3.496E+11 3.453E+11 3.370E+11 3.133E+11 2.775E+11 1.880E+11
0              PRINCIPAL PHOTON SOURCES IN GROUP  7,PHOTONS/SEC
               MEAN ENERGY= 0.225MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

  U237     7.697E+15 2.928E+10 2.853E+10 2.719E+10 2.353E+10 1.850E+10 8.564E+09
  U239     9.769E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NP239      1.741E+17 2.980E+11 2.980E+11 2.980E+11 2.979E+11 2.978E+11 2.973E+11
 CM242      2.615E+10 1.212E+10 5.581E+09 1.187E+09 1.610E+07 4.732E+06 4.393E+06
 CM243      3.862E+11 3.816E+11 3.770E+11 3.679E+11 3.420E+11 3.028E+11 2.052E+11
1                                          OUTPUT UNIT =  6                PAGE   61
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP  8,PHOTONS/SEC
               MEAN ENERGY= 0.375MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 PA233      7.411E+09 7.328E+09 7.328E+09 7.331E+09 7.344E+09 7.383E+09 7.598E+09
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

U237	4.541E+14	1.727E+09	1.683E+09	1.604E+09	1.388E+09	1.091E+09	5.052E+08
U239	3.311E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP239	1.677E+16	2.872E+10	2.872E+10	2.872E+10	2.871E+10	2.870E+10	2.865E+10
PU239	7.066E+08	7.156E+08	7.156E+08	7.156E+08	7.155E+08	7.155E+08	7.152E+08
AM241	1.140E+08	1.648E+08	2.144E+08	3.100E+08	5.696E+08	9.240E+08	1.602E+09
CM243	6.789E+08	6.707E+08	6.626E+08	6.467E+08	6.012E+08	5.323E+08	3.607E+08

0 PRINCIPAL PHOTON SOURCES IN GROUP 9,PHOTONS/SEC
MEAN ENERGY= 0.575MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
TL208	1.040E+08	1.401E+08	1.774E+08	2.506E+08	4.298E+08	5.749E+08	5.716E+08
PA234M	1.541E+08	1.514E+08	1.514E+08	1.514E+08	1.514E+08	1.514E+08	1.514E+08
U239	3.115E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP238	5.242E+13	1.038E+07	1.036E+07	1.031E+07	1.017E+07	9.939E+06	9.240E+06
NP239	7.227E+13	1.237E+08	1.237E+08	1.237E+08	1.237E+08	1.236E+08	1.234E+08
NP240M	4.160E+13	7.229E+03	7.229E+03	7.229E+03	7.229E+03	7.229E+03	7.229E+03
NP240	2.737E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU239	2.603E+07	2.636E+07	2.636E+07	2.636E+07	2.636E+07	2.635E+07	2.634E+07
AM241	6.249E+07	9.039E+07	1.176E+08	1.700E+08	3.124E+08	5.067E+08	8.784E+08
AM243	1.317E+07	1.319E+07	1.319E+07	1.318E+07	1.318E+07	1.317E+07	1.315E+07
CM242	6.587E+09	3.052E+09	1.406E+09	2.990E+08	4.056E+06	1.192E+06	1.107E+06

0 PRINCIPAL PHOTON SOURCES IN GROUP 10,PHOTONS/SEC
MEAN ENERGY= 0.850MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
TL208	1.390E+07	1.872E+07	2.371E+07	3.349E+07	5.745E+07	7.683E+07	7.639E+07
BI212	3.545E+07	4.774E+07	6.044E+07	8.540E+07	1.465E+08	1.959E+08	1.948E+08
PA234M	8.326E+07	8.181E+07	8.181E+07	8.182E+07	8.181E+07	8.181E+07	8.181E+07
PA234	3.000E+08	2.133E+07	2.133E+07	2.133E+07	2.133E+07	2.133E+07	2.133E+07
U239	4.615E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP238	4.849E+15	9.601E+08	9.579E+08	9.535E+08	9.406E+08	9.194E+08	8.547E+08
NP240	3.343E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	7.670E+07	8.025E+07	8.150E+07	8.190E+07	8.026E+07	7.717E+07	6.803E+07
AM241	1.836E+07	2.655E+07	3.455E+07	4.994E+07	9.177E+07	1.489E+08	2.581E+08
CM242	1.400E+09	6.489E+08	2.989E+08	6.356E+07	8.623E+05	2.534E+05	2.353E+05

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 CM244     6.436E+08 6.315E+08 6.195E+08 5.962E+08 5.316E+08 4.390E+08 2.379E+08
1                                                OUTPUT UNIT =  6                PAGE   62
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP 11,PHOTONS/SEC
               MEAN ENERGY= 1.250MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 BI212     2.411E+06 3.247E+06 4.111E+06 5.808E+06 9.962E+06 1.332E+07 1.325E+07
 PA234M    7.209E+07 7.084E+07 7.084E+07 7.084E+07 7.084E+07 7.084E+07 7.084E+07
  U239     5.439E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NP238     3.043E+15 6.026E+08 6.012E+08 5.985E+08 5.903E+08 5.770E+08 5.364E+08
 NP240     3.523E+13 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CM242     4.123E+08 1.911E+08 8.801E+07 1.872E+07 2.539E+05 7.462E+04 6.927E+04
 CM244     2.997E+08 2.941E+08 2.885E+08 2.777E+08 2.476E+08 2.044E+08 1.108E+08
0              PRINCIPAL PHOTON SOURCES IN GROUP 12,PHOTONS/SEC
               MEAN ENERGY= 1.750MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 BI212     9.146E+06 1.232E+07 1.560E+07 2.203E+07 3.779E+07 5.054E+07 5.025E+07
 PA234M    1.044E+07 1.026E+07 1.026E+07 1.026E+07 1.026E+07 1.026E+07 1.026E+07
 NP240M    1.209E+12 2.102E+02 2.102E+02 2.102E+02 2.102E+02 2.102E+02 2.102E+02
 CM242     1.622E+08 7.515E+07 3.461E+07 7.361E+06 9.985E+04 2.935E+04 2.724E+04
 CM244     1.464E+08 1.436E+08 1.409E+08 1.356E+08 1.209E+08 9.984E+07 5.412E+07
0              PRINCIPAL PHOTON SOURCES IN GROUP 13,PHOTONS/SEC
               MEAN ENERGY= 2.250MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 PU240     5.638E+05 5.639E+05 5.640E+05 5.643E+05 5.650E+05 5.660E+05 5.678E+05
 CM242     9.402E+07 4.357E+07 2.007E+07 4.268E+06 5.790E+04 1.702E+04 1.580E+04
 CM244     8.480E+07 8.321E+07 8.163E+07 7.857E+07 7.004E+07 5.784E+07 3.135E+07
 CM246     3.471E+05 3.471E+05 3.470E+05 3.470E+05 3.468E+05 3.466E+05 3.458E+05
0              PRINCIPAL PHOTON SOURCES IN GROUP 14,PHOTONS/SEC
               MEAN ENERGY= 2.750MEV
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 TL208     9.227E+07 1.243E+08 1.573E+08 2.223E+08 3.812E+08 5.099E+08 5.069E+08
 CM242      5.430E+07 2.517E+07 1.159E+07 2.465E+06 3.344E+04 9.828E+03 9.123E+03
 CM244      4.914E+07 4.822E+07 4.730E+07 4.553E+07 4.059E+07 3.352E+07 1.817E+07
0               PRINCIPAL PHOTON SOURCES IN GROUP 15,PHOTONS/SEC
                MEAN ENERGY= 3.500MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 PU240     2.921E+05 2.922E+05 2.922E+05 2.924E+05 2.927E+05 2.933E+05 2.942E+05
 CM242      4.877E+07 2.260E+07 1.041E+07 2.214E+06 3.003E+04 8.827E+03 8.194E+03
 CM244      4.426E+07 4.343E+07 4.260E+07 4.100E+07 3.656E+07 3.019E+07 1.636E+07
 CM246      1.804E+05 1.804E+05 1.804E+05 1.803E+05 1.803E+05 1.801E+05 1.797E+05
1                                                OUTPUT UNIT =  6                PAGE   63
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0               PRINCIPAL PHOTON SOURCES IN GROUP 16,PHOTONS/SEC
                MEAN ENERGY= 5.000MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 PU240     1.250E+05 1.250E+05 1.251E+05 1.251E+05 1.253E+05 1.255E+05 1.259E+05
 CM242      2.087E+07 9.670E+06 4.454E+06 9.472E+05 1.285E+04 3.777E+03 3.506E+03
 CM244      1.893E+07 1.858E+07 1.823E+07 1.754E+07 1.564E+07 1.292E+07 7.001E+06
 CM246      7.724E+04 7.723E+04 7.723E+04 7.722E+04 7.718E+04 7.713E+04 7.695E+04
0               PRINCIPAL PHOTON SOURCES IN GROUP 17,PHOTONS/SEC
                MEAN ENERGY= 7.000MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 PU240     1.434E+04 1.434E+04 1.435E+04 1.435E+04 1.437E+04 1.440E+04 1.444E+04
 CM242      2.396E+06 1.110E+06 5.114E+05 1.088E+05 1.475E+03 4.336E+02 4.025E+02
 CM244      2.184E+06 2.143E+06 2.102E+06 2.023E+06 1.804E+06 1.490E+06 8.075E+05
 CM246      8.922E+03 8.921E+03 8.920E+03 8.919E+03 8.915E+03 8.909E+03 8.888E+03
0               PRINCIPAL PHOTON SOURCES IN GROUP 18,PHOTONS/SEC
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

MEAN ENERGY= 9.500MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
PU240	1.646E+03	1.647E+03	1.647E+03	1.648E+03	1.650E+03	1.653E+03	1.658E+03
CM242	2.765E+05	1.282E+05	5.903E+04	1.255E+04	1.703E+02	5.005E+01	4.646E+01
CM244	2.509E+05	2.462E+05	2.415E+05	2.325E+05	2.073E+05	1.712E+05	9.277E+04
CM246	1.027E+03	1.027E+03	1.026E+03	1.026E+03	1.026E+03	1.025E+03	1.023E+03

1 OUTPUT UNIT = 6 PAGE 64
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
PHOTON SPECTRUM FOR FISSION PRODUCTS
0 ST OF ORIGEN2 V2.1 - BWR FUEL ASSY - STANDARD BURNUP (BWRU)
POWER= 1.00 MW, BURNUP= 1. MWD, FLUX= 1.00E+00 N/CM**2-SEC
0 18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM, 4 CYCLE

EMEAN	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
1.000E-02	1.492E+18	2.750E+16	1.817E+16	9.842E+15	3.570E+15	2.501E+15	1.646E+15
2.500E-02	3.903E+17	6.185E+15	4.081E+15	2.243E+15	8.132E+14	5.336E+14	3.381E+14
3.750E-02	3.191E+17	6.341E+15	4.249E+15	2.348E+15	9.277E+14	6.552E+14	4.051E+14
5.750E-02	3.215E+17	5.651E+15	3.771E+15	2.022E+15	7.012E+14	4.830E+14	3.140E+14
8.500E-02	2.362E+17	3.946E+15	2.647E+15	1.400E+15	4.603E+14	3.014E+14	1.866E+14
1.250E-01	2.534E+17	4.969E+15	3.046E+15	1.549E+15	4.684E+14	2.879E+14	1.459E+14
2.250E-01	5.487E+17	3.414E+15	2.290E+15	1.204E+15	3.802E+14	2.495E+14	1.583E+14
3.750E-01	4.042E+17	1.810E+15	1.236E+15	6.625E+14	2.017E+14	1.125E+14	6.609E+13
5.750E-01	6.675E+17	1.811E+16	1.422E+16	1.072E+16	6.264E+15	4.259E+15	2.713E+15
8.500E-01	6.778E+17	1.876E+16	6.790E+15	3.485E+15	1.321E+15	3.391E+14	4.323E+13
1.250E+00	3.870E+17	1.060E+15	8.440E+14	5.868E+14	2.854E+14	1.471E+14	3.875E+13
1.750E+00	1.450E+17	8.769E+13	5.926E+13	3.141E+13	8.755E+12	4.297E+12	1.322E+12
2.250E+00	7.286E+16	1.420E+14	9.165E+13	3.857E+13	2.973E+12	4.841E+10	2.981E+07
2.750E+00	3.113E+16	2.367E+12	1.611E+12	8.030E+11	1.003E+11	3.180E+09	5.260E+04
3.500E+00	1.572E+16	2.842E+11	2.010E+11	1.011E+11	1.284E+10	4.125E+08	6.873E+03
5.000E+00	6.919E+15	7.916E-05	7.979E-05	8.082E-05	8.268E-05	8.381E-05	8.421E-05
7.000E+00	6.170E+13	5.137E-06	5.177E-06	5.244E-06	5.365E-06	5.438E-06	5.464E-06

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 9.500E+00  1.302E+10 3.248E-07 3.274E-07 3.316E-07 3.392E-07 3.439E-07 3.455E-07
0  TOTAL    5.969E+18 9.798E+16 6.150E+16 3.613E+16 1.540E+16 9.874E+15 6.056E+15
0MEV/SEC    2.419E+18 3.156E+16 1.756E+16 1.120E+16 5.494E+15 3.180E+15 1.800E+15
0                          18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
                        BASIS=MTIHM 4.5% UO2 FUEL ASSY;BURNUP=45,000 MWD/MTIHM,
4 CYCLE
 EMEAN
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 1.000E-02  1.492E+10 2.750E+08 1.817E+08 9.842E+07 3.570E+07 2.501E+07 1.646E+07
 2.500E-02  9.758E+09 1.546E+08 1.020E+08 5.607E+07 2.033E+07 1.334E+07 8.452E+06
 3.750E-02  1.197E+10 2.378E+08 1.593E+08 8.804E+07 3.479E+07 2.457E+07 1.519E+07
 5.750E-02  1.849E+10 3.249E+08 2.168E+08 1.162E+08 4.032E+07 2.777E+07 1.806E+07
 8.500E-02  2.008E+10 3.354E+08 2.250E+08 1.190E+08 3.912E+07 2.562E+07 1.586E+07
 1.250E-01  3.168E+10 6.211E+08 3.807E+08 1.936E+08 5.854E+07 3.598E+07 1.824E+07
 2.250E-01  1.234E+11 7.682E+08 5.152E+08 2.708E+08 8.555E+07 5.614E+07 3.562E+07
 3.750E-01  1.516E+11 6.786E+08 4.634E+08 2.485E+08 7.565E+07 4.219E+07 2.478E+07
 5.750E-01  3.838E+11 1.042E+10 8.177E+09 6.165E+09 3.602E+09 2.449E+09 1.560E+09
 8.500E-01  5.761E+11 1.594E+10 5.772E+09 2.963E+09 1.123E+09 2.883E+08 3.675E+07
 1.250E+00  4.838E+11 1.326E+09 1.055E+09 7.336E+08 3.568E+08 1.839E+08 4.844E+07
 1.750E+00  2.538E+11 1.535E+08 1.037E+08 5.496E+07 1.532E+07 7.520E+06 2.314E+06
 2.250E+00  1.639E+11 3.194E+08 2.062E+08 8.679E+07 6.688E+06 1.089E+05 6.708E+01
 2.750E+00  8.560E+10 6.508E+06 4.429E+06 2.208E+06 2.759E+05 8.745E+03 1.447E-01
 3.500E+00  5.504E+10 9.946E+05 7.035E+05 3.537E+05 4.495E+04 1.444E+03 2.406E-02
 5.000E+00  3.460E+10 3.958E-10 3.989E-10 4.041E-10 4.134E-10 4.190E-10 4.211E-10
 7.000E+00  4.319E+08 3.596E-11 3.624E-11 3.671E-11 3.755E-11 3.807E-11 3.825E-11
 9.500E+00  1.237E+05 3.086E-12 3.110E-12 3.150E-12 3.223E-12 3.267E-12 3.282E-12
0  TOTAL    2.419E+12 3.156E+10 1.756E+10 1.120E+10 5.494E+09 3.180E+09 1.800E+09
0 GAM POW   3.878E+05 5.059E+03 2.815E+03 1.795E+03 8.806E+02 5.097E+02 2.885E+02
1                                          OUTPUT UNIT =  6                PAGE   65
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP  1,PHOTONS/SEC
               MEAN ENERGY= 0.010MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 KR 85      6.382E+13 6.180E+13 5.983E+13 5.609E+13 4.620E+13 3.344E+13 1.188E+13
 RB 88      1.980E+16 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

KR 89	1.599E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	6.917E+15	5.641E+14	4.599E+13	3.057E+11	8.980E+04	1.166E-06	0.000E+00
KR 90	1.630E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90	2.197E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	4.181E+14	4.131E+14	4.082E+14	3.986E+14	3.712E+14	3.295E+14	2.252E+14
Y 90	2.145E+15	2.041E+15	2.017E+15	1.969E+15	1.834E+15	1.628E+15	1.112E+15
Y 91	9.077E+15	1.051E+15	1.208E+14	1.595E+12	3.673E+06	1.474E-03	0.000E+00
RB 92	4.420E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 92	2.630E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 93	2.529E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	1.962E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	3.663E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	2.309E+15	3.194E+14	4.416E+13	8.444E+11	5.903E+06	1.509E-02	0.000E+00
Y 96	6.047E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 97	1.728E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	4.982E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	4.019E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	3.911E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	7.656E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	3.850E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	3.530E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104	1.744E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	1.297E+16	8.444E+15	5.987E+15	3.010E+15	3.825E+14	1.229E+13	2.047E+08
I134	2.078E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	6.174E+14	5.219E+14	4.412E+14	3.152E+14	1.150E+14	2.141E+13	9.878E+10
TE135	3.067E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	2.754E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	1.727E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	4.702E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	4.943E+14	4.886E+14	4.830E+14	4.720E+14	4.404E+14	3.923E+14	2.711E+14
I138	1.940E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE138	1.770E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	3.300E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	3.330E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	4.376E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA139	2.418E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	2.159E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA141	2.331E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	2.000E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

CE144	1.389E+15	8.900E+14	5.702E+14	2.340E+14	1.617E+13	1.883E+11	1.219E+05
PR144	1.878E+16	1.195E+16	7.652E+15	3.140E+15	2.171E+14	2.527E+12	1.636E+06
PM147	1.391E+14	1.274E+14	1.117E+14	8.575E+13	3.881E+13	1.036E+13	1.511E+11
EU154	9.937E+13	9.544E+13	9.167E+13	8.457E+13	6.641E+13	4.438E+13	1.222E+13

1 OUTPUT UNIT = 6 PAGE 66
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 2,PHOTONS/SEC
MEAN ENERGY= 0.025MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 85	1.251E+13	1.211E+13	1.172E+13	1.099E+13	9.052E+12	6.551E+12	2.328E+12
RB 88	4.439E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	1.444E+15	1.178E+14	9.603E+12	6.384E+10	1.875E+04	2.434E-07	0.000E+00
RB 90	4.903E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	7.995E+13	7.900E+13	7.807E+13	7.623E+13	7.098E+13	6.301E+13	4.306E+13
Y 90	4.610E+14	4.386E+14	4.334E+14	4.232E+14	3.941E+14	3.498E+14	2.390E+14
Y 91	1.903E+15	2.204E+14	2.533E+13	3.344E+11	7.699E+05	3.090E-04	0.000E+00
RB 92	1.006E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 92	5.798E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 93	5.488E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	4.493E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	8.132E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	1.361E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	1.104E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	8.858E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	8.825E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	8.505E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH103M	2.212E+15	8.825E+13	3.517E+12	5.587E+09	2.238E+01	2.265E-13	0.000E+00
TC104	7.723E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	2.851E+15	1.856E+15	1.316E+15	6.617E+14	8.409E+13	2.701E+12	4.501E+07
SB125	1.818E+14	1.616E+14	1.426E+14	1.110E+14	5.241E+13	1.500E+13	2.736E+11
TE125M	9.742E+13	9.473E+13	8.458E+13	6.597E+13	3.114E+13	8.910E+12	1.626E+11
SN130	4.869E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE131	4.687E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132M	4.035E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE132	2.361E+16	3.160E-01	4.229E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	1.279E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 I134     4.971E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 I134M    3.980E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS134     1.170E+14 9.886E+13 8.357E+13 5.971E+13 2.178E+13 4.056E+12 1.871E+10
TE135     6.873E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 I136     6.140E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 I136M    4.954E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
XE137     1.039E+16 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS137     9.346E+13 9.239E+13 9.133E+13 8.924E+13 8.326E+13 7.418E+13 5.125E+13
 I138     4.421E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS138     7.183E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
XE139     7.371E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS139     9.691E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
BA139     5.127E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
BA140     8.968E+15 4.510E+11 2.268E+07 5.735E-02 0.000E+00 0.000E+00 0.000E+00
BA141     4.597E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
LA141     4.991E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
LA142     4.285E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CE144     1.922E+14 1.231E+14 7.887E+13 3.237E+13 2.237E+12 2.604E+10 1.686E+04
1                                        OUTPUT UNIT =  6                PAGE   67
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
PR144     4.081E+15 2.595E+15 1.663E+15 6.823E+14 4.716E+13 5.491E+11 3.555E+05
EU154     1.466E+13 1.408E+13 1.353E+13 1.248E+13 9.798E+12 6.548E+12 1.803E+12
0            PRINCIPAL PHOTON SOURCES IN GROUP  3,PHOTONS/SEC
             MEAN ENERGY= 0.038MEV

NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

SR 89     9.412E+14 7.676E+13 6.258E+12 4.160E+10 1.222E+04 1.586E-07 0.000E+00
RB 90     3.336E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
SR 90     4.914E+13 4.856E+13 4.799E+13 4.686E+13 4.363E+13 3.873E+13 2.647E+13
 Y 90     3.055E+14 2.907E+14 2.873E+14 2.805E+14 2.612E+14 2.319E+14 1.584E+14
 Y 91     1.243E+15 1.439E+14 1.654E+13 2.184E+11 5.028E+05 2.018E-04 0.000E+00
RB 92     6.901E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Y 92     3.875E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Y 93     3.659E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Y 94     5.494E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Y 96     9.298E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NB 98     7.472E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NB 99	5.978E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	6.038E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	5.725E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	5.172E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	1.906E+15	1.241E+15	8.798E+14	4.423E+14	5.621E+13	1.806E+12	3.009E+07
SB125	4.986E+13	4.432E+13	3.911E+13	3.045E+13	1.437E+13	4.113E+12	7.503E+10
TE132	4.109E+15	5.500E-02	7.360E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	2.056E+16	8.348E+05	2.759E-05	2.995E-26	0.000E+00	0.000E+00	0.000E+00
CS134	1.163E+14	9.829E+13	8.308E+13	5.936E+13	2.165E+13	4.032E+12	1.860E+10
TE135	4.676E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	4.176E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	7.164E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	5.698E+13	5.632E+13	5.567E+13	5.440E+13	5.076E+13	4.522E+13	3.125E+13
BA137M	3.082E+14	3.043E+14	3.008E+14	2.939E+14	2.742E+14	2.443E+14	1.688E+14
XE138	3.531E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	4.820E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	4.978E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	6.534E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA139	5.172E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	5.459E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA141	3.321E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	7.117E+15	1.458E+14	2.970E+12	1.233E+09	8.814E-02	1.086E-18	0.000E+00
BA142	8.169E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE143	2.418E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144	2.805E+15	1.797E+15	1.151E+15	4.724E+14	3.265E+13	3.801E+11	2.461E+05
PR144	2.721E+15	1.730E+15	1.108E+15	4.549E+14	3.144E+13	3.660E+11	2.370E+05
CE145	1.460E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND147	8.179E+15	8.759E+10	9.373E+05	1.073E-04	0.000E+00	0.000E+00	0.000E+00
ND149	3.707E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM153	7.902E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	1.352E+14	1.299E+14	1.247E+14	1.151E+14	9.036E+13	6.039E+13	1.663E+13
EU155	6.783E+13	6.325E+13	5.898E+13	5.129E+13	3.372E+13	1.677E+13	1.791E+12

1 OUTPUT UNIT = 6 PAGE 68
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 4,PHOTONS/SEC
MEAN ENERGY= 0.058MEV

NUCLIDE
ASSY DIS 0.5YR 1.0YR 2.0YR 5.0YR 10.0YR 26.0YR

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

KR 85	1.044E+13	1.010E+13	9.783E+12	9.171E+12	7.554E+12	5.467E+12	1.943E+12
BR 88	3.333E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 88	4.587E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 89	3.502E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	1.346E+15	1.098E+14	8.950E+12	5.950E+10	1.748E+04	2.268E-07	0.000E+00
KR 90	3.220E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90	5.066E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	6.344E+13	6.269E+13	6.195E+13	6.050E+13	5.633E+13	5.001E+13	3.417E+13
Y 90	4.496E+14	4.277E+14	4.227E+14	4.127E+14	3.843E+14	3.412E+14	2.331E+14
Y 91	1.778E+15	2.059E+14	2.366E+13	3.125E+11	7.193E+05	2.887E-04	0.000E+00
RB 92	1.067E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 92	5.828E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 93	5.453E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	4.801E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	8.278E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	1.425E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 97	3.456E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	1.134E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	8.945E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	9.241E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	8.588E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	7.793E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104	3.629E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	2.851E+15	1.856E+15	1.316E+15	6.617E+14	8.409E+13	2.701E+12	4.501E+07
SN130	4.234E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE132	4.577E+15	6.127E-02	8.199E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	4.089E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	9.316E+13	7.875E+13	6.656E+13	4.756E+13	1.735E+13	3.231E+12	1.490E+10
TE135	7.156E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	6.320E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	3.990E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	1.061E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	7.247E+13	7.164E+13	7.081E+13	6.920E+13	6.456E+13	5.752E+13	3.974E+13
I138	4.665E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE138	3.314E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	7.137E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	7.532E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	9.867E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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 BA139     4.991E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BA141     4.433E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 LA141     4.867E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 LA142     4.166E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CE143     6.064E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CE144     1.615E+14 1.035E+14 6.629E+13 2.720E+13 1.880E+12 2.189E+10 1.417E+04
 PR144     4.055E+15 2.579E+15 1.652E+15 6.780E+14 4.686E+13 5.455E+11 3.532E+05
1                                          OUTPUT UNIT =  6                PAGE   69
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
 CE145     5.674E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 EU154     3.627E+13 3.484E+13 3.346E+13 3.087E+13 2.424E+13 1.620E+13 4.462E+12
 EU155     2.045E+13 1.907E+13 1.778E+13 1.546E+13 1.016E+13 5.054E+12 5.400E+11
0              PRINCIPAL PHOTON SOURCES IN GROUP  5,PHOTONS/SEC
               MEAN ENERGY= 0.085MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 RB 88     3.003E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SR 89     8.056E+14 6.570E+13 5.357E+12 3.561E+10 1.046E+04 1.358E-07 0.000E+00
 RB 90     3.316E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 SR 90     3.224E+13 3.185E+13 3.148E+13 3.074E+13 2.862E+13 2.541E+13 1.736E+13
  Y 90     2.793E+14 2.657E+14 2.626E+14 2.564E+14 2.387E+14 2.119E+14 1.448E+14
  Y 91     1.068E+15 1.237E+14 1.421E+13 1.876E+11 4.320E+05 1.734E-04 0.000E+00
 RB 92     7.149E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  Y 92     3.753E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  Y 93     3.447E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 94     3.237E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  Y 94     5.348E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
  Y 96     9.449E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NB 98     7.386E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 NB 99     5.760E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 ZR101     6.136E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 MO101     3.145E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC102     5.518E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC104     5.032E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RH106     1.828E+15 1.190E+15 8.441E+14 4.244E+14 5.393E+13 1.732E+12 2.886E+07
 TE133M    2.567E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE133     1.840E+16 7.471E+05 2.469E-05 2.680E-26 0.000E+00 0.000E+00 0.000E+00
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

TE134	8.707E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	2.466E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	4.801E+13	4.058E+13	3.430E+13	2.451E+13	8.940E+12	1.665E+12	7.680E+09
TE135	4.720E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	4.153E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	2.611E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	6.896E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	3.613E+13	3.572E+13	3.531E+13	3.450E+13	3.219E+13	2.868E+13	1.982E+13
I138	3.117E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	4.519E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	4.946E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	6.402E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA139	3.090E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	2.754E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA141	3.040E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA142	5.304E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	2.595E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144	6.440E+14	4.126E+14	2.643E+14	1.085E+14	7.497E+12	8.728E+10	5.651E+04
PR144	2.572E+15	1.635E+15	1.048E+15	4.300E+14	2.972E+13	3.460E+11	2.240E+05
ND147	5.180E+15	5.548E+10	5.937E+05	6.798E-05	0.000E+00	0.000E+00	0.000E+00
EU154	6.950E+12	6.676E+12	6.412E+12	5.916E+12	4.645E+12	3.104E+12	8.549E+11

1 OUTPUT UNIT = 6 PAGE 70
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

EU155	1.021E+14	9.518E+13	8.876E+13	7.718E+13	5.074E+13	2.523E+13	2.696E+12

0 PRINCIPAL PHOTON SOURCES IN GROUP 6,PHOTONS/SEC
MEAN ENERGY= 0.125MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 90	8.177E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	1.716E+13	1.696E+13	1.676E+13	1.637E+13	1.524E+13	1.353E+13	9.243E+12
Y 90	1.871E+14	1.780E+14	1.759E+14	1.717E+14	1.599E+14	1.420E+14	9.700E+13
Y 91	6.877E+14	7.965E+13	9.152E+12	1.208E+11	2.782E+05	1.117E-04	0.000E+00
KR 92	3.779E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 92	5.142E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 92	2.591E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	3.736E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	6.728E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NB 98	5.196E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	3.988E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 99	3.338E+15	3.408E-05	3.477E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 99M	4.152E+16	4.663E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	4.376E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	3.833E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	3.565E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	1.261E+15	8.212E+14	5.823E+14	2.927E+14	3.720E+13	1.195E+12	1.991E+07
TE131	1.935E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132M	2.983E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	4.314E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	2.618E+13	2.213E+13	1.871E+13	1.337E+13	4.875E+12	9.079E+11	4.188E+09
TE135	3.328E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	2.912E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	4.791E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.894E+13	1.872E+13	1.851E+13	1.809E+13	1.688E+13	1.503E+13	1.039E+13
CS138	3.898E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	3.621E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	4.429E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	2.256E+16	4.621E+14	9.415E+12	3.908E+09	2.794E-01	3.441E-18	0.000E+00
CE144	3.012E+15	1.930E+15	1.236E+15	5.074E+14	3.507E+13	4.083E+11	2.643E+05
PR144	1.755E+15	1.116E+15	7.151E+14	2.935E+14	2.029E+13	2.362E+11	1.529E+05
SM153	3.442E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	2.210E+14	2.123E+14	2.039E+14	1.881E+14	1.477E+14	9.871E+13	2.718E+13
EU155	5.620E+13	5.241E+13	4.887E+13	4.250E+13	2.794E+13	1.389E+13	1.484E+12

1 OUTPUT UNIT = 6 PAGE 71
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 7,PHOTONS/SEC
MEAN ENERGY= 0.225MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 89	6.711E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	6.642E+14	5.416E+13	4.416E+12	2.936E+10	8.623E+03	1.119E-07	0.000E+00
SR 90	1.357E+13	1.341E+13	1.325E+13	1.294E+13	1.205E+13	1.070E+13	7.308E+12
Y 90	2.633E+14	2.505E+14	2.475E+14	2.417E+14	2.250E+14	1.998E+14	1.365E+14
Y 91	8.902E+14	1.031E+14	1.185E+13	1.564E+11	3.602E+05	1.446E-04	0.000E+00
RB 92	8.367E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Y 93	6.313E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	5.714E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	1.077E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	8.031E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	6.022E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	3.887E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	9.516E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	5.808E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	7.444E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	1.875E+15	1.221E+15	8.655E+14	4.351E+14	5.530E+13	1.776E+12	2.960E+07
SB125	2.613E+13	2.323E+13	2.050E+13	1.596E+13	7.533E+12	2.156E+12	3.933E+10
SN130	7.715E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE132	3.222E+16	4.313E-01	5.772E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133M	6.711E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	2.992E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134M	5.589E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	2.400E+13	2.029E+13	1.715E+13	1.225E+13	4.470E+12	8.324E+11	3.840E+09
TE135	8.418E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE135	1.410E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	1.126E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	7.433E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.504E+13	1.487E+13	1.470E+13	1.436E+13	1.340E+13	1.194E+13	8.250E+12
XE138	2.040E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	5.608E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	4.073E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	6.841E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA139	1.025E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	3.070E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA142	1.649E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE143	2.293E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	2.564E+15	1.630E+15	1.044E+15	4.286E+14	2.963E+13	3.449E+11	2.233E+05
ND149	6.811E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	4.567E+13	4.386E+13	4.213E+13	3.887E+13	3.052E+13	2.040E+13	5.617E+12

1 OUTPUT UNIT = 6 PAGE 72
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 8,PHOTONS/SEC
MEAN ENERGY= 0.375MEV

NUCLIDE

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 87	6.807E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	2.535E+14	2.067E+13	1.685E+12	1.120E+10	3.291E+03	4.272E-08	0.000E+00
SR 90	1.339E+12	1.323E+12	1.307E+12	1.276E+12	1.188E+12	1.055E+12	7.209E+11
Y 90	1.212E+14	1.153E+14	1.139E+14	1.112E+14	1.036E+14	9.194E+13	6.282E+13
Y 91	3.476E+14	4.026E+13	4.626E+12	6.108E+10	1.406E+05	5.645E-05	0.000E+00
RB 92	5.029E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	6.198E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	4.423E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	7.945E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC101	3.167E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	3.365E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU105	6.160E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH105	5.683E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	9.978E+14	6.497E+14	4.607E+14	2.316E+14	2.943E+13	9.454E+11	1.575E+07
RH107	1.459E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH108	7.259E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	1.552E+14	1.379E+14	1.217E+14	9.476E+13	4.473E+13	1.280E+13	2.335E+11
I131	2.024E+16	3.033E+09	4.412E+02	9.331E-12	0.000E+00	0.000E+00	0.000E+00
TE133	2.852E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	9.161E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	8.876E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	1.740E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	2.254E+12	2.228E+12	2.203E+12	2.152E+12	2.008E+12	1.789E+12	1.236E+12
XE138	1.462E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	5.144E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	5.496E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	9.459E+15	5.240E+11	2.635E+07	6.664E-02	0.000E+00	0.000E+00	0.000E+00
BA141	1.589E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA142	7.123E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	1.266E+15	8.052E+14	5.158E+14	2.117E+14	1.463E+13	1.704E+11	1.103E+05
CE145	5.622E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE146	5.550E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR148	1.069E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	7.276E+12	6.989E+12	6.713E+12	6.193E+12	4.863E+12	3.250E+12	8.950E+11

0 PRINCIPAL PHOTON SOURCES IN GROUP 9,PHOTONS/SEC
MEAN ENERGY= 0.575MEV

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 89	7.513E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 90	8.061E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 90	6.439E+13	6.126E+13	6.054E+13	5.911E+13	5.504E+13	4.886E+13	3.339E+13
Y 91M	1.482E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	4.750E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	1.977E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TC102	3.024E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU103	3.291E+16	1.312E+15	5.229E+13	8.301E+10	3.328E+02	3.367E-12	0.000E+00
TC104	1.552E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU105	1.291E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	5.206E+15	3.390E+15	2.403E+15	1.208E+15	1.536E+14	4.932E+12	8.219E+07
SB125	1.994E+14	1.773E+14	1.564E+14	1.218E+14	5.749E+13	1.645E+13	3.001E+11
SB131	9.018E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132	1.498E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132M	1.118E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I132	6.157E+16	8.351E-01	1.117E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133M	8.434E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I133	4.248E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	1.473E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	2.781E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	8.636E+15	7.300E+15	6.170E+15	4.409E+15	1.608E+15	2.995E+14	1.382E+12
TE135	2.069E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE135M	7.638E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	1.334E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	4.876E+15	4.814E+15	4.759E+15	4.650E+15	4.339E+15	3.865E+15	2.671E+15
I138	1.601E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	1.780E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA140	8.180E+15	4.114E+11	2.069E+07	5.231E-02	0.000E+00	0.000E+00	0.000E+00
LA140	1.686E+16	9.342E+11	4.698E+07	1.188E-01	0.000E+00	0.000E+00	0.000E+00
BA141	1.141E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	2.460E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	1.219E+15	7.753E+14	4.967E+14	2.038E+14	1.409E+13	1.640E+11	1.062E+05

0 PRINCIPAL PHOTON SOURCES IN GROUP 10,PHOTONS/SEC
MEAN ENERGY= 0.850MEV

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
BR 88	9.786E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90	7.507E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 90	2.008E+13	1.910E+13	1.888E+13	1.843E+13	1.716E+13	1.524E+13	1.041E+13
SR 91	7.199E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	9.854E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	3.088E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	3.078E+16	4.256E+15	5.886E+14	1.125E+13	7.868E+07	2.011E-01	0.000E+00
NB 95	2.790E+16	8.622E+15	1.322E+15	2.679E+13	1.811E+08	4.629E-01	0.000E+00
NB 97M	3.384E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 99	7.018E+15	7.164E-05	7.310E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	7.094E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	1.010E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU105	1.465E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.114E+14	2.028E+14	1.438E+14	7.228E+13	9.186E+12	2.951E+11	4.916E+06
AG110M	2.139E+14	1.289E+14	7.768E+13	2.820E+13	1.350E+12	8.516E+09	7.764E+02
SB128M	8.502E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB129	6.965E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB130M	2.458E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB131	1.858E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6 PAGE 74
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12

SB132	1.842E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132M	1.002E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I132	3.995E+16	5.418E-01	7.250E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133M	3.117E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	1.964E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	1.056E+17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	5.997E+15	5.070E+15	4.285E+15	3.062E+15	1.117E+15	2.080E+14	9.595E+11
LA140	1.901E+16	1.053E+12	5.296E+07	1.339E-01	0.000E+00	0.000E+00	0.000E+00
BA142	1.158E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	2.773E+14	1.764E+14	1.130E+14	4.636E+13	3.205E+12	3.731E+10	2.416E+04
CE145	1.653E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	2.585E+14	2.483E+14	2.385E+14	2.200E+14	1.727E+14	1.154E+14	3.179E+13

0 PRINCIPAL PHOTON SOURCES IN GROUP 11,PHOTONS/SEC
MEAN ENERGY= 1.250MEV

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 89	4.852E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 89	1.941E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 90	7.868E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 90	6.591E+12	6.271E+12	6.197E+12	6.051E+12	5.634E+12	5.002E+12	3.418E+12
SR 91	8.334E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 92	3.098E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	5.494E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	1.574E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	4.771E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	7.059E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.966E+14	2.583E+14	1.831E+14	9.206E+13	1.170E+13	3.758E+11	6.262E+06
AG110M	4.319E+13	2.603E+13	1.568E+13	5.694E+12	2.725E+11	1.719E+09	1.568E+02
SB130M	5.834E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB131	5.541E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I132	8.576E+15	1.163E-01	1.556E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133	6.876E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	1.792E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	3.964E+14	3.351E+14	2.833E+14	2.024E+14	7.383E+13	1.375E+13	6.342E+10
I135	3.554E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	2.280E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	1.446E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	5.422E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	3.944E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	4.955E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	5.747E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA142	1.827E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	7.182E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	2.203E+14	1.401E+14	8.974E+13	3.683E+13	2.546E+12	2.964E+10	1.919E+04
EU154	2.862E+14	2.749E+14	2.640E+14	2.436E+14	1.912E+14	1.278E+14	3.520E+13

1 OUTPUT UNIT = 6 PAGE 75
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0 PRINCIPAL PHOTON SOURCES IN GROUP 12,PHOTONS/SEC
MEAN ENERGY= 1.750MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

KR 88	2.106E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 88	3.960E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 89	4.011E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 90	3.741E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 90	5.143E+11	4.894E+11	4.836E+11	4.722E+11	4.397E+11	3.903E+11	2.667E+11
Y 94	2.513E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	5.666E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	9.820E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	7.390E+13	4.812E+13	3.412E+13	1.715E+13	2.180E+12	7.002E+10	1.167E+06
AG110M	1.668E+13	1.005E+13	6.058E+12	2.199E+12	1.053E+11	6.641E+08	6.055E+01
SB124	1.774E+13	2.166E+12	2.644E+11	3.943E+09	1.307E+04	9.628E-06	0.000E+00
SB131	3.666E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132	1.522E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133	1.847E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133M	2.035E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134	8.089E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I135	1.159E+16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE138	8.328E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	2.564E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	1.456E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	3.985E+16	2.208E+12	1.110E+08	2.807E-01	0.000E+00	0.000E+00	0.000E+00
BA141	2.003E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	8.729E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	2.556E+13	1.625E+13	1.041E+13	4.273E+12	2.954E+11	3.439E+09	2.226E+03
EU154	8.579E+12	8.240E+12	7.915E+12	7.302E+12	5.734E+12	3.832E+12	1.055E+12

0 PRINCIPAL PHOTON SOURCES IN GROUP 13,PHOTONS/SEC
MEAN ENERGY= 2.250MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
KR 88	9.996E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 89	1.152E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 89	3.308E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 90	5.677E+07	5.401E+07	5.337E+07	5.212E+07	4.852E+07	4.308E+07	2.944E+07
Y 94	9.121E+14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	3.824E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	2.607E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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RH106     2.278E+13 1.483E+13 1.051E+13 5.286E+12 6.718E+11 2.158E+10 3.596E+05
SB131     1.766E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
TE133M    1.216E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
I135      1.255E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
I136      4.289E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
XE138     8.619E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS138     7.276E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
XE139     1.691E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1                                        OUTPUT UNIT =  6                PAGE   76
ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
CS139     1.088E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
LA142     1.409E+16 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
PR144     1.991E+14 1.266E+14 8.111E+13 3.329E+13 2.301E+12 2.678E+10 1.734E+04
EU156     1.069E+15 2.569E+11 6.157E+07 3.537E+00 0.000E+00 0.000E+00 0.000E+00
0            PRINCIPAL PHOTON SOURCES IN GROUP 14,PHOTONS/SEC
             MEAN ENERGY= 2.750MEV

NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

KR 87     1.465E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
BR 88     7.784E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RB 88     3.878E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
KR 89     1.100E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RB 89     2.381E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RB 90M    8.013E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RB 92     4.037E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
Y 94      4.945E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NB 99M    3.286E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
TC104     2.321E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
RH106     3.331E+12 2.169E+12 1.538E+12 7.732E+11 9.826E+10 3.156E+09 5.259E+04
SB132M    3.188E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
I136      2.641E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS138     3.633E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
XE139     9.536E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CS139     5.350E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
LA140     1.517E+15 8.405E+10 4.227E+06 1.069E-02 0.000E+00 0.000E+00 0.000E+00
LA142     8.491E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
PR144     1.784E+11 1.135E+11 7.269E+10 2.983E+10 2.062E+09 2.400E+07 1.554E+01
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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0              PRINCIPAL PHOTON SOURCES IN GROUP 15,PHOTONS/SEC
               MEAN ENERGY= 3.500MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 BR 84     7.388E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 BR 88     1.240E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR 89     1.880E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 89     2.971E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 90     3.621E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 90M     1.160E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 92     3.067E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 94     1.853E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 TC104      1.241E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RH106      4.354E+11 2.835E+11 2.010E+11 1.011E+11 1.284E+10 4.125E+08 6.873E+03
  I136     4.627E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS138      2.410E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 XE139      2.066E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CS139      2.921E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 LA142      3.067E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1                                          OUTPUT UNIT =  6                PAGE   77
 ORIGEN2 V2.1 (8-1-91), Run on Aug 20 1999 at 10:07:12
0              PRINCIPAL PHOTON SOURCES IN GROUP 16,PHOTONS/SEC
               MEAN ENERGY= 5.000MEV

 NUCLIDE
        ASSY DIS     0.5YR     1.0YR     2.0YR     5.0YR    10.0YR    26.0YR

 BR 88     1.524E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 KR 89     1.387E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 90     4.191E+15 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 90M     1.844E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 RB 92     7.352E+14 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 CE142      7.198E-05 7.198E-05 7.198E-05 7.198E-05 7.198E-05 7.198E-05 7.198E-05
 SM147      6.466E-06 7.180E-06 7.805E-06 8.833E-06 1.069E-05 1.182E-05 1.223E-05
0              PRINCIPAL PHOTON SOURCES IN GROUP 17,PHOTONS/SEC
               MEAN ENERGY= 7.000MEV
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
RB 92	5.796E+13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	3.607E+12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	4.670E-06	4.670E-06	4.670E-06	4.670E-06	4.670E-06	4.670E-06	4.670E-06
SM147	4.196E-07	4.659E-07	5.065E-07	5.732E-07	6.939E-07	7.671E-07	7.934E-07

0 PRINCIPAL PHOTON SOURCES IN GROUP 18,PHOTONS/SEC
MEAN ENERGY= 9.500MEV

NUCLIDE	ASSY DIS	0.5YR	1.0YR	2.0YR	5.0YR	10.0YR	26.0YR
RB 94	1.302E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	2.953E-07	2.953E-07	2.953E-07	2.953E-07	2.953E-07	2.953E-07	2.953E-07
SM147	2.653E-08	2.946E-08	3.203E-08	3.624E-08	4.388E-08	4.851E-08	5.017E-08

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Scientific Notebook #170

Issued to: S. Mohanty

Issue Date: Apr. 3, 1996

Account Number: 20-01402-762

Title: DCAGS

Participants: J. Weldy

12/27/00 - Modifications to Module DCAGS

The DCAGS Module was modified to account for a time-dependent mass-loading factor, which decreases exponentially following a volcanic event.

This modification is made for both critical groups and both the current and pluvial biospheres.

Modifications made:

```
added line 150: dimension tmassload(maxntime)
replaced line 166:      name = 'AirborneMassLoadForVolcanismDoseCalculation[g/m3]'
with lines 171:         name = 'AirborneMassLoadAboveFreshAshBlanket[g/m3]'

added lines 187-195: call clearchar( 60, name )
                     name = 'AirborneMassLoadAboveSoil[g/m3]'
                     isoilmassload = ispquery( name )

                     call clearchar( 60, name )
                     name = 'RateOfReductionOfMassLoadingFactor[1/yr]'
                     ireductionrate = ispquery( name )

added lines 274, 275: soilmassload=valuesp( isoilmassload )
                     reductionrate=valuesp( ireductionrate )

added lines 305, 306: tmassload(it)=(dmassload-soilmassload)*exp(-reductionrate
                     &    *(tim(it)-tim(itoe)))+soilmassload
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

replaced lines 449-450, 499-500, 553-554, and 599-600 (all identical lines):

```
dcf(it,k)=dcfde(k)+dcfinh(k)/(gramsashpercm2*1.d+04)*dmassload
&    *occupancy*resuspendablefraction(it)+dcfinga(k)+dcfingp(k)
```

with lines 479-481, 533-535, 590-592, and 639-641 (all identical lines):

```
dcf(it,k)=dcfde(k)+dcfinh(k)/(gramsashpercm2*1.d+04)
&    *tmassload(it)*occupancy*resuspendablefraction(it)
&    +dcfinga(k)+dcfingp(k)
```

New Parameters and Justification for Initial Values:

1. AirborneMassLoadAboveFreshAshBlanket[g/m3]: this parameter is identical to the AirborneMassLoadForVolcanismDoseCalculation[g/m3] parameter in TPA 3.3 and represents the mass load in the year following the volcanic eruption. The range of a loguniform distribution from 10^{-4} to 10^{-2} is kept based on literature search and result of experiments above the Cerro Negro ash blanket.

2. AirborneMassLoadAboveSoil[g/m3]: this parameter represents the mass load above the ash blanket at very long times after the event so that the ash material is essentially soil and is set to a value of 10^{-4} to be consistent with the parameter used to calculate the DCFs in the GENII Code and based on data in Anspaugh, 1975.

Anspaugh, L.R., J.H. Shinn, P.L. Phelps, and N.C. Kennedy. 1975. Resuspension and Redistribution of Plutonium in Soils. *Health Physics*. Vol. 29, pp. 571-582.

3. RateOfReductionOfMassLoadingFactor[1/yr]: this parameter specifies how quickly the mass loading factor drops and is set to a value of 2e-2, which was calculated by fitting a curve to two points, a mass load of 1e-3 in the year of the event and a mass load of 1e-4 at 1000 years after the event.

Tests:

1. Set the decrease rate of the mass loading factor to essentially zero. This should cause the results to be identical to the results running TPA 3.3.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Scientific Notebook #170

Issued to: S. Mohanty

Issue Date: Apr. 3, 1996

Account Number: 20-01402-762

Title: DCAGW

Participants: J. Weldy

2/7/00 - Modifications to Module DCAGW

Objectives:
1) The DCAGW Module was modified to use a different well pumping rate under pluvial conditions. This is done in the calculations of the DCFs, so to be consistent, ti should be done to determine the concentration of RNs in the groundwater. Per discussions with R. Fedors and D. Farrell, implementation should only be done for the 20 km receptor group, as the 10 km receptor group uses most of their water for personal uses, not irrigation of crops, so the pumping rate will not change much under pluvial conditions. Additionally, changing the pumping rate does not affect any other parameters used in the TPA code.

2) Allow the user to specify the time at which pluvial conditions occur. This change is being implemented to replace the current methodology of determining when pluvial conditions occur of using the current precipitation and temperature values and switch to pluvial conditions when the climate state switches from arid to semi-arid. This method was leading to a change to pluvial conditions much too early, when conditions were not consistent with the rainfall and temperature assumptions used to derive the pluvial pumping rates and DCFs.

3) Add the calculation of the leach factor from Kd values to the TPA code prior to running the GENII code. This change will give the user more control to modify these values to determine the sensitivity they have on the results. Currently, the leach rate is specified as a default value in the file gftrans.dat. This modification will cause this value to be changes for the TPA radionuclides when the data is transferred to the file gftrans.inp.

Modifications made:

Added two new parameters and got their values with the function valuesp. The two new parameters

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
are PluvialWellPumpingRateAtReceptorGroup20km[gal/day] and PluvialSwitchTime[yr].

Convert pluvial pump rate to m3/yr by multiplying by (365.25 day/yr) * (1 m^3/264.172 gal).

Replace pluvial cutoff time determination with a set time. Add parameter to remember the dKG value at the cutoff time so the code can return to current conditions when the temperature and rainfall return to current values. The pump rate should be a pluvial pump rate when the time is greater than the switch time, the dKG value is smaller than the value at the switch time, and the receptor group is specified as the 20 km group. Otherwise, the pump rate should be the current conditions pump rate.

For the calculations of the leach rate, insert the calculation in the subroutine gentpa between the lines where the values from the file gftrans.dat are read and where they are written to the file gftrans.inp. The formula that should be used to calculate the leach rate is the formula from Baes and Sharp (1981):

$$\lambda_{leach} = \frac{P + I - E}{d(1 + \frac{\rho}{\theta} K_d)}$$

where,

P = Annual precipitation [m/yr]
I = Irrigation rate [m/yr]
E = Annual evapotranspiration rate [m/yr]
d = Depth of rooting zone [m]
ρ = Density of soil [g/cm3]
θ = Soil volumetric water content [mL/cm3] or []
K_d = Distribution coefficient [cm3/g]

New Parameters and Justification for Initial Values:

1. PluvialWellPumpingRateAtReceptorGroup20km. Laplante et al., 1997 states that the irrigation rate at Blackfoot ID (which was determined to be an analog to pluvial conditions at Amargosa Valley) is about 71% of the current irrigation rate at Amargosa Valley. Therefore, multiply the range of current pumping rates by 0.71 to get a range of 3.2e6 to 9.23e6. Note that this should be strongly correlated to the current pump rate and to the irrigation rate (pluvial) used for GENII, if this parameter is sampled.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

2. PluvialSwitchTime: The current climato2.dat file reaches 50% of full pluvial conditions at about 13,000 years. This seems like a logical initial value for the parameter..

3. KD values for radionuclides in soil. These values were taken from Sheppard and Thibault (1990) for a sandy soil. Note that Sheppard and Thibault does not list a Kd for Cl-36, so this parameter was taken from the UZ and SZ retardation in the mountain and given a Kd of 0.

4. Current precipitation rate. 0.085 m/yr at Amargosa Valley (from Wilson et. al., 1993. More current AMRs indicate similar rates (0.09-0.1 m/yr).

5. Current irrigation rate. 1.52 m/yr at Amargosa Valley (Laplante et al., 1997).

6. Current evapotranspiration rate. 0.8 m/yr (Laplante, et al., 1997).

7. Depth of the rooting zone. 0.15 m (LaPlante et al., 1997).

8. Density of surface soil. 1.5 g/cm3 (LaPlante et al., 1997).

9. Soil volumetric water content. 0.35 (Laplante et al., 1997).

Tests:

1. Check that the code switches to pluvial conditions at the time set by the user.
2. Change the Pluvial Switch Time to a time beyond the end of the calculational period and ensure that the code does not switch to pluvial conditions.
3. Set the pluvial pump rate to a very small value and ensure that the doses become much larger when pluvial conditions are reached.
4. For base case, confirm that all values calculated in the code are identical to those values in gftrans.def. The one exception to this is for Cl-36, which is somewhat different due to different assumptions in the retardation factor for Cl-36 between here and Laplante, 1997.
5. Change the Kds for all RNs in the TPA code to a unique value and make sure that this change shows up for all of the TPA RNs in the gftrans.inp file.

Scientific Notebook #170-10e
James Weldy
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Definition of Mass Loading Parameters for DCAGS modified for version 5.0

Objective:

Three parameters have to be defined for the implementation of DCAGS in TPA: AirborneMassLoadAboveFreshAshBlanket[g/m3], AirborneMassLoadAboveSoil[g/m3], and RateOfReductionOfMassLoad[1/yr].

AirborneMassLoadAboveFreshAshBlanket[g/m3] - Calculated based on an **initial** value for plowing between **0.1 and 0.2 g/m^3** (1-2 times the value humans can barely tolerate (Stewart, 1964)). The initial value decays with a **half-life of 140 days in the first year** (Data from thin film deposits, such as Chernobyl, would support a decay by a factor of 100 in the first year. See also Anspaugh (1975) which cites Langham (1969) and Kathren (1968)] for half-lives of 35 and 45 days, respectively). This is somewhat longer than the value for thin film deposits due to the thicker deposits associated with the tephra deposit, and is consistent with data from Yakima, WA following the Mt. St. Helens eruption presented at the Igneous Activity Issue Closure Technical Exchange, which indicates a drop in the mass load in the months following the event with a half-life of about 140 days). For the very high mass loads encountered in early years following deposition, consideration needs to be taken for the time that plowing/activity that would create the very dusty conditions is occurring. It seems realistic to assume that farmers plow their fields for 1 to 3 work weeks of dusty conditions (40 to 120 hours per year). To have very dusty conditions requires not only high winds or aggressive physical activity such as plowing, but a dry soil. If they can avoid it, farmers do not typically plow during very windy and dry conditions, because they do not want to lose their soils from the farming areas. Therefore, the values calculated by a model such as that given above need to multiplied by a plowing time factor.

Plowing Time Factor = 0.0046 - 0.0137.

The rest of the time that people are exposed to the airborne radionuclides outdoors, it is assumed that they are walking over the ash blanket. All other time, it is assumed that they are exposed to indoor air concentrations, which is between 0.2 and 0.7 times the undisturbed outdoor concentration (NUREG/CR-5512). Data from Nicaragua indicates that the mass load over a surface being disturbed by an individual walking on it is about an order of magnitude smaller than the mass load over a surface that is being heavily disturbed and the undisturbed mass load is about an order of magnitude below that.

Performing the integration (the average concentration of a decaying exponential function with a lambda of 1.8/yr over one year is 0.464 times the initial value) and weighting for the fraction of the year that plowing occurs yields the following first year range:

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-761

Min: 1.21E-3
Max: 3.64E-3

A lognormal distribution may be assumed.

Activity	Fraction of Year	Average Mass Load (g/m^3)
Plowing	0.0046 - 0.0137	4.64e-2 – 9.28e-2
Walking Outside	0.2	4.64e-3 – 9.28e-3
Indoors	0.55	9.28e-5 – 6.5e-4
Offsite (since tephra deposit is widely distributed, assume that receptor is still exposed to ash while offsite. Assume receptor works or spends time indoors while offsite.)	0.236 – 0.245	9.28e-5 – 6.5e-4

Note that corrections for exposure times in the code would have to be divided back out of this range since it is already weighted for occupancy time. Since the current value for the occupancy factor in the TPA Code is 0.605, this range needs to be divided by 0.605 to ensure that the code is using the proper value. This results in the following range which should be used as the input distribution for the mass loading value in the TPA Code:

Lognormal Distribution
Min: 2.0E-3 g/m^3
Max: 6.0E-3 g/m^3

RateOfReductionOfMassLoad[1/yr] - A long-term **half-life of 10 yr** starting at year 1 (lambda = 0.0693). Chernobyl data would easily support a half-life of 1.0 yr or less. Sehmel and Orgill (1974) and NRC (1975) also would support a half-life on the order of 1.0 yr. However, there is significantly more material released in a volcanic event that the studies on which this data is based, with the potential for replacement of fine material due to fluvial redistribution or deposition from other areas. Therefore, assume an order of magnitude longer half-life to account for this.

Note that Nicaragua data would indicate that for a range of plowing times of 1-3 weeks and

similar behaviors as assumed for the critical group for Yucca Mountain, the average mass load would be between 2.9E-4 and 4.4E-4 g/m^3. Decaying our initial range (before dividing by the 0.605 occupancy factor) by the 6 year age of the ash blanket yields a range from 2.8e-4 to 8.3e-4 g/m^3. Considering that Nicaragua is a much wetter environment than the Yucca Mountain environment, this provides confidence that these values are credible.

AirborneMassLoadAboveSoil[g/m3] - From the list of references for mass loads originally compiled by B. Eid, 5 references were selected as appearing to be applicable to the Amargosa Valley region. These references are listed in the following table, along with justification as to why they are applicable and the range of mass loading values reported:

Reference	Justification for applicability	Min Mass Load Reported (g/m3)	Max Mass Load Reported (g/m3)
Sehmel (1977)	Data collected at the Hanford Site, which is an arid climate with sparse vegetation, similar to the Amargosa Valley region. Includes information on level of disturbance, particle size distribution, and height of measurements.	2.8e-5	0.23
Tegen and Fung (1994)	Data collected in areas of high dust loading such as deserts and eroding cultivated areas.	1e-4	1e-4
Anspaugh (1975)	Data collected in Nevada on the Nevada Test Site. Information on measurement height and level of disturbance, but particle size distribution is unknown.	1e-4	5e-3
Rognon (1991)	Data collected in a desert region, which would likely have soil similar to the Amargosa Valley region.	1.6e-6	1.3e-5
Soldat (1973)	Data collected for Retrievable Surface Storage Facility in Hanford, WA which has similar soil characteristics to Amargosa Valley.	1e-4	1e-4

The Sehmel (1977) paper was investigated to determine why the high value was so much higher than the other sources. Investigation revealed that the maximum value in Table 6 included

particle sizes up to 230 microns and were measured at a height of only 30 cm. Particles above 100 microns are not inhalable by human beings and therefore should not be included in the mass load value used to determine dose to humans. Additionally, human breathe air at a height of almost 2 m, so the mass load at 30 cm is not what will be inhaled by people. Sehmel (1977) divided the measurements by particle size, and the maximum concentration of dust in the air smaller than 100 microns was 4.51e-2 g/m3 at 30 cm. The minimum concentration of dust in the air smaller than 100 microns was 2.6e-5 g/m3. Investigation of Figure 10 showed that the maximum concentration at 30 cm ranged from between 4 and 6 times the maximum concentration at 2 m. Therefore, the maximum concentration was divided by a factor of 4 to yield a value of 1.13e-2 g/m3.

To determine a range from these varying estimates of mass load, each of the references was assigned a median value based on assuming that the distribution of estimates within a reference is log-uniform. Therefore, the following median values were determined for the references : Sehmel - 5.5e-4, Rognon - 4.6e-6, Tegen and Fung - 1e-4, Anspaugh - 7.1e-4, Soldat - 1e-4. The geometric means of these values is 1.12e-4, with a geometric standard error of the mean of 2.5. To define the range of the parameter, assume a log-uniform range to maximize the entropy of the distribution with a range of plus or minus the standard error of the mean. The final distribution for the parameter is:

loguniform
AirborneMassLoadAboveSoil[g/m3]
5e-5, 3e-4

** Note that I recently was able to acquire the Rognon (1991) paper and am evaluating whether the data is in fact appropriate to use in the development of the mass loading value above soil for Yucca Mountain. If it was excluded from the calculation, the result would be:

loguniform
AirborneMassLoadAboveSoil[g/m3]
1.72e-4, 3.62e-4

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Title: TPA 4.0 Testing

Participants: J. Weldy

3/7/00 Testing of changes to TPA 4.0

SCR 301

Functional Tests:

Test 2

This test is for whether the DCFs are properly switching to the pluvial DCFs at the proper time. The test will consist of running a case of adult dose for 100,000 years (so that the pluvial DCFs will kick in and return to current conditions). Then an Excel spreadsheet will be used to multiply the releases from SZFT (in dcagw.ech) by the DCF (in gw_cb_ad.dat and gw_pb_ad.dat) and divide by the proper pumping rate (from tpa.inp) to check that both are switching at the pluvial time.

Test routine: Run a base case for the adult receptor group. Compare the DCFs calculated for the base case to the DCFs calculated for the other age groups. Confirm that the ratio of the total DCFs are consistent with Smith et al. (2000). Confirm that the ratio of the pathway-specific DCFs are consistent with the Excel calculations.

Files needed for test: gw_cb_ad.dat for 6 age groups

Test conducted by JRW on 3/7/00

The following table shows how the doses were compared for U-234 and U-238.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Time	U238 (Ci/yr)	U234 (Ci/yr)	Dilution Volume (gal/day)	Dilution Volume (m3/yr)	U238 DCF (rem/yr/Ci/m3)	U234 DCF (rem/yr/Ci/m3)	U238 Dose (rem/yr)	U234 Dose (rem/yr)	U238 Dose from rgwna	U234 Dose from rgwna	U238 Difference	U234 Difference
0.00e+00	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00				
2.31e+01	0.00e+00	0.00e+00	8750000	1.2e+07	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.67e+01	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
7.09e+01	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
9.57e+01	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.21e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.47e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.74e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.01e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.28e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15

2.57e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.86e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.16e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.46e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.78e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.10e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.42e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.76e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.10e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.45e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.81e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.17e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.55e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.93e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
7.33e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
7.73e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
8.14e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
8.56e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
9.00e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
9.44e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
9.89e+02	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.04e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.08e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.13e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.18e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.23e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

1.28e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.34e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.39e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.45e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.50e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.56e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.62e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.68e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.74e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.81e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.87e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
1.94e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.01e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.08e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.15e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.23e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.30e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.38e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.46e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.54e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.62e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.70e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.79e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.88e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
2.97e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.06e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15

3.16e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.25e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.35e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.45e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.56e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.66e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.77e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
3.88e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.00e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.12e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.24e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.36e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.48e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.61e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.74e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
4.88e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.01e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.15e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.30e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.44e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.59e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.75e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
5.91e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.07e+03	0.00e+00	0.00e+00	8750000	12096623	585000	635000	0.00e+00	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.23e+03	9.23e-28	0.00e+00	8750000	12096623	585000	635000	4.46e-29	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.40e+03	2.23e-26	0.00e+00	8750000	12096623	585000	635000	1.08e-27	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

6.58e+03	2.39e-25	0.00e+00	8750000	12096623	585000	635000	1.16e-26	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.75e+03	1.80e-24	0.00e+00	8750000	12096623	585000	635000	8.72e-26	0.00e+00	1.00e-15	1.00e-15	1e-15	1e-15
6.93e+03	9.70e-24	1.02e-23	8750000	12096623	585000	635000	4.69e-25	5.36e-25	1.00e-15	1.00e-15	1e-15	1e-15
7.12e+03	4.11e-23	6.13e-23	8750000	12096623	585000	635000	1.99e-24	3.22e-24	1.00e-15	1.00e-15	1e-15	1e-15
7.31e+03	1.54e-22	3.04e-22	8750000	12096623	585000	635000	7.46e-24	1.59e-23	1.00e-15	1.00e-15	1e-15	1e-15
7.50e+03	5.08e-22	1.19e-21	8750000	12096623	585000	635000	2.46e-23	6.25e-23	1.00e-15	1.00e-15	1e-15	1e-15
7.70e+03	1.51e-21	4.05e-21	8750000	12096623	585000	635000	7.32e-23	2.12e-22	1.00e-15	1.00e-15	1e-15	1e-15
7.91e+03	4.14e-21	1.22e-20	8750000	12096623	585000	635000	2.00e-22	6.38e-22	1.00e-15	1.00e-15	1e-15	1e-15
8.11e+03	1.06e-20	3.35e-20	8750000	12096623	585000	635000	5.12e-22	1.76e-21	1.00e-15	1.00e-15	1e-15	1e-15
8.33e+03	2.52e-20	8.41e-20	8750000	12096623	585000	635000	1.22e-21	4.41e-21	1.00e-15	1.00e-15	1e-15	1e-15
8.54e+03	5.66e-20	1.97e-19	8750000	12096623	585000	635000	2.74e-21	1.03e-20	1.00e-15	1.00e-15	1e-15	1e-15
8.77e+03	1.22e-19	4.37e-19	8750000	12096623	585000	635000	5.89e-21	2.29e-20	1.00e-15	1.00e-15	1e-15	1e-15
9.00e+03	2.50e-19	9.18e-19	8750000	12096623	585000	635000	1.21e-20	4.82e-20	1.00e-15	1.00e-15	1e-15	1e-15
9.23e+03	4.91e-19	1.84e-18	8750000	12096623	585000	635000	2.38e-20	9.66e-20	1.00e-15	1.00e-15	1e-15	1e-15
9.47e+03	9.32e-19	3.54e-18	8750000	12096623	585000	635000	4.51e-20	1.86e-19	1.00e-15	1.00e-15	1e-15	1e-15
9.71e+03	1.71e-18	6.58e-18	8750000	12096623	585000	635000	8.27e-20	3.45e-19	1.00e-15	1.00e-15	1e-15	1e-15
9.96e+03	3.04e-18	1.18e-17	8750000	12096623	585000	635000	1.47e-19	6.20e-19	1.00e-15	1.00e-15	1e-15	1e-15
1.02e+04	5.29e-18	2.07e-17	8750000	12096623	585000	635000	2.56e-19	1.09e-18	1.00e-15	1.00e-15	1e-15	1e-15
1.05e+04	8.95e-18	3.52e-17	8750000	12096623	585000	635000	4.33e-19	1.85e-18	1.00e-15	1.00e-15	1e-15	1e-15
1.08e+04	1.48e-17	5.86e-17	8750000	12096623	585000	635000	7.16e-19	3.08e-18	1.00e-15	1.00e-15	1e-15	1e-15
1.10e+04	2.40e-17	9.56e-17	8750000	12096623	585000	635000	1.16e-18	5.02e-18	1.00e-15	1.01e-15	1e-15	1e-15
1.13e+04	3.82e-17	1.52e-16	8750000	12096623	585000	635000	1.85e-18	8.00e-18	1.00e-15	1.01e-15	1e-15	1e-15
1.16e+04	5.98e-17	2.40e-16	8750000	12096623	585000	635000	2.89e-18	1.26e-17	1.00e-15	1.01e-15	1e-15	1e-15
1.19e+04	9.22e-17	3.70e-16	8750000	12096623	585000	635000	4.46e-18	1.94e-17	1.00e-15	1.02e-15	1e-15	1e-15
1.22e+04	1.40e-16	5.64e-16	8750000	12096623	585000	635000	6.77e-18	2.96e-17	1.01e-15	1.03e-15	1e-15	1e-15
1.25e+04	2.10e-16	8.46e-16	8750000	12096623	585000	635000	1.01e-17	4.44e-17	1.01e-15	1.04e-15	1e-15	1e-15

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

1.28e+04	3.10e-16	1.25e-15	8750000	12096623	585000	635000	1.50e-17	6.58e-17	1.01e-15	1.07e-15	1e-15	1e-15
1.31e+04	4.53e-16	1.84e-15	6215000	8592058.8	436000	475000	2.30e-17	1.02e-16	1.02e-15	1.10e-15	1e-15	1e-15
1.35e+04	6.56e-16	2.66e-15	6215000	8592058.8	436000	475000	3.33e-17	1.47e-16	1.03e-15	1.15e-15	1e-15	1e-15
1.38e+04	9.39e-16	3.81e-15	6215000	8592058.8	436000	475000	4.76e-17	2.11e-16	1.05e-15	1.21e-15	1e-15	1e-15
1.42e+04	1.33e-15	5.41e-15	6215000	8592058.8	436000	475000	6.75e-17	2.99e-16	1.07e-15	1.30e-15	1e-15	1e-15
1.45e+04	1.87e-15	7.61e-15	6215000	8592058.8	436000	475000	9.49e-17	4.21e-16	1.09e-15	1.42e-15	1e-15	1e-15
1.49e+04	2.61e-15	1.06e-14	6215000	8592058.8	436000	475000	1.32e-16	5.87e-16	1.13e-15	1.59e-15	1e-15	1e-15
1.52e+04	3.60e-15	1.47e-14	6215000	8592058.8	436000	475000	1.83e-16	8.12e-16	1.18e-15	1.81e-15	1e-15	1e-15
1.56e+04	4.94e-15	2.02e-14	6215000	8592058.8	436000	475000	2.51e-16	1.11e-15	1.25e-15	2.11e-15	1e-15	1e-15
1.60e+04	6.74e-15	2.75e-14	6215000	8592058.8	436000	475000	3.42e-16	1.52e-15	1.34e-15	2.52e-15	1e-15	1e-15
1.64e+04	9.12e-15	3.72e-14	6215000	8592058.8	436000	475000	4.63e-16	2.06e-15	1.46e-15	3.06e-15	1e-15	1e-15
1.68e+04	1.23e-14	5.01e-14	6215000	8592058.8	436000	475000	6.22e-16	2.77e-15	1.62e-15	3.77e-15	1e-15	1e-15
1.72e+04	1.64e-14	6.69e-14	6215000	8592058.8	436000	475000	8.31e-16	3.70e-15	1.83e-15	4.70e-15	1e-15	1e-15
1.77e+04	2.18e-14	8.89e-14	6215000	8592058.8	436000	475000	1.10e-15	4.91e-15	2.10e-15	5.91e-15	1e-15	1e-15
1.81e+04	2.88e-14	1.17e-13	6215000	8592058.8	436000	475000	1.46e-15	6.49e-15	2.46e-15	7.49e-15	1e-15	1e-15
1.85e+04	3.78e-14	1.54e-13	6215000	8592058.8	436000	475000	1.92e-15	8.53e-15	2.92e-15	9.53e-15	1e-15	1e-15
1.90e+04	4.94e-14	2.02e-13	6215000	8592058.8	436000	475000	2.51e-15	1.12e-14	3.51e-15	1.22e-14	1e-15	1e-15
1.95e+04	6.43e-14	2.63e-13	6215000	8592058.8	436000	475000	3.26e-15	1.45e-14	4.26e-15	1.55e-14	1e-15	1e-15
1.99e+04	8.33e-14	3.40e-13	6215000	8592058.8	436000	475000	4.23e-15	1.88e-14	5.22e-15	1.98e-14	1e-15	1e-15
2.04e+04	1.07e-13	4.38e-13	6215000	8592058.8	436000	475000	5.45e-15	2.42e-14	6.45e-15	2.52e-14	1e-15	1e-15
2.09e+04	1.38e-13	5.63e-13	6215000	8592058.8	436000	475000	7.00e-15	3.11e-14	7.99e-15	3.21e-14	1e-15	1e-15
2.15e+04	1.76e-13	7.19e-13	6215000	8592058.8	436000	475000	8.94e-15	3.97e-14	9.94e-15	4.07e-14	1e-15	1e-15
2.20e+04	2.24e-13	9.15e-13	6215000	8592058.8	436000	475000	1.14e-14	5.06e-14	1.24e-14	5.15e-14	1e-15	9e-16
2.25e+04	2.85e-13	1.16e-12	6215000	8592058.8	436000	475000	1.44e-14	6.41e-14	1.54e-14	6.51e-14	1e-15	1e-15
2.31e+04	3.60e-13	1.47e-12	6215000	8592058.8	436000	475000	1.83e-14	8.10e-14	1.93e-14	8.19e-14	1e-15	9e-16
2.36e+04	4.53e-13	1.84e-12	6215000	8592058.8	436000	475000	2.30e-14	1.02e-13	2.40e-14	1.03e-13	1e-15	1e-15

2.42e+04	5.69e-13	2.31e-12	6215000	8592058.8	436000	475000	2.89e-14	1.28e-13	2.98e-14	1.29e-13	9e-16	1e-15
2.48e+04	7.11e-13	2.89e-12	6215000	8592058.8	436000	475000	3.61e-14	1.60e-13	3.71e-14	1.61e-13	1e-15	1e-15
2.54e+04	8.86e-13	3.60e-12	6215000	8592058.8	436000	475000	4.50e-14	1.99e-13	4.59e-14	2.00e-13	9e-16	1e-15
2.60e+04	1.10e-12	4.46e-12	6215000	8592058.8	436000	475000	5.59e-14	2.47e-13	5.68e-14	2.48e-13	9e-16	1e-15
2.66e+04	1.36e-12	5.52e-12	6215000	8592058.8	436000	475000	6.92e-14	3.05e-13	7.02e-14	3.06e-13	1e-15	8e-16
2.73e+04	1.68e-12	6.81e-12	6215000	8592058.8	436000	475000	8.54e-14	3.76e-13	8.64e-14	3.77e-13	1e-15	6e-16
2.80e+04	2.07e-12	8.37e-12	6215000	8592058.8	436000	475000	1.05e-13	4.63e-13	1.06e-13	4.63e-13	8e-16	2e-16
2.86e+04	2.54e-12	1.03e-11	6215000	8592058.8	436000	475000	1.29e-13	5.67e-13	1.30e-13	5.68e-13	9e-16	7e-16
2.93e+04	3.11e-12	1.25e-11	6215000	8592058.8	436000	475000	1.58e-13	6.93e-13	1.59e-13	6.94e-13	1e-15	6e-16
3.00e+04	3.80e-12	1.53e-11	6215000	8592058.8	436000	475000	1.93e-13	8.45e-13	1.94e-13	8.45e-13	1e-15	-1e-17
3.08e+04	4.62e-12	1.86e-11	6215000	8592058.8	436000	475000	2.35e-13	1.03e-12	2.35e-13	1.03e-12	4e-16	3e-15
3.15e+04	5.61e-12	2.25e-11	6215000	8592058.8	436000	475000	2.85e-13	1.24e-12	2.86e-13	1.24e-12	1e-15	-4e-15
3.23e+04	6.79e-12	2.72e-11	6215000	8592058.8	436000	475000	3.45e-13	1.50e-12	3.45e-13	1.50e-12	5e-16	-4e-15
3.30e+04	8.20e-12	3.28e-11	6215000	8592058.8	436000	475000	4.16e-13	1.81e-12	4.17e-13	1.81e-12	1e-15	-2e-15
3.38e+04	9.87e-12	3.94e-11	6215000	8592058.8	436000	475000	5.01e-13	2.18e-12	5.01e-13	2.18e-12	3e-16	2e-15
3.47e+04	1.19e-11	4.72e-11	6215000	8592058.8	436000	475000	6.01e-13	2.61e-12	6.02e-13	2.61e-12	7e-16	-4e-16
3.55e+04	1.42e-11	5.65e-11	6215000	8592058.8	436000	475000	7.20e-13	3.12e-12	7.21e-13	3.12e-12	7e-16	-1e-15
3.63e+04	1.70e-11	6.73e-11	6215000	8592058.8	436000	475000	8.61e-13	3.72e-12	8.61e-13	3.72e-12	5e-16	-2e-15
3.72e+04	2.02e-11	8.01e-11	6215000	8592058.8	436000	475000	1.03e-12	4.43e-12	1.03e-12	4.42e-12	5e-15	-6e-15
3.81e+04	2.40e-11	9.50e-11	6215000	8592058.8	436000	475000	1.22e-12	5.25e-12	1.22e-12	5.25e-12	7e-16	-2e-15
3.90e+04	2.85e-11	1.12e-10	6215000	8592058.8	436000	475000	1.45e-12	6.21e-12	1.45e-12	6.21e-12	4e-15	-4e-15
4.00e+04	3.37e-11	1.33e-10	6215000	8592058.8	436000	475000	1.71e-12	7.34e-12	1.71e-12	7.33e-12	-5e-16	-5e-15
4.09e+04	3.98e-11	1.56e-10	6215000	8592058.8	436000	475000	2.02e-12	8.64e-12	2.02e-12	8.63e-12	1e-15	-7e-15
4.19e+04	4.68e-11	1.84e-10	6215000	8592058.8	436000	475000	2.38e-12	1.01e-11	2.38e-12	1.01e-11	3e-15	-5e-14
4.29e+04	5.50e-11	2.15e-10	6215000	8592058.8	436000	475000	2.79e-12	1.19e-11	2.79e-12	1.19e-11	-2e-15	1e-14
4.39e+04	6.45e-11	2.51e-10	6215000	8592058.8	436000	475000	3.27e-12	1.39e-11	3.27e-12	1.39e-11	-2e-15	6e-15

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

4.50e+04	7.54e-11	2.93e-10	6215000	8592058.8	436000	475000	3.82e-12	1.62e-11	3.82e-12	1.62e-11	-5e-15	-9e-16
4.61e+04	8.79e-11	3.41e-10	6215000	8592058.8	436000	475000	4.46e-12	1.88e-11	4.46e-12	1.88e-11	-2e-15	-5e-14
4.72e+04	1.02e-10	3.96e-10	6215000	8592058.8	436000	475000	5.19e-12	2.19e-11	5.19e-12	2.19e-11	-2e-15	3e-14
4.83e+04	1.19e-10	4.58e-10	6215000	8592058.8	436000	475000	6.03e-12	2.53e-11	6.02e-12	2.53e-11	-7e-15	-2e-14
4.95e+04	1.38e-10	5.29e-10	6215000	8592058.8	436000	475000	6.98e-12	2.92e-11	6.98e-12	2.92e-11	-1e-15	-4e-14
5.06e+04	1.59e-10	6.09e-10	6215000	8592058.8	436000	475000	8.07e-12	3.37e-11	8.06e-12	3.37e-11	-8e-15	2e-14
5.18e+04	1.83e-10	7.00e-10	6215000	8592058.8	436000	475000	9.30e-12	3.87e-11	9.30e-12	3.87e-11	-1e-15	-2e-14
5.31e+04	2.11e-10	8.03e-10	6215000	8592058.8	436000	475000	1.07e-11	4.44e-11	1.07e-11	4.44e-11	5e-16	1e-14
5.43e+04	2.42e-10	9.18e-10	6215000	8592058.8	436000	475000	1.23e-11	5.08e-11	1.23e-11	5.07e-11	2e-14	-8e-14
5.56e+04	2.77e-10	1.05e-09	6215000	8592058.8	436000	475000	1.41e-11	5.79e-11	1.41e-11	5.79e-11	4e-14	-4e-14
5.70e+04	3.16e-10	1.19e-09	6215000	8592058.8	436000	475000	1.61e-11	6.60e-11	1.61e-11	6.59e-11	4e-14	-5e-14
5.83e+04	3.61e-10	1.35e-09	6215000	8592058.8	436000	475000	1.83e-11	7.49e-11	1.83e-11	7.48e-11	-3e-15	-9e-14
5.97e+04	4.10e-10	1.53e-09	6215000	8592058.8	436000	475000	2.08e-11	8.48e-11	2.08e-11	8.48e-11	-9e-15	-4e-14
6.11e+04	4.65e-10	1.73e-09	6215000	8592058.8	436000	475000	2.36e-11	9.59e-11	2.36e-11	9.58e-11	-3e-15	-7e-14
6.26e+04	5.26e-10	1.95e-09	6215000	8592058.8	436000	475000	2.67e-11	1.08e-10	2.67e-11	1.08e-10	-9e-15	-7e-14
6.41e+04	5.94e-10	2.20e-09	6215000	8592058.8	436000	475000	3.02e-11	1.22e-10	3.01e-11	1.21e-10	-5e-14	-5e-13
6.56e+04	6.69e-10	2.47e-09	6215000	8592058.8	436000	475000	3.40e-11	1.36e-10	3.39e-11	1.36e-10	-6e-14	-3e-13
6.72e+04	7.52e-10	2.76e-09	6215000	8592058.8	436000	475000	3.82e-11	1.52e-10	3.81e-11	1.52e-10	-5e-14	-5e-13
6.88e+04	8.43e-10	3.08e-09	6215000	8592058.8	436000	475000	4.28e-11	1.70e-10	4.27e-11	1.70e-10	-6e-14	-1e-13
7.04e+04	9.42e-10	3.43e-09	6215000	8592058.8	436000	475000	4.78e-11	1.89e-10	4.78e-11	1.89e-10	2e-15	-4e-13
7.21e+04	1.05e-09	3.80e-09	6215000	8592058.8	436000	475000	5.33e-11	2.10e-10	5.33e-11	2.10e-10	-7e-15	-2e-13
7.38e+04	1.17e-09	4.21e-09	6215000	8592058.8	436000	475000	5.93e-11	2.33e-10	5.93e-11	2.33e-10	-6e-17	2e-13
7.55e+04	1.30e-09	4.65e-09	6215000	8592058.8	436000	475000	6.58e-11	2.57e-10	6.58e-11	2.57e-10	5e-15	-9e-14
7.73e+04	1.44e-09	5.12e-09	8750000	12096623	585000	635000	6.94e-11	2.69e-10	7.28e-11	2.83e-10	3e-12	1e-11
7.91e+04	1.59e-09	5.64e-09	8750000	12096623	585000	635000	7.68e-11	2.96e-10	7.67e-11	2.96e-10	-9e-14	-2e-14
8.10e+04	1.83e-09	6.47e-09	8750000	12096623	585000	635000	8.86e-11	3.40e-10	8.85e-11	3.40e-10	-8e-14	2e-13

8.29e+04	2.64e-09	9.29e-09	8750000	12096623	585000	635000	1.28e-10	4.88e-10	1.28e-10	4.88e-10	3e-13	5e-13
8.49e+04	4.66e-09	1.63e-08	8750000	12096623	585000	635000	2.25e-10	8.56e-10	2.25e-10	8.56e-10	-4e-13	-7e-14
8.69e+04	7.40e-09	2.58e-08	8750000	12096623	585000	635000	3.58e-10	1.35e-09	3.58e-10	1.35e-09	-4e-15	-3e-12
8.90e+04	1.01e-08	3.49e-08	8750000	12096623	585000	635000	4.87e-10	1.83e-09	4.87e-10	1.83e-09	-4e-14	2e-13
9.11e+04	1.26e-08	4.35e-08	8750000	12096623	585000	635000	6.11e-10	2.28e-09	6.10e-10	2.28e-09	-7e-13	-1e-12
9.32e+04	1.52e-08	5.20e-08	8750000	12096623	585000	635000	7.36e-10	2.73e-09	7.35e-10	2.73e-09	-9e-13	-2e-12
9.54e+04	1.78e-08	6.06e-08	8750000	12096623	585000	635000	8.63e-10	3.18e-09	8.62e-10	3.18e-09	-8e-13	-2e-12
9.77e+04	2.05e-08	6.93e-08	8750000	12096623	585000	635000	9.92e-10	3.64e-09	9.92e-10	3.64e-09	-4e-13	3e-12
1.00e+05	2.33e-08	7.82e-08	8750000	12096623	585000	635000	1.13e-09	4.10e-09	1.13e-09	4.10e-09	3e-12	-3e-12

The difference between the two doses never exceeds 1e-11 and therefore is acceptable. Similar testing was conducted for other radionuclides as is shown in the following table:

Nuclide	Current DCF (rem/yr/Ci/m3)	Pluvial DCF (rem/yr/Ci/m3)	Ratio of Pluvial to Current DCF	Ratio of Pluvial to Current Well Pumping Rates	Ratio of SZ Release in year 1310 0 to year 1280 0	Ratio of SZ Release in year 77300 to year 79100	Expected Ratio of Dose at year 13100 to year 12800	Expected Ratio of Dose at year 77300 to year 79100	Actual ratio of year 13100 to year 12800	Actual ratio of dose in year 77300 to year 79100

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

U238	5.847e+05	4.358e+05	7.454e-01	7.103e-01	1.462e+00	9.038e-01	**1.534e+00**	*9.485e-01*	**1.010e+00**	*9.492e-01*	NOTE: difference in value is because 1e-15 mrem added to calculated dose to avoic reporting zer dose. This wi have no effec on the reported results, since it is many orders of magnitude below total calculated doses.
Cm246	7.739e+06	5.837e+06	7.542e-01	7.103e-01			**0.000e+00**	*0.000e+00*			
Pu242	7.016e+06	5.298e+06	7.552e-01	7.103e-01			**0.000e+00**	*0.000e+00*			
Am242 m	7.384e+06	5.571e+06	7.544e-01	7.103e-01			**0.000e+00**	*0.000e+00*			
Pu238	6.694e+06	5.046e+06	7.539e-01	7.103e-01			**0.000e+00**	*0.000e+00*			
U234	6.354e+05	4.747e+05	7.471e-01	7.103e-01	1.464e+00	9.083e-01	**1.540e+00**	*9.555e-01*	**1.028e+00**	*9.561e-01*	NOTE: difference in value is because 1e-15 mrem added to calculated

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Th230	1.158e+06	8.738e+05	7.545e-01	7.103e-01	8.771e-01	**0.000e+00**	*9.317e-01*
Ra226	3.265e+06	2.409e+06	7.378e-01	7.103e-01	8.719e-01	**0.000e+00**	*9.056e-01*
Pb210	1.245e+07	9.317e+06	7.485e-01	7.103e-01	8.719e-01	**0.000e+00**	*9.188e-01*
Cm243	5.312e+06	3.998e+06	7.527e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Am243	7.696e+06	5.800e+06	7.536e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Pu239	7.386e+06	5.578e+06	7.552e-01	7.103e-01		**0.000e+00**	*0.000e+00*
U235	6.688e+05	4.966e+05	7.425e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Pa231	2.233e+07	1.690e+07	7.572e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Ac227	3.059e+07	2.301e+07	7.522e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Cm245	7.869e+06	5.932e+06	7.539e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Pu241	1.430e+05	1.079e+05	7.549e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Am241	7.631e+06	5.755e+06	7.542e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Np237	9.701e+06	7.300e+06	7.524e-01	7.103e-01	9.672e-01	**0.000e+00**	*1.025e+00*
U233	6.472e+05	4.842e+05	7.482e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Th229	8.013e+06	5.969e+06	7.450e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Cm244	4.218e+06	3.142e+06	7.450e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Pu240	7.386e+06	5.578e+06	7.552e-01	7.103e-01		**0.000e+00**	*0.000e+00*
U236	6.015e+05	4.495e+05	7.473e-01	7.103e-01		**0.000e+00**	*0.000e+00*
U232	3.083e+06	2.307e+06	7.481e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Sm151	9.815e+02	7.232e+02	7.368e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Cs137	3.735e+05	2.546e+05	6.816e-01	7.103e-01		**0.000e+00**	*0.000e+00*
Cs135	5.448e+04	3.620e+04	6.645e-01	7.103e-01		**0.000e+00**	*0.000e+00*

I129	1.932e+06	1.295e+06	6.701e-01	7.103e-01	9.614e-01	1.508e+00	**9.071e-01**	*1.423e+00*	**9.0**
Sn126	1.183e+06	8.267e+05	6.990e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Sn121m	2.063e+04	1.358e+04	6.580e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Ag108m	8.260e+05	5.782e+05	7.000e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Pd107	8.019e+02	5.618e+02	7.006e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Tc99	4.101e+03	3.042e+03	7.417e-01	7.103e-01	9.522e-01	8.856e-01	**9.943e-01**	*9.248e-01*	**9.9**
Mo93	8.329e+03	5.990e+03	7.192e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Nb94	8.378e+05	6.019e+05	7.184e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Zr93	3.758e+03	2.827e+03	7.522e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Sr90	6.575e+05	4.663e+05	7.091e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Se79	3.646e+04	2.562e+04	7.026e-01	7.103e-01		1.011e+00	**0.000e+00**	*9.999e-01*	
Ni63	3.460e+03	2.359e+03	6.818e-01	7.103e-01			**0.000e+00**	*0.000e+00*	
Ni59	1.263e+03	8.605e+02	6.813e-01	7.103e-01		9.769e-01	**0.000e+00**	*9.371e-01*	
Cl36	6.887e+04	4.837e+04	7.023e-01	7.103e-01	9.562e-01	1.602e+00	**9.454e-01**	*1.584e+00*	**9.4**
C14	1.740e+04	1.159e+04	6.661e-01	7.103e-01					

All of the files used for this test (dcagw.ech, pluvdcfreadtest.xls, regsa.tpa, gw_cb_ad.dat, gw_pb_ad.dat, rgwna.tpa, and tpa.inp) are contained in the following directory: /home/jweldy/tpa40m/TEST/301/test2

Results: This shows that for a number of representative radionuclides, the pluvial DCF switch is being conducted properly. Therefore, it can be concluded that the code is switching from base to pluvial DCFs at the proper time.

Test 3

Test 3: This test is to ensure that the parameters in tpa.inp for the GENII code are being sampled properly. This test will consist of running a series of 100 realizations of the TPA code and checking to see that the distribution of values generated by the sampling routine is appropriate for the distribution sampled. The tpa.inp file will be used to set up the distributions of the parameters that are sampled and the sp.tpa file will be checked to ensure that the values are sampled properly.

	Min	Max	Mean	Expected Mean
InterceptionFraction	1.05e-01	9.31e-01	4.86e-01	0.487
LeafyVegetableIrrigationRatePB[in	2.49e+01	4.30e+01	3.63e+01	36.3
OtherVegetableIrrigationRatePB[in	2.48e+01	4.29e+01	3.63e+01	36.3

FruitIrrigationRatePB[in	2.43e+01	4.30e+01	3.63e+01	36.3
GrainIrrigationRatePB[in	2.41e+01	4.29e+01	3.63e+01	36.3
HomeIrrigationRatePB[in	1.82e+01	6.47e+01	4.15e+01	41.5
PoultryFeedIrrigationRatePB[in	2.47e+01	4.30e+01	3.63e+01	36.3
HenFeedIrrigationRatePB[in	2.42e+01	4.29e+01	3.63e+01	36.3
LeafyVegetableIrrigationTimePB[mo	3.06e+00	9.97e+00	6.50e+00	6.5
OtherVegetableIrrigationTimePB[mo	2.06e+00	9.98e+00	6.00e+00	6
FruitIrrigationTimePB[mo	2.00e+00	5.96e+00	4.00e+00	4
GrainIrrigationTimePB[mo	6.01e+00	7.99e+00	7.00e+00	7
HomeIrrigationTimePB[mo	9.02e+00	1.20e+01	1.05e+01	10.5
PoultryFeedIrrigationTimePB[mo	6.01e+00	7.98e+00	7.00e+00	7
HenFeedIrrigationTimePB[mo	6.02e+00	7.99e+00	7.00e+00	7
LeafyVegetableIrrigationRateCB[in	3.17e+01	5.99e+01	5.03e+01	50.3
OtherVegetableIrrigationRateCB[in	3.35e+01	6.00e+01	5.04e+01	50.3
FruitIrrigationRateCB[in	3.12e+01	5.99e+01	5.03e+01	50.3
GrainIrrigationRateCB[in	3.22e+01	6.00e+01	5.03e+01	50.3
HomeIrrigationRateCB[in	2.61e+01	9.09e+01	5.85e+01	58.5
PoultryFeedIrrigationRateCB[in	3.35e+01	5.99e+01	5.03e+01	50.3
HenFeedIrrigationRateCB[in	3.36e+01	5.99e+01	5.03e+01	50.3
LeafyVegetableIrrigationTimeCB[mo	3.02e+00	7.96e+00	5.50e+00	5.5
OtherVegetableIrrigationTimeCB[mo	2.02e+00	8.00e+00	5.00e+00	5
FruitIrrigationTimeCB[mo	2.00e+00	3.00e+00	2.50e+00	2.5
GrainIrrigationTimeCB[mo	6.01e+00	7.98e+00	7.00e+00	7
HomeIrrigationTimeCB[mo	6.04e+00	1.20e+01	9.00e+00	9
PoultryFeedIrrigationTimeCB[mo	6.01e+00	7.98e+00	7.00e+00	7
HenFeedIrrigationTimeCB[mo	6.01e+00	7.98e+00	7.00e+00	7
PoultryFeedGrowTime[day]	6.02e+01	9.00e+01	7.50e+01	75
HenFeedGrowTime[day]	6.01e+01	9.00e+01	7.50e+01	75
BeefFreshForageDietFraction	2.07e-01	8.81e-01	5.50e-01	0.55
MilkFreshForageDietFraction	1.20e-01	9.80e-01	5.50e-01	0.55
BeefFreshForageGrowTime[day]	3.02e+01	6.19e+01	4.60e+01	46
MilkFreshForageGrowTime[day]	3.02e+01	6.20e+01	4.60e+01	46
BeefFreshForageIrrigationRatePB[in	2.45e+01	4.30e+01	3.63e+01	36.3
MilkFreshForageIrrigationRatePB[in	2.44e+01	4.30e+01	3.63e+01	36.3
BeefFreshForageIrrigationTimePB[mo	3.06e+00	9.93e+00	6.50e+00	6.5
MilkFreshForageIrrigationTimePB[mo	3.05e+00	9.94e+00	6.50e+00	6.5
BeefFreshForageIrrigationRateCB[in	3.37e+01	6.00e+01	5.03e+01	50.3
MilkFreshForageIrrigationRateCB[in	3.37e+01	5.99e+01	5.03e+01	50.3
BeefFreshForageIrrigationTimeCB[mo	3.01e+00	7.98e+00	5.50e+00	5.5
MilkFreshForageIrrigationTimeCB[mo	3.05e+00	7.96e+00	5.50e+00	5.5

DrinkingWaterConsumptionRate1[L	1.93e+01	4.16e+02	1.10e+02	110
DrinkingWaterConsumptionRate2[L	5.23e+01	9.11e+02	2.84e+02	284
DrinkingWaterConsumptionRate3[L	5.00e+01	8.34e+02	2.84e+02	284
DrinkingWaterConsumptionRate4[L	5.83e+01	1.22e+03	3.72e+02	372
DrinkingWaterConsumptionRate5[L	1.37e+02	2.02e+03	5.46e+02	546
LeafyVegetableConsumptionRate6[kg	3.15e+00	4.88e+01	1.25e+01	12.5
OtherVegetableConsumptionRate6[kg	5.74e+00	3.59e+02	7.15e+01	71.5
FruitConsumptionRate6[kg	6.31e+00	3.95e+02	6.52e+01	65.2
GrainConsumptionRate6[kg	9.19e+00	7.21e+02	9.83e+01	98.3
BeefConsumptionRate6[kg	1.37e+01	2.58e+02	6.64e+01	66.4
PoultryConsumptionRate6[kg	1.70e+00	2.01e+01	6.78e+00	6.78
MilkConsumptionRate6[kg	9.70e+00	8.82e+02	1.41e+02	141
PlantUptakeScaleFactor	1.00e-01	8.60e+00	1.31e+00	1.31
AnimalUptakeScaleFactor	1.51e-01	6.04e+00	1.29e+00	1.29
KD_Soil_Cm[cm3	6.04e+00	1.10e+07	1.54e+05	1.53e+05
KD_Soil_Pu[cm3	6.92e+00	9.75e+04	3.08e+03	3080
KD_Soil_U[cm3	1.20e-03	2.55e+05	4.18e+03	4180
KD_Soil_Am[cm3	4.92e-01	1.32e+06	4.50e+04	4.50e+04
KD_Soil_Np[cm3	2.76e-02	3.68e+02	2.13e+01	21.3
KD_Soil_Th[cm3	1.06e+01	1.24e+06	3.30e+04	3.30e+04
KD_Soil_Ra[cm3	1.66e-01	2.38e+06	5.07e+04	5.06e+04
KD_Soil_Pb[cm3	4.68e-01	5.20e+05	7.56e+03	7560
KD_Soil_Cs[cm3	4.38e-01	1.00e+06	1.38e+04	1.38e+04
KD_Soil_I[cm3	2.38e-03	2.51e+02	9.98e+00	9.98
KD_Soil_Tc[cm3	7.09e-04	1.61e+01	5.83e-01	0.582
KD_Soil_Ni[cm3	8.81e+00	2.06e+04	1.29e+03	1290
KD_Soil_C[cm3	5.59e-01	4.30e+01	7.17e+00	7.17
KD_Soil_Se[cm3	2.07e+01	1.62e+02	6.14e+01	61.4

The calculated means correspond very closely to the means predicted by theory. Therefore, it can be concluded that the sampling routine is sampling the biosphere values correctly.

Files associated with this test (gdefault.inp, gftrans.inp, ggenii,inp, spread.tpa, sp.tpa, spread.xls, and tpa.inp) can be found in the following directory: /home/jweldy/tpa40m/TEST/301/test3.

Test 4

Test 4: This test is to ensure that the appropriate GENII files are updated between realizations based on new values that are sampled for the GENII code. This test will consist of running a single realization run and a two realization run. For both

runs, it will be confirmed that the values written to ggenii.inp and gftrans.inp are correctly being transferred from the sampled value contained in sp.tpa to these GENII input files.

Files inspected for the test: default.inp, gftrans.inp, ggenii.inp, sp.tpa, tpa.inp

Procedure: The sampled value of the biosphere parameters were looked up in the sp.tpa file. For the appropriate realization, these values were compared to the values that ended up in the input files for GENII (gdefault,inp, gftrans.inp, ggenii.inp). Note that these files are overwritten for each realization of the TPA code, so only the values from the last realization will be saved at the end of a run. Therefore, only a one realization and two realization run of the TPA code was made.

Results: The values in the GENII input files corresponded precisely to the values sampled in the sp.tpa file. The files used for this test (gdefault.inp, gdefault.inp.1, gdefault.inp.2, gftrans.inp, gftrans.inp.1, gftrans.inp.2, ggenii.inp, ggenii.inp.1, ggenii.inp.2, sp.tpa.1, sp.tpa.2, tpa.inp.1, and tpa.inp.2) can be located in the following directory:

/home/jweldy/tpa40m/TEST/301/test4

Reasonableness Tests

Test 1

This test is for whether the age-specific DCFs are implemented properly in the TPA code. The test will consist of running a base case of adult DCFs which will be compared to the DCFs for the other age groups. The results will be compared to age-specific dose calculations performed earlier using an Excel spreadsheet by Weldy by comparing the products of the intake quantity times the appropriate age DCF. This spreadsheet only indicates the changes to pathway specific dose, not overall dose.

Method: Perform a single run of the TPA code for each age group. Compare gw_cb_ad.dat files generated for each age group to get ratio of DCFs for each radionuclide. The comparisons are done using an Excel spreadsheet (gentpatest.xls) using data from an old spreadsheet (agedepdcf.xls). Note that the ratio generated is between the age group of interest and age group 5 in the tpa.inp file (ICRP 72 adult) since that is the ratio that the comparison data is available for.

Results: All adult to other age group ratios correspond to within a reasonable tolerance band (<10% difference) with a few exceptions. Note that the exceptions do not necessarily indicate that there is an error in the code since we are summing pathways with different differences in intakes and concentrations (indicated by 'Pathway' in the table) and the reference data does not include the effects of daughters, which sometimes contribute significantly to the total DCF (indicated by 'Daughters' in the table). Where there are exceptions, they are investigated further, either by looking at whether the daughters are contributing significantly to the DCF or by looking at the env.out file to determine the actual intake of

radionuclides for the adult and reference age group and comparing that ratio to the reference adult to other age group ratio.

Age Group	Radionuclide	Pathway	Reason for Difference	Predicted ratio from Env.out (age group DCF/ adult DCF)	Code ratio (age group DCF/ adult DCF)
Infant	Ac-227	Milk	Daughters		
Infant	Th-229	Milk	Daughters		
Infant	Zr-93	Milk	Daughters		
Toddler	Cl-36	Crops	Pathway	3.16	3.27
Toddler	Zr-93	Animal	Daughters		
Toddler	Nb-94	Animal	Pathway	2.0	1.92
Toddler	Tc-99	Animal	Pathway	3.35	3.27
Toddler	U-232	Animal	Pathway	0.98	0.927
Toddler	U-236	Animal	Pathway	1.06	0.992
Toddler	Th-229	Animal	Daughters		
Toddler	Tc-99	Crops	Pathway	2.98	2.98
Toddler	Ac-227	Animal	Daughters		
Toddler	U-235	Animal	Pathway	1.06	1.00
Toddler	Pb-210	Animal	Daughters		
Toddler	U-234	Animal	Pathway	1.03	0.968
Toddler	U-238	Animal	Pathway	1.03	0.983
Pre-Teen	Most	Crops	Pathway	All U + Pu isotopes checked - assume all others are correct	All U + Pu isotopes determined to be correct
Pre-Teen	Ac-227	Milk	Daughters		
Pre-Teen	Th-229	Milk	Daughters		
Pre-Teen	Zr-93	Milk	Daughters		
Pre-Teen	U-238	Animal	Pathway	1.14	1.08
Pre-Teen	U-234	Animal	Pathway	1.14	1.08

Pre-Teen	U-235	Animal	Pathway	1.14	1.08
Pre-Teen	Ac-227	Animal	Daughters		
Pre-Teen	U-233	Animal	Pathway	1.14	1.08
Pre-Teen	Th-229	Animal	Daughters		
Pre-Teen	U-236	Animal	Pathway	1.13	1.08
Pre-Teen	U-232	Animal	Pathway	1.31	1.25
Pre-Teen	Tc-99	Animal	Pathway	1.88	1.85
Pre-Teen	Nb-94	Animal	Pathway	1.52	1.45
Pre-Teen	Zr-93	Animal	Daughters		
Pre-Teen	C-14	Animal	Pathway	0.901	0.859
Teen	U-238	Animal	Pathway	1.49	1.44
Teen	Pb-210	Animal	Daughters		
Teen	U-235	Animal	Pathway	1.49	1.44
Teen	Ac-227	Animal	Daughters		
Teen	Th-229	Animal	Daughters		
Teen	U-236	Animal	Pathway	1.49	1.45
Teen	U-232	Animal	Pathway	1.49	1.45
Teen	Tc-99	Animal	Pathway	1.42	1.42
Teen	Nb-94	Animal	Pathway	1.21	1.2
Teen	Zr-93	Animal	Daughters		
Teen	Pb-210	Crops	Daughters		
Teen	Th-229	Crops	Daughters		
Teen	Sr-90	Crops	Pathway	2.5	2.55
Teen	Ac-227	Crops	Daughters		
Teen	Th-229	Crops	Daughters		

Results: The DCFs for all age groups appear to be reasonable. It can be concluded that the code is properly calculating the DCFs for all age groups. All files used in this test (gentpatest.xls and agedepdcf.xls) can be found in the directory:
d:\personal\excel files\TPA Files\40 Test on the computer Kraken

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Test 5

This test is to ensure that the pluvial DCFs calculated in the current implementation of the TPA code match the DCFs calculated for TPA 3.3 when the same input data is used. This test will consist of setting all the gentpa values in tpa.inp to constant values that match the values used in Laplante, et al. (1997) and ensure that the pluvial DCFs match those in the same reference. Files used in the test include tpa.inp, for the input data, and gw_pb_ad.dat to check the DCF.

Method: Visual comparison between the DCF values generated in the file gw_pb_ad.dat and the results in Laplante, et al. (1997).

Results: All generated pluvial DCFs matched the values in Laplante, et al. (1997). Therefore, it can be concluded that the implementation of the calculation of the pluvial DCFs using GENII in TPA is correct. Files used for this test (tpa.inp, gw_pb_ad.dat) are located in the directory /home/jweldy/tpa40m/TEST/301/test5.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
SCR 311

Test 1

This test will make sure that the switch that was put in the volcano module properly switches between a geometric method to calculate the number of WPs ejected by a volcano based on the diameter of the cone and a user specified distribution of WPs ejected. Two single realizations were run for this test. For both realizations, the number of WPs ejected based on the geometric method is very small (1) and the number of WPs ejected based on the user input method is higher (75) to tell the difference between the two.

Results:

FROM SCREEN.OUT.1

```
==================================================
        ========================
      exec: Welcome to TPA Version 4.0betaM
    Job started: Mon Jun 19 13:39:48 2000
==================================================
        ========================
REPOSITORY DESIGN INFORMATION
Subarea  Area      Waste   Number of WP
  #    [m^2]     [MTU]
  1   723591.3   14200.8      1455
  2   784763.0   15303.7      1568
  3   390372.0    7564.0       775
  4   207581.3    4157.8       426
  5   378972.8    7417.6       760
  6   424872.5    8305.8       851
  7   163938.3    3152.5       323
  8   393468.9    7944.6       814

Total Area [acre]        =    856.82238463061
Total Buried Waste [MTU] =    68046.720000000
Repository AML [MTU/acre] =    79.417532992367

Specified Global Parameters:

        Compliance Period = 100000.0 (yr)
     Maximum Simulation Time = 100000.0 (yr)
      Number Of Realizations =     1
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
        Number Of Subareas =     8
        Volcanism scenario =     1 (yes=1, no=0)
         Faulting scenario =     0 (yes=1, no=0)
          Seismic scenario =     1 (yes=1, no=0)
   Distance to Receptor Group =    20.0 (km)


**>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED
      <<<**
**>>> You may not be using the standard chains specified   <<<**
**>>> in the invent module.                                <<<**
**>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


***>>> NOTE: When running with volcanism, verify that   <<<***
***>>> the maximum value of the PDF for parameter       <<<***
***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
***>>> equal to the parameter MaximumTime[yr].          <<<***


The specified path for data  = $TPA_DATA/
The specified path for codes = $TPA_TEST/

**To modify global parameters or the path, stop code execution using
      control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
(see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
By selecting this option, files are written which may require    6 megs of disk
      space.
(more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
    *** No Corrosion WP Failure ***
 exec: calling seismo
 exec: calling volcano
  *** failed WPs:   0  out of   1455 ***
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------------
   subarea   2 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
 exec: failed WPs from VOLCANIC  event =   1307 at time =   1874.3 yr
        (includes ejected WPs)
  *** failed WPs:   1307  out of   1568 ***
  *** ejected WPs:   75
 exec: calling ebsrel
             Highest release rates from Sub Area  2
          Tc99    1.1926E+00 [Ci/yr/SA] at  3.665E+03 yr
          C14     5.8096E-01 [Ci/yr/SA] at  3.665E+03 yr
          Cs135   2.0689E-01 [Ci/yr/SA] at  3.665E+03 yr
          Se79    1.7658E-01 [Ci/yr/SA] at  3.665E+03 yr
          Ni59    5.3418E-02 [Ci/yr/SA] at  3.665E+03 yr
          Am243   1.4004E-02 [Ci/yr/SA] at  1.451E+04 yr
 exec: calling uzft
     *** NEFTRAN is skipped for this UZ path since no layers have significant
        ground water travel time. ***
             Highest release rates from UZ
          Tc99    1.1926E+00 [Ci/yr/SA] at  3.665E+03 yr
          Cs135   2.0689E-01 [Ci/yr/SA] at  3.665E+03 yr
          Se79    1.7658E-01 [Ci/yr/SA] at  3.665E+03 yr
          Ni59    5.3418E-02 [Ci/yr/SA] at  3.665E+03 yr
          Am243   1.4004E-02 [Ci/yr/SA] at  1.451E+04 yr
          I129    1.3793E-02 [Ci/yr/SA] at  3.665E+03 yr
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: calling szft
                Highest release rates from SZ
          Tc99    1.5815E-01 [Ci/yr/SA] at  8.113E+03 yr
          I129    2.0465E-03 [Ci/yr/SA] at  5.444E+03 yr
          Cl36    1.3768E-03 [Ci/yr/SA] at  4.742E+03 yr
          Se79    7.8871E-04 [Ci/yr/SA] at  9.713E+03 yr
          Np237   2.5981E-04 [Ci/yr/SA] at  1.000E+05 yr
          U234    4.7980E-06 [Ci/yr/SA] at  8.293E+04 yr
-----------------------------------------------------------------
   subarea   3 of   8        realization    1 of    1
-----------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
 *** failed WPs:   0  out of   775 ***
exec: calling ebsrel
                There is no EBS release
exec: calling uzft
                There is no UZ release
exec: calling szft
                There is no SZ release
-----------------------------------------------------------------
   subarea   4 of   8        realization    1 of    1
-----------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
 *** failed WPs:   0  out of   426 ***
exec: calling ebsrel
                There is no EBS release
exec: calling uzft
                There is no UZ release
exec: calling szft
                There is no SZ release
-----------------------------------------------------------------
   subarea   5 of   8        realization    1 of    1
-----------------------------------------------------------------
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   760 ***
 exec: calling ebsrel
                 There is no EBS release
 exec: calling uzft
                 There is no UZ release
 exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------
   subarea   6 of   8        realization    1 of    1
-----------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   851 ***
 exec: calling ebsrel
                 There is no EBS release
 exec: calling uzft
                 There is no UZ release
 exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------
   subarea   7 of   8        realization    1 of    1
-----------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   323 ***
 exec: calling ebsrel
                 There is no EBS release
 exec: calling uzft
                 There is no UZ release
 exec: calling szft
                 There is no SZ release
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

---

subarea 8 of 8 realization 1 of 1

```
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
 *** failed WPs:  0  out of  814 ***
exec: calling ebsrel
                 There is no EBS release
exec: calling uzft
                 There is no UZ release
exec: calling szft
                 There is no SZ release
exec: calling dcagw
               Highest annual dose GW pathway
          I129    2.5904E+00 [mrem/yr]  at  5.444E+03 yr
          Np237   2.6855E-01 [mrem/yr]  at  1.000E+05 yr
          Tc99    1.6397E-01 [mrem/yr]  at  8.113E+03 yr
          Cl36    3.6800E-02 [mrem/yr]  at  4.742E+03 yr
          Se79    1.5629E-02 [mrem/yr]  at  1.314E+04 yr
          U234    5.8073E-04 [mrem/yr]  at  7.730E+04 yr
        At end of TPI, annual dose GW pathway
          Np237   2.6855E-01 [mrem/yr]
          I129    7.1826E-03 [mrem/yr]
          Se79    2.1254E-03 [mrem/yr]
          Tc99    1.8349E-03 [mrem/yr]
          U234    3.0712E-04 [mrem/yr]
          U238    8.7956E-05 [mrem/yr]
            sum  2.8013E-01 [mrem/yr]
exec: calling ashplumo
exec: calling ashrmovo
exec: calling dcags
               Highest annual dose from GS
          Pu240  7.5988E+03 [mrem/yr] at  1.874E+03 yr
          Pu239  5.9059E+03 [mrem/yr] at  1.874E+03 yr
          Am241  4.4295E+03 [mrem/yr] at  1.874E+03 yr
          Am243  3.8242E+02 [mrem/yr] at  1.874E+03 yr
          Pu242  3.3754E+01 [mrem/yr] at  1.874E+03 yr
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Np237 3.0382E+01 [mrem/yr] at 1.874E+03 yr
exec: end realizations

exec: Run Successfully Completed

FROM SCREEN.OUT.2

```
=================================================
=========================
```

exec: Welcome to TPA Version 4.0betaM
Job started: Mon Jun 19 13:44:06 2000

```
=================================================
=========================
```

REPOSITORY DESIGN INFORMATION

Subarea #	Area [m^2]	Waste [MTU]	Number of WP
1	723591.3	14200.8	1455
2	784763.0	15303.7	1568
3	390372.0	7564.0	775
4	207581.3	4157.8	426
5	378972.8	7417.6	760
6	424872.5	8305.8	851
7	163938.3	3152.5	323
8	393468.9	7944.6	814

Total Area [acre] = 856.82238463061
Total Buried Waste [MTU] = 68046.720000000
Repository AML [MTU/acre] = 79.417532992367

Specified Global Parameters:

Compliance Period = 100000.0 (yr)
Maximum Simulation Time = 100000.0 (yr)
Number Of Realizations = 1
Number Of Subareas = 8
Volcanism scenario = 1 (yes=1, no=0)
Faulting scenario = 0 (yes=1, no=0)
Seismic scenario = 1 (yes=1, no=0)

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
    Distance to Receptor Group =     20.0 (km)


 **>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED
        <<<**
 **>>> You may not be using the standard chains specified   <<<**
 **>>> in the invent module.                                <<<**
 **>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


 ***>>> NOTE: When running with volcanism, verify that   <<<***
 ***>>> the maximum value of the PDF for parameter       <<<***
 ***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
 ***>>> equal to the parameter MaximumTime[yr].          <<<***


 The specified path for data  = $TPA_DATA/
 The specified path for codes = $TPA_TEST/

 **To modify global parameters or the path, stop code execution using
        control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
 (see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
 For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
 By selecting this option, files are written which may require    6 megs of disk
        space.
 (more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
 exec: calling seismo
 exec: calling volcano
  *** failed WPs:   0  out of   1455 ***
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------------
    subarea   2 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
 exec: failed WPs from VOLCANIC  event =      9 at time =   1874.3 yr (includes
         ejected WPs)
 exec: failed WPs from INITIAL   event =      1 at time =   4875.7 yr
  *** failed WPs:   10  out of   1568 ***
  *** ejected WPs:   1
 exec: calling ebsrel
              Highest release rates from Sub Area  2
          Tc99    7.7439E-03 [Ci/yr/SA] at  3.665E+03 yr
          C14     3.7725E-03 [Ci/yr/SA] at  3.665E+03 yr
          Cs135   1.3435E-03 [Ci/yr/SA] at  3.665E+03 yr
          Se79    1.1467E-03 [Ci/yr/SA] at  3.665E+03 yr
          Ni59    3.4687E-04 [Ci/yr/SA] at  3.665E+03 yr
          Am243   9.6823E-05 [Ci/yr/SA] at  1.451E+04 yr
 exec: calling uzft
     *** NEFTRAN is skipped for this UZ path since no layers have significant
         ground water travel time. ***
                Highest release rates from UZ
          Tc99    7.7439E-03 [Ci/yr/SA] at  3.665E+03 yr
          Cs135   1.3435E-03 [Ci/yr/SA] at  3.665E+03 yr
          Se79    1.1467E-03 [Ci/yr/SA] at  3.665E+03 yr
          Ni59    3.4687E-04 [Ci/yr/SA] at  3.665E+03 yr
          Am243   9.6823E-05 [Ci/yr/SA] at  1.451E+04 yr
          I129    8.9562E-05 [Ci/yr/SA] at  3.665E+03 yr
 exec: calling szft
                Highest release rates from SZ
          Tc99    1.0269E-03 [Ci/yr/SA] at  8.113E+03 yr
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
        I129    1.3289E-05 [Ci/yr/SA] at  5.444E+03 yr
        Cl36    8.9406E-06 [Ci/yr/SA] at  4.742E+03 yr
        Se79    5.2263E-06 [Ci/yr/SA] at  1.641E+04 yr
        Np237   1.6874E-06 [Ci/yr/SA] at  1.000E+05 yr
        U234    3.5031E-08 [Ci/yr/SA] at  8.293E+04 yr
-----------------------------------------------------------------------
   subarea   3 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
 exec: failed WPs from VOLCANIC  event =      2 at time =   1874.3 yr
  *** failed WPs:   2  out of   775 ***
 exec: calling ebsrel
            Highest release rates from Sub Area  3
        Tc99    1.0288E-03 [Ci/yr/SA] at  3.665E+03 yr
        C14     5.0273E-04 [Ci/yr/SA] at  3.665E+03 yr
        Cs135   1.7794E-04 [Ci/yr/SA] at  3.665E+03 yr
        Se79    1.5187E-04 [Ci/yr/SA] at  3.665E+03 yr
        Ni59    4.6545E-05 [Ci/yr/SA] at  3.665E+03 yr
        Am243   2.1157E-05 [Ci/yr/SA] at  1.562E+04 yr
 exec: calling uzft
            Highest release rates from UZ
        Tc99    4.0151E-04 [Ci/yr/SA] at  4.116E+03 yr
        Se79    7.8001E-06 [Ci/yr/SA] at  1.601E+04 yr
        I129    4.4907E-06 [Ci/yr/SA] at  4.116E+03 yr
        Cm245   3.7163E-06 [Ci/yr/SA] at  4.357E+03 yr
        Cl36    2.7689E-06 [Ci/yr/SA] at  4.116E+03 yr
        Cs135   2.6523E-06 [Ci/yr/SA] at  2.540E+04 yr
 exec: calling szft
            Highest release rates from SZ
        Tc99    1.5081E-04 [Ci/yr/SA] at  8.544E+03 yr
        I129    1.8690E-06 [Ci/yr/SA] at  5.907E+03 yr
        Cl36    1.1730E-06 [Ci/yr/SA] at  5.297E+03 yr
        Se79    9.0086E-07 [Ci/yr/SA] at  2.796E+04 yr
        U234    6.5795E-09 [Ci/yr/SA] at  9.323E+04 yr
        U238    2.0371E-09 [Ci/yr/SA] at  9.543E+04 yr
-----------------------------------------------------------------------
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
   subarea  4 of  8        realization   1 of   1
-----------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: failed WPs from VOLCANIC  event =     1 at time =  1874.3 yr
 *** failed WPs:  1  out of  426 ***
exec: calling ebsrel
            Highest release rates from Sub Area  4
         Tc99    5.3679E-04 [Ci/yr/SA] at  3.774E+03 yr
         C14     2.6116E-04 [Ci/yr/SA] at  3.774E+03 yr
         Cs135   9.4048E-05 [Ci/yr/SA] at  3.774E+03 yr
         Se79    8.0266E-05 [Ci/yr/SA] at  3.774E+03 yr
         Ni59    2.3240E-05 [Ci/yr/SA] at  3.774E+03 yr
         Am243   9.6647E-06 [Ci/yr/SA] at  1.524E+04 yr
exec: calling uzft
            Highest release rates from UZ
         Tc99    2.5341E-04 [Ci/yr/SA] at  4.116E+03 yr
         Se79    5.5431E-06 [Ci/yr/SA] at  1.451E+04 yr
         Cs135   4.8164E-06 [Ci/yr/SA] at  1.854E+04 yr
         I129    2.9470E-06 [Ci/yr/SA] at  4.116E+03 yr
         Cl36    1.8268E-06 [Ci/yr/SA] at  4.116E+03 yr
         Cm245   1.2321E-06 [Ci/yr/SA] at  4.235E+03 yr
exec: calling szft
            Highest release rates from SZ
         Tc99    8.8477E-05 [Ci/yr/SA] at  8.544E+03 yr
         I129    1.1251E-06 [Ci/yr/SA] at  5.749E+03 yr
         Cl36    7.1428E-07 [Ci/yr/SA] at  5.153E+03 yr
         Se79    4.7660E-07 [Ci/yr/SA] at  2.363E+04 yr
         U234    3.1466E-09 [Ci/yr/SA] at  9.107E+04 yr
         U238    9.6422E-10 [Ci/yr/SA] at  9.323E+04 yr
-----------------------------------------------------------------
   subarea  5 of  8        realization   1 of   1
-----------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: failed WPs from VOLCANIC  event =      6 at time =   1874.3 yr
 *** failed WPs:   6  out of   760 ***
exec: calling ebsrel
            Highest release rates from Sub Area  5
         Tc99    3.1121E-03 [Ci/yr/SA] at  3.665E+03 yr
         C14     1.6443E-03 [Ci/yr/SA] at  3.665E+03 yr
         Cs135   5.7765E-04 [Ci/yr/SA] at  3.665E+03 yr
         Se79    4.9303E-04 [Ci/yr/SA] at  3.665E+03 yr
         Ni59    1.1519E-04 [Ci/yr/SA] at  3.774E+03 yr
         Am243   5.7513E-05 [Ci/yr/SA] at  1.347E+04 yr
exec: calling uzft
            Highest release rates from UZ
         Tc99    1.1536E-03 [Ci/yr/SA] at  4.235E+03 yr
         Se79    2.1428E-05 [Ci/yr/SA] at  1.854E+04 yr
         I129    1.4006E-05 [Ci/yr/SA] at  4.235E+03 yr
         Cl36    8.7275E-06 [Ci/yr/SA] at  4.235E+03 yr
         Cs135   5.7340E-06 [Ci/yr/SA] at  3.722E+04 yr
         Cm245   5.3459E-06 [Ci/yr/SA] at  4.483E+03 yr
exec: calling szft
            Highest release rates from SZ
         Tc99    6.5663E-04 [Ci/yr/SA] at  9.713E+03 yr
         I129    8.8267E-06 [Ci/yr/SA] at  6.233E+03 yr
         Cl36    5.6528E-06 [Ci/yr/SA] at  5.595E+03 yr
         Se79    4.8302E-06 [Ci/yr/SA] at  3.384E+04 yr
         U234    2.2045E-08 [Ci/yr/SA] at  9.323E+04 yr
         U238    6.8685E-09 [Ci/yr/SA] at  9.769E+04 yr
-----------------------------------------------------------------------
   subarea   6 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: failed WPs from VOLCANIC  event =      1 at time =   1874.3 yr
 *** failed WPs:   1  out of   851 ***
exec: calling ebsrel
            Highest release rates from Sub Area  6
         Tc99    8.5525E-04 [Ci/yr/SA] at  3.774E+03 yr
         C14     4.2134E-04 [Ci/yr/SA] at  3.774E+03 yr
```

```
        Cs135   1.5044E-04 [Ci/yr/SA] at  3.774E+03 yr
        Se79    1.2839E-04 [Ci/yr/SA] at  3.774E+03 yr
        Ni59    3.6496E-05 [Ci/yr/SA] at  3.774E+03 yr
        I129    1.0029E-05 [Ci/yr/SA] at  3.774E+03 yr
exec: calling uzft
            Highest release rates from UZ
        Tc99    2.0975E-04 [Ci/yr/SA] at  4.235E+03 yr
        I129    2.4580E-06 [Ci/yr/SA] at  4.235E+03 yr
        Se79    1.6786E-06 [Ci/yr/SA] at  2.540E+04 yr
        Cl36    1.5245E-06 [Ci/yr/SA] at  4.235E+03 yr
        Cs135   1.4471E-06 [Ci/yr/SA] at  3.812E+04 yr
        Cm245   7.2552E-07 [Ci/yr/SA] at  4.483E+03 yr
exec: calling szft
            Highest release rates from SZ
        Tc99    1.3859E-04 [Ci/yr/SA] at  9.713E+03 yr
        I129    1.7363E-06 [Ci/yr/SA] at  6.402E+03 yr
        Cl36    1.0799E-06 [Ci/yr/SA] at  5.595E+03 yr
        Se79    7.1985E-07 [Ci/yr/SA] at  3.997E+04 yr
        U234    3.5952E-09 [Ci/yr/SA] at  9.543E+04 yr
        U238    1.1288E-09 [Ci/yr/SA] at  1.000E+05 yr
-----------------------------------------------------------------------
   subarea   7 of   8          realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
 *** failed WPs:   0  out of   323 ***
exec: calling ebsrel
                There is no EBS release
exec: calling uzft
                There is no UZ release
exec: calling szft
                There is no SZ release
-----------------------------------------------------------------------
   subarea   8 of   8          realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

exec: calling ebsfail
**** No Corrosion WP Failure ****
exec: failed WPs from VOLCANIC event = 2 at time = 1874.3 yr
**** failed WPs: 2 out of 814 ****
exec: calling ebsrel
Highest release rates from Sub Area 8
Tc99 1.3483E-03 [Ci/yr/SA] at 3.774E+03 yr
C14 6.7689E-04 [Ci/yr/SA] at 3.774E+03 yr
Cs135 2.4292E-04 [Ci/yr/SA] at 3.774E+03 yr
Se79 2.0733E-04 [Ci/yr/SA] at 3.774E+03 yr
Ni59 5.2470E-05 [Ci/yr/SA] at 3.774E+03 yr
Am243 1.7838E-05 [Ci/yr/SA] at 1.451E+04 yr
exec: calling uzft
**** NEFTRAN is skipped for this UZ path since no layers have significant ground water travel time. ****
Highest release rates from UZ
Tc99 1.3483E-03 [Ci/yr/SA] at 3.774E+03 yr
Cs135 2.4292E-04 [Ci/yr/SA] at 3.774E+03 yr
Se79 2.0733E-04 [Ci/yr/SA] at 3.774E+03 yr
Ni59 5.2470E-05 [Ci/yr/SA] at 3.774E+03 yr
Am243 1.7838E-05 [Ci/yr/SA] at 1.451E+04 yr
I129 1.6195E-05 [Ci/yr/SA] at 3.774E+03 yr
exec: calling szft
Highest release rates from SZ
Tc99 1.9776E-04 [Ci/yr/SA] at 8.113E+03 yr
I129 2.7996E-06 [Ci/yr/SA] at 5.444E+03 yr
Cl36 1.8024E-06 [Ci/yr/SA] at 4.876E+03 yr
Se79 1.0439E-06 [Ci/yr/SA] at 9.713E+03 yr
Np237 3.1761E-07 [Ci/yr/SA] at 1.000E+05 yr
U234 6.2571E-09 [Ci/yr/SA] at 8.293E+04 yr
exec: calling dcagw
Highest annual dose GW pathway
I129 2.2483E-02 [mrem/yr] at 6.233E+03 yr
Np237 2.0728E-03 [mrem/yr] at 1.000E+05 yr
Tc99 1.3839E-03 [mrem/yr] at 8.113E+03 yr
Cl36 3.2565E-04 [mrem/yr] at 5.444E+03 yr
Se79 2.3009E-04 [mrem/yr] at 3.227E+04 yr
U234 8.9509E-06 [mrem/yr] at 7.730E+04 yr
At end of TPI, annual dose GW pathway

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Np237 2.0728E-03 [mrem/yr]
I129 1.2435E-04 [mrem/yr]
Se79 3.4523E-05 [mrem/yr]
Tc99 3.1601E-05 [mrem/yr]
U234 5.2857E-06 [mrem/yr]
U238 1.5227E-06 [mrem/yr]
sum 2.2709E-03 [mrem/yr]

exec: calling ashplumo
exec: calling ashrmovo
exec: calling dcags

Highest annual dose from GS
Pu240 1.4890E+02 [mrem/yr] at 1.874E+03 yr
Pu239 1.1573E+02 [mrem/yr] at 1.874E+03 yr
Am241 8.6800E+01 [mrem/yr] at 1.874E+03 yr
Am243 7.4940E+00 [mrem/yr] at 1.874E+03 yr
Pu242 6.6144E-01 [mrem/yr] at 1.874E+03 yr
Np237 5.9537E-01 [mrem/yr] at 1.874E+03 yr

exec: end realizations

exec: Run Successfully Completed

The ratio of the peak dose in the year of the eruption in rgssa.tpa was compared, and was noted to be 75, which is correct because the user distribution model released 75 waste packages and the geometric model released 1.

Results: The test was completed successfully. The files that were used for this test (rgssa.tpa.1, rgssa.tpa.2, screen.out.1, screen.out.2, tpa.inp.1, and tpa.inp.2) are located in the directory:
/home/jweldy/tpa40m/TEST/311/test1

<u>Test 2</u>

This test will make sure that the code properly uses the input values for number of WPs failed and ejected by a volcanic event when user specified parameters are used. One single realization was run for this test. For the realization, the number of WPs ejected is 10 and the number of WPs failed is 30. The screen output will be examined to ensure that the proper number of WPs are reported as having been failed and ejected by the

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

volcanic event. Files needed for testing include tpa.inp and screen.out (a capture of the screen output) for the realization.

Output from screen.out:

```
=================================================
        ========================
      exec: Welcome to TPA Version 4.0betaM
     Job started: Mon Jun 19 13:53:47 2000
=================================================
        ========================
 REPOSITORY DESIGN INFORMATION
 Subarea   Area      Waste   Number of WP
   #     [m^2]     [MTU]
   1   723591.3   14200.8      1455
   2   784763.0   15303.7      1568
   3   390372.0    7564.0       775
   4   207581.3    4157.8       426
   5   378972.8    7417.6       760
   6   424872.5    8305.8       851
   7   163938.3    3152.5       323
   8   393468.9    7944.6       814

 Total Area [acre]        =    856.82238463061
 Total Buried Waste [MTU]  =    68046.720000000
 Repository AML [MTU/acre] =    79.417532992367

 Specified Global Parameters:

          Compliance Period = 100000.0 (yr)
      Maximum Simulation Time = 100000.0 (yr)
       Number Of Realizations =     1
         Number Of Subareas =     8
         Volcanism scenario =     1 (yes=1, no=0)
          Faulting scenario =     0 (yes=1, no=0)
           Seismic scenario =     1 (yes=1, no=0)
    Distance to Receptor Group =    20.0 (km)
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
**>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED
        <<<**
**>>> You may not be using the standard chains specified   <<<**
**>>> in the invent module.                                <<<**
**>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


***>>> NOTE: When running with volcanism, verify that   <<<***
***>>> the maximum value of the PDF for parameter       <<<***
***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
***>>> equal to the parameter MaximumTime[yr].          <<<***


The specified path for data  = $TPA_DATA/
The specified path for codes = $TPA_TEST/

**To modify global parameters or the path, stop code execution using
        control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
(see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
By selecting this option, files are written which may require    6 megs of disk
        space.
(more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8          realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: calling seismo
exec: calling volcano
 *** failed WPs:   0  out of   1455 ***
exec: calling ebsrel
                 There is no EBS release
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

exec: calling uzft
There is no UZ release
exec: calling szft
There is no SZ release

---

subarea 2 of 8 realization 1 of 1

---

exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
**** No Corrosion WP Failure ****
exec: ***failed WPs from VOLCANIC event = 40 at time = 1874.3 yr (includes ejected WPs)***
exec: failed WPs from INITIAL event = 1 at time = 4875.7 yr
**** failed WPs: 41 out of 1568 ****
****** ejected WPs: 10***
exec: calling ebsrel
Highest release rates from Sub Area 2
Tc99 2.9040E-02 [Ci/yr/SA] at 3.665E+03 yr
C14 1.4147E-02 [Ci/yr/SA] at 3.665E+03 yr
Cs135 5.0379E-03 [Ci/yr/SA] at 3.665E+03 yr
Se79 4.2999E-03 [Ci/yr/SA] at 3.665E+03 yr
Ni59 1.3008E-03 [Ci/yr/SA] at 3.665E+03 yr
Am243 3.4689E-04 [Ci/yr/SA] at 1.451E+04 yr
exec: calling uzft
**** NEFTRAN is skipped for this UZ path since no layers have significant ground water travel time. ****
Highest release rates from UZ
Tc99 2.9040E-02 [Ci/yr/SA] at 3.665E+03 yr
Cs135 5.0379E-03 [Ci/yr/SA] at 3.665E+03 yr
Se79 4.2999E-03 [Ci/yr/SA] at 3.665E+03 yr
Ni59 1.3008E-03 [Ci/yr/SA] at 3.665E+03 yr
Am243 3.4689E-04 [Ci/yr/SA] at 1.451E+04 yr
I129 3.3586E-04 [Ci/yr/SA] at 3.665E+03 yr
exec: calling szft
Highest release rates from SZ
Tc99 3.8511E-03 [Ci/yr/SA] at 8.113E+03 yr
I129 4.9833E-05 [Ci/yr/SA] at 5.444E+03 yr
Cl36 3.3526E-05 [Ci/yr/SA] at 4.742E+03 yr

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
        Se79    1.9206E-05 [Ci/yr/SA] at  9.713E+03 yr
        Np237   6.3268E-06 [Ci/yr/SA] at  1.000E+05 yr
        U234    1.2071E-07 [Ci/yr/SA] at  8.293E+04 yr
-----------------------------------------------------------------------
   subarea   3 of   8        realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   775 ***
 exec: calling ebsrel
                 There is no EBS release
 exec: calling uzft
                 There is no UZ release
 exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------------
   subarea   4 of   8        realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   426 ***
 exec: calling ebsrel
                 There is no EBS release
 exec: calling uzft
                 There is no UZ release
 exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------------
   subarea   5 of   8        realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   760 ***
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------
   subarea   6 of   8          realization    1 of    1
-----------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   851 ***
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------
   subarea   7 of   8          realization    1 of    1
-----------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   323 ***
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------
   subarea   8 of   8          realization    1 of    1
-----------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: calling ebsfail
    *** No Corrosion WP Failure ***
 *** failed WPs:   0  out of   814 ***
exec: calling ebsrel
                 There is no EBS release
exec: calling uzft
                 There is no UZ release
exec: calling szft
                 There is no SZ release
exec: calling dcagw
              Highest annual dose GW pathway
          I129    6.3078E-02 [mrem/yr]  at  5.444E+03 yr
          Np237   6.5408E-03 [mrem/yr]  at  1.000E+05 yr
          Tc99    3.9928E-03 [mrem/yr]  at  8.113E+03 yr
          Cl36    8.9611E-04 [mrem/yr]  at  4.742E+03 yr
          Se79    3.8170E-04 [mrem/yr]  at  1.314E+04 yr
          U234    1.4642E-05 [mrem/yr]  at  7.730E+04 yr
        At end of TPI, annual dose GW pathway
          Np237   6.5408E-03 [mrem/yr]
          I129    1.8363E-04 [mrem/yr]
          Se79    5.4407E-05 [mrem/yr]
          Tc99    4.6745E-05 [mrem/yr]
          U234    7.7427E-06 [mrem/yr]
          U238    2.2173E-06 [mrem/yr]
            sum  6.8368E-03 [mrem/yr]
exec: calling ashplumo
exec: calling ashrmovo
exec: calling dcags
              Highest annual dose from GS
          Pu240  2.6130E+04 [mrem/yr] at  1.874E+03 yr
          Pu239  2.0309E+04 [mrem/yr] at  1.874E+03 yr
          Am241  1.5243E+04 [mrem/yr] at  1.874E+03 yr
          Am243  1.3172E+03 [mrem/yr] at  1.874E+03 yr
          Pu242  1.1606E+02 [mrem/yr] at  1.874E+03 yr
          Np237  1.0595E+02 [mrem/yr] at  1.874E+03 yr
exec: end realizations

exec:  Run Successfully Completed
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Results: The screen output indicates that the correct number of waste packages are failed and ejected. The files used for this test (screen.out, tpa.inp) are located in the following directory:
/home/jweldy/tpa40m/TEST/311/test2

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Test 3

This test will make sure that the code puts the volcanic event in the correct subarea as specified in the input file when user specified parameters are used. Two single realizations were run for this test. For the first realization, the number of WPs ejected is 10 and the number of WPs failed is 30. The subarea in which the event occurs is changed from the base value of 2 to the test value of 3. The second realization is the same as the first, but the switch is returned to the geometric value to ensure that the code does not place the volcano in subarea 3 using this model. The screen output will be examined to ensure that the WPs are failed in the proper subarea. Additionally, the file uzft.ech will be examined to ensure that the release of radionuclides to subarea 3 is larger than the other subareas, since more WPs have failed in that subarea. Files needed for testing include tpa.inp and screen.out (a capture of the screen output) for the realization.

The screen output for the first run looked as follows:

```
=====================================================
        ====================
     exec: Welcome to TPA Version 4.0betaM
    Job started: Mon Jun 19 16:00:45 2000
=====================================================
        ====================
REPOSITORY DESIGN INFORMATION
Subarea  Area      Waste   Number of WP
  #    [m^2]     [MTU]
  1   723591.3   14200.8      1455
  2   784763.0   15303.7      1568
  3   390372.0    7564.0       775
  4   207581.3    4157.8       426
  5   378972.8    7417.6       760
  6   424872.5    8305.8       851
  7   163938.3    3152.5       323
  8   393468.9    7944.6       814

Total Area [acre]        =    856.82238463061
Total Buried Waste [MTU] =    68046.720000000
Repository AML [MTU/acre] =   79.417532992367
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Specified Global Parameters:

```
        Compliance Period =  10000.0 (yr)
   Maximum Simulation Time =  10000.0 (yr)
    Number Of Realizations =     1
       Number Of Subareas =     8
       Volcanism scenario =     1 (yes=1, no=0)
        Faulting scenario =     0 (yes=1, no=0)
         Seismic scenario =     1 (yes=1, no=0)
  Distance to Receptor Group =    20.0 (km)


**>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED <<<**
**>>> You may not be using the standard chains specified   <<<**
**>>> in the invent module.                                <<<**
**>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


***>>> NOTE: When running with volcanism, verify that   <<<***
***>>> the maximum value of the PDF for parameter       <<<***
***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
***>>> equal to the parameter MaximumTime[yr].         <<<***


The specified path for data  = $TPA_DATA/
The specified path for codes = $TPA_TEST/

**To modify global parameters or the path, stop code execution using control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
(see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
By selecting this option, files are written which may require    6 megs of disk space.
(more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8          realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: calling seismo
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: calling volcano
 *** failed WPs:   0  out of   1455 ***
exec: calling ebsrel
                 There is no EBS release
exec: calling uzft
                 There is no UZ release
exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------------
   subarea   2 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: failed WPs from INITIAL   event =      1 at time =   4945.1 yr
 *** failed WPs:   1  out of   1568 ***
exec: calling ebsrel
            Highest release rates from Sub Area  2
         Tc99    6.8075E-05 [Ci/yr/SA] at  8.101E+03 yr
         C14     2.0837E-05 [Ci/yr/SA] at  8.101E+03 yr
         Cs135   1.2523E-05 [Ci/yr/SA] at  8.101E+03 yr
         Se79    1.0674E-05 [Ci/yr/SA] at  8.101E+03 yr
         Am243   8.0686E-06 [Ci/yr/SA] at  1.000E+04 yr
         Ni59    2.5015E-06 [Ci/yr/SA] at  8.101E+03 yr
exec: calling uzft
    *** NEFTRAN is skipped for this UZ path since no layers have significant ground
        water travel time. ***
            Highest release rates from UZ
         Tc99    6.8075E-05 [Ci/yr/SA] at  8.101E+03 yr
         Cs135   1.2523E-05 [Ci/yr/SA] at  8.101E+03 yr
         Se79    1.0674E-05 [Ci/yr/SA] at  8.101E+03 yr
         Am243   8.0686E-06 [Ci/yr/SA] at  1.000E+04 yr
         Ni59    2.5015E-06 [Ci/yr/SA] at  8.101E+03 yr
         Pu239   1.3068E-06 [Ci/yr/SA] at  1.000E+04 yr
exec: calling szft
            Highest release rates from SZ
         I129    4.1998E-07 [Ci/yr/SA] at  1.000E+04 yr
         Cl36    3.5321E-07 [Ci/yr/SA] at  1.000E+04 yr
         U234    8.4551E-17 [Ci/yr/SA] at  1.000E+04 yr
         U238    2.0439E-17 [Ci/yr/SA] at  1.000E+04 yr
         Np237   2.6563E-18 [Ci/yr/SA] at  1.000E+04 yr
         Th230   1.4160E-23 [Ci/yr/SA] at  1.000E+04 yr
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

---

subarea 3 of 8 *realization 1 of 1*

---

exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
**** No Corrosion WP Failure ****
exec: failed WPs from VOLCANIC event = 40 at time = 1900.0 yr
**** failed WPs: 40 out of 775 ****
****** ejected WPs: 10***
exec: calling ebsrel
Highest release rates from Sub Area 3
Tc99 2.6053E-02 [Ci/yr/SA] at 3.722E+03 yr
C14 1.2423E-02 [Ci/yr/SA] at 3.722E+03 yr
Cs135 4.4652E-03 [Ci/yr/SA] at 3.722E+03 yr
Se79 3.8109E-03 [Ci/yr/SA] at 3.722E+03 yr
Ni59 1.2156E-03 [Ci/yr/SA] at 3.722E+03 yr
I129 2.9767E-04 [Ci/yr/SA] at 3.722E+03 yr
exec: calling uzft
Highest release rates from UZ
Tc99 8.2281E-03 [Ci/yr/SA] at 4.191E+03 yr
I129 9.2408E-05 [Ci/yr/SA] at 4.191E+03 yr
Cl36 5.6999E-05 [Ci/yr/SA] at 4.191E+03 yr
Cm245 5.2683E-05 [Ci/yr/SA] at 4.394E+03 yr
Cm246 8.2421E-06 [Ci/yr/SA] at 4.394E+03 yr
Nb94 9.5308E-07 [Ci/yr/SA] at 1.000E+04 yr
exec: calling szft
Highest release rates from SZ
Tc99 3.1168E-03 [Ci/yr/SA] at 8.691E+03 yr
I129 3.8339E-05 [Ci/yr/SA] at 5.971E+03 yr
Cl36 2.3925E-05 [Ci/yr/SA] at 5.308E+03 yr
U238 7.7831E-17 [Ci/yr/SA] at 1.000E+04 yr
Np237 5.5218E-17 [Ci/yr/SA] at 1.000E+04 yr
The remaining 15 nuclide(s) have zero release

---

subarea 4 of 8 *realization 1 of 1*

---

exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
**** No Corrosion WP Failure ****
**** failed WPs: 0 out of 426 ****
exec: calling ebsrel

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------------
   subarea   5 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   760 ***
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------------
   subarea   6 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   851 ***
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------------
   subarea   7 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   323 ***
 exec: calling ebsrel
                    There is no EBS release
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
-----------------------------------------------------------------------
    subarea   8 of   8          realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
     *** No Corrosion WP Failure ***
  *** failed WPs:   0  out of   814 ***
 exec: calling ebsrel
                    There is no EBS release
 exec: calling uzft
                    There is no UZ release
 exec: calling szft
                    There is no SZ release
 exec: calling dcagw
                  Highest annual dose GW pathway
           I129    4.8529E-02 [mrem/yr]  at  5.971E+03 yr
           Tc99    3.2315E-03 [mrem/yr]  at  8.691E+03 yr
           Cl36    6.3948E-04 [mrem/yr]  at  5.308E+03 yr
           Np237   5.9832E-14 [mrem/yr]  at  1.000E+04 yr
           U238    6.9055E-15 [mrem/yr]  at  1.000E+04 yr
           U234    6.4747E-15 [mrem/yr]  at  1.000E+04 yr
          At end of TPI, annual dose GW pathway
           I129    1.4276E-03 [mrem/yr]
           Tc99    9.2041E-04 [mrem/yr]
           Cl36    1.4622E-05 [mrem/yr]
           Np237   5.9832E-14 [mrem/yr]
           U238    6.9055E-15 [mrem/yr]
           U234    6.4747E-15 [mrem/yr]
             sum  2.3626E-03 [mrem/yr]
 exec: calling ashplumo
 exec: calling ashrmovo
 exec: calling dcags
                  Highest annual dose from GS
            Pu240  2.6059E+04 [mrem/yr] at  1.900E+03 yr
            Pu239  2.0295E+04 [mrem/yr] at  1.900E+03 yr
            Am241  1.4628E+04 [mrem/yr] at  1.900E+03 yr
            Am243  1.3140E+03 [mrem/yr] at  1.900E+03 yr
            Pu242  1.1605E+02 [mrem/yr] at  1.900E+03 yr
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Np237 1.0610E+02 [mrem/yr] at 1.900E+03 yr
exec: end realizations

exec: Run Successfully Completed

Therefore, it appears that the input value to move the volcanic event from subarea to subarea is working correctly. The second test was run to ensure that the geometric model still placed the volcano at the center of the repository, i.e., in subarea two.

```
=============================================================
          ==========
      exec: Welcome to TPA Version 4.0betaM
    Job started: Mon Jun 19 16:30:23 2000
=============================================================
          ====================
REPOSITORY DESIGN INFORMATION
Subarea  Area      Waste   Number of WP
  #    [m^2]     [MTU]
  1   723591.3   14200.8      1455
  2   784763.0   15303.7      1568
  3   390372.0    7564.0       775
  4   207581.3    4157.8       426
  5   378972.8    7417.6       760
  6   424872.5    8305.8       851
  7   163938.3    3152.5       323
  8   393468.9    7944.6       814

Total Area [acre]        =    856.82238463061
Total Buried Waste [MTU] =    68046.720000000
Repository AML [MTU/acre] =    79.417532992367

Specified Global Parameters:

          Compliance Period =  10000.0 (yr)
      Maximum Simulation Time =  10000.0 (yr)
       Number Of Realizations =      1
          Number Of Subareas =      8
          Volcanism scenario =      1 (yes=1, no=0)
           Faulting scenario =      0 (yes=1, no=0)
           Seismic scenario =      1 (yes=1, no=0)
    Distance to Receptor Group =     20.0 (km)
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
**>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED <<<**
**>>> You may not be using the standard chains specified   <<<**
**>>> in the invent module.                                <<<**
**>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


***>>> NOTE: When running with volcanism, verify that   <<<***
***>>> the maximum value of the PDF for parameter       <<<***
***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
***>>> equal to the parameter MaximumTime[yr].          <<<***


The specified path for data  = $TPA_DATA/
The specified path for codes = $TPA_TEST/

**To modify global parameters or the path, stop code execution using control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
(see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
By selecting this option, files are written which may require    6 megs of disk space.
(more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: calling seismo
exec: calling volcano
 *** failed WPs:   0  out of   1455 ***
exec: calling ebsrel
                 There is no EBS release
exec: calling uzft
                 There is no UZ release
exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------------
   subarea   2 of   8        realization    1 of    1
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

---

exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
**** No Corrosion WP Failure ****
exec: failed WPs from VOLCANIC event = 9 at time = 1900.0 yr (includes ejected WPs)
exec: failed WPs from INITIAL event = 1 at time = 4945.1 yr
**** failed WPs: 10 out of 1568 ****
****** ejected WPs: 1***
exec: calling ebsrel
Highest release rates from Sub Area 2
Tc99 7.1951E-03 [Ci/yr/SA] at 3.722E+03 yr
C14 3.5236E-03 [Ci/yr/SA] at 3.722E+03 yr
Cs135 1.2546E-03 [Ci/yr/SA] at 3.722E+03 yr
Se79 1.0709E-03 [Ci/yr/SA] at 3.722E+03 yr
Ni59 3.1659E-04 [Ci/yr/SA] at 3.722E+03 yr
I129 8.3644E-05 [Ci/yr/SA] at 3.722E+03 yr
exec: calling uzft
**** NEFTRAN is skipped for this UZ path since no layers have significant ground water travel time. ****
Highest release rates from UZ
Tc99 7.1951E-03 [Ci/yr/SA] at 3.722E+03 yr
Cs135 1.2546E-03 [Ci/yr/SA] at 3.722E+03 yr
Se79 1.0709E-03 [Ci/yr/SA] at 3.722E+03 yr
Ni59 3.1659E-04 [Ci/yr/SA] at 3.722E+03 yr
I129 8.3644E-05 [Ci/yr/SA] at 3.722E+03 yr
Am243 7.2664E-05 [Ci/yr/SA] at 1.000E+04 yr
exec: calling szft
Highest release rates from SZ
Tc99 1.1249E-03 [Ci/yr/SA] at 8.101E+03 yr
I129 1.5118E-05 [Ci/yr/SA] at 5.434E+03 yr
Cl36 9.8699E-06 [Ci/yr/SA] at 4.830E+03 yr
Se79 5.7029E-06 [Ci/yr/SA] at 9.769E+03 yr
U234 2.6837E-12 [Ci/yr/SA] at 1.000E+04 yr
U238 6.4881E-13 [Ci/yr/SA] at 1.000E+04 yr

---

subarea 3 of 8 realization 1 of 1

---

exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
**** No Corrosion WP Failure ****

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: failed WPs from VOLCANIC  event =      2 at time =   1900.0 yr
 *** failed WPs:   2  out of   775 ***
exec: calling ebsrel
            Highest release rates from Sub Area  3
         Tc99    1.7368E-03 [Ci/yr/SA] at  3.722E+03 yr
         C14     8.2822E-04 [Ci/yr/SA] at  3.722E+03 yr
         Cs135   2.9767E-04 [Ci/yr/SA] at  3.722E+03 yr
         Se79    2.5406E-04 [Ci/yr/SA] at  3.722E+03 yr
         Ni59    8.1041E-05 [Ci/yr/SA] at  3.722E+03 yr
         I129    1.9845E-05 [Ci/yr/SA] at  3.722E+03 yr
exec: calling uzft
            Highest release rates from UZ
         Tc99    5.4854E-04 [Ci/yr/SA] at  4.191E+03 yr
         I129    6.1606E-06 [Ci/yr/SA] at  4.191E+03 yr
         Cl36    3.7999E-06 [Ci/yr/SA] at  4.191E+03 yr
         Cm245   3.5123E-06 [Ci/yr/SA] at  4.394E+03 yr
         Cm246   5.4948E-07 [Ci/yr/SA] at  4.394E+03 yr
         Nb94    6.3539E-08 [Ci/yr/SA] at  1.000E+04 yr
exec: calling szft
            Highest release rates from SZ
         Tc99    2.0778E-04 [Ci/yr/SA] at  8.691E+03 yr
         I129    2.5559E-06 [Ci/yr/SA] at  5.971E+03 yr
         Cl36    1.5949E-06 [Ci/yr/SA] at  5.308E+03 yr
         U238    5.1888E-18 [Ci/yr/SA] at  1.000E+04 yr
         Np237   3.6813E-18 [Ci/yr/SA] at  1.000E+04 yr
    The remaining   15  nuclide(s) have zero release
-----------------------------------------------------------------------
   subarea   4 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: failed WPs from VOLCANIC  event =      1 at time =   1900.0 yr
 *** failed WPs:   1  out of   426 ***
exec: calling ebsrel
            Highest release rates from Sub Area  4
         Tc99    9.4339E-04 [Ci/yr/SA] at  3.722E+03 yr
         C14     4.7234E-04 [Ci/yr/SA] at  3.722E+03 yr
         Cs135   1.6882E-04 [Ci/yr/SA] at  3.722E+03 yr
         Se79    1.4408E-04 [Ci/yr/SA] at  3.722E+03 yr
         Ni59    3.7721E-05 [Ci/yr/SA] at  3.722E+03 yr
         I129    1.1255E-05 [Ci/yr/SA] at  3.722E+03 yr
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: calling uzft
            Highest release rates from UZ
        Tc99    3.8490E-04 [Ci/yr/SA] at  4.093E+03 yr
        I129    4.5435E-06 [Ci/yr/SA] at  4.093E+03 yr
        Cl36    2.8218E-06 [Ci/yr/SA] at  4.093E+03 yr
        Cm245   1.2655E-06 [Ci/yr/SA] at  4.291E+03 yr
        Cm246   2.0277E-07 [Ci/yr/SA] at  4.291E+03 yr
        Nb94    2.9851E-08 [Ci/yr/SA] at  1.000E+04 yr
exec: calling szft
            Highest release rates from SZ
        Tc99    1.2191E-04 [Ci/yr/SA] at  8.490E+03 yr
        I129    1.6238E-06 [Ci/yr/SA] at  5.832E+03 yr
        Cl36    1.0189E-06 [Ci/yr/SA] at  5.308E+03 yr
        U238    2.2530E-18 [Ci/yr/SA] at  1.000E+04 yr
        Np237   1.6293E-18 [Ci/yr/SA] at  1.000E+04 yr
        U234    9.5988E-21 [Ci/yr/SA] at  1.000E+04 yr
-----------------------------------------------------------------------
   subarea   5 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: failed WPs from VOLCANIC  event =      6 at time =   1900.0 yr
 *** failed WPs:   6  out of   760 ***
exec: calling ebsrel
            Highest release rates from Sub Area  5
        Tc99    4.3686E-03 [Ci/yr/SA] at  3.722E+03 yr
        C14     2.2904E-03 [Ci/yr/SA] at  3.722E+03 yr
        Cs135   8.1043E-04 [Ci/yr/SA] at  3.722E+03 yr
        Se79    6.9170E-04 [Ci/yr/SA] at  3.722E+03 yr
        Ni59    1.4929E-04 [Ci/yr/SA] at  3.722E+03 yr
        I129    5.4028E-05 [Ci/yr/SA] at  3.722E+03 yr
exec: calling uzft
            Highest release rates from UZ
        Tc99    1.5259E-03 [Ci/yr/SA] at  4.191E+03 yr
        I129    1.8748E-05 [Ci/yr/SA] at  4.191E+03 yr
        Cl36    1.1701E-05 [Ci/yr/SA] at  4.191E+03 yr
        Cm245   5.0716E-06 [Ci/yr/SA] at  4.499E+03 yr
        Cm246   7.8941E-07 [Ci/yr/SA] at  4.499E+03 yr
        Nb94    1.9503E-07 [Ci/yr/SA] at  1.000E+04 yr
exec: calling szft
            Highest release rates from SZ
```

```
        Tc99    8.0113E-04 [Ci/yr/SA] at  9.543E+03 yr
        I129    1.0924E-05 [Ci/yr/SA] at  6.258E+03 yr
        Cl36    6.9980E-06 [Ci/yr/SA] at  5.564E+03 yr
        U238    4.9299E-18 [Ci/yr/SA] at  1.000E+04 yr
        Np237   2.8747E-18 [Ci/yr/SA] at  1.000E+04 yr
    The remaining   15  nuclide(s) have zero release
-----------------------------------------------------------------------
   subarea   6 of   8        realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
 exec: calling nfenv
 exec: calling ebsfail
    *** No Corrosion WP Failure ***
 exec: failed WPs from VOLCANIC  event =      1 at time =   1900.0 yr
  *** failed WPs:   1  out of   851 ***
 exec: calling ebsrel
            Highest release rates from Sub Area  6
        Tc99    7.0265E-04 [Ci/yr/SA] at  3.722E+03 yr
        C14     3.5142E-04 [Ci/yr/SA] at  3.722E+03 yr
        Cs135   1.2489E-04 [Ci/yr/SA] at  3.722E+03 yr
        Se79    1.0659E-04 [Ci/yr/SA] at  3.722E+03 yr
        Ni59    2.8836E-05 [Ci/yr/SA] at  3.722E+03 yr
        I129    8.3256E-06 [Ci/yr/SA] at  3.722E+03 yr
 exec: calling uzft
            Highest release rates from UZ
        Tc99    2.1550E-04 [Ci/yr/SA] at  4.291E+03 yr
        I129    2.5272E-06 [Ci/yr/SA] at  4.291E+03 yr
        Cl36    1.5674E-06 [Ci/yr/SA] at  4.291E+03 yr
        Cm245   7.6162E-07 [Ci/yr/SA] at  4.607E+03 yr
        Cm246   1.1768E-07 [Ci/yr/SA] at  4.607E+03 yr
        Nb94    3.1175E-08 [Ci/yr/SA] at  1.000E+04 yr
 exec: calling szft
            Highest release rates from SZ
        Tc99    1.3451E-04 [Ci/yr/SA] at  9.769E+03 yr
        I129    1.6941E-06 [Ci/yr/SA] at  6.407E+03 yr
        Cl36    1.0628E-06 [Ci/yr/SA] at  5.696E+03 yr
        U238    7.5683E-19 [Ci/yr/SA] at  1.000E+04 yr
        Np237   4.3307E-19 [Ci/yr/SA] at  1.000E+04 yr
    The remaining   15  nuclide(s) have zero release
-----------------------------------------------------------------------
   subarea   7 of   8        realization    1 of    1
-----------------------------------------------------------------------
 exec: calling uzflow
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
 *** failed WPs:   0  out of   323 ***
exec: calling ebsrel
                 There is no EBS release
exec: calling uzft
                 There is no UZ release
exec: calling szft
                 There is no SZ release
-----------------------------------------------------------------
   subarea   8 of   8        realization    1 of    1
-----------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: failed WPs from VOLCANIC  event =      2 at time =   1900.0 yr
 *** failed WPs:   2  out of   814 ***
exec: calling ebsrel
            Highest release rates from Sub Area  8
         Tc99    1.5992E-03 [Ci/yr/SA] at  3.722E+03 yr
         C14     8.2342E-04 [Ci/yr/SA] at  3.722E+03 yr
         Cs135   2.9291E-04 [Ci/yr/SA] at  3.722E+03 yr
         Se79    2.5000E-04 [Ci/yr/SA] at  3.722E+03 yr
         Ni59    5.7980E-05 [Ci/yr/SA] at  3.722E+03 yr
         I129    1.9527E-05 [Ci/yr/SA] at  3.722E+03 yr
exec: calling uzft
    *** NEFTRAN is skipped for this UZ path since no layers have significant ground
        water travel time. ***
            Highest release rates from UZ
         Tc99    1.5992E-03 [Ci/yr/SA] at  3.722E+03 yr
         Cs135   2.9291E-04 [Ci/yr/SA] at  3.722E+03 yr
         Se79    2.5000E-04 [Ci/yr/SA] at  3.722E+03 yr
         Ni59    5.7980E-05 [Ci/yr/SA] at  3.722E+03 yr
         I129    1.9527E-05 [Ci/yr/SA] at  3.722E+03 yr
         Am243   1.2457E-05 [Ci/yr/SA] at  1.000E+04 yr
exec: calling szft
            Highest release rates from SZ
         Tc99    2.2917E-04 [Ci/yr/SA] at  8.293E+03 yr
         I129    3.3224E-06 [Ci/yr/SA] at  5.434E+03 yr
         Cl36    2.1791E-06 [Ci/yr/SA] at  4.830E+03 yr
         Se79    1.2468E-06 [Ci/yr/SA] at  9.769E+03 yr
```

```
        U234    5.0123E-13 [Ci/yr/SA] at  1.000E+04 yr
        U238    1.2118E-13 [Ci/yr/SA] at  1.000E+04 yr
exec: calling dcagw
            Highest annual dose GW pathway
        I129    2.6933E-02 [mrem/yr]  at  6.258E+03 yr
        Tc99    1.5603E-03 [mrem/yr]  at  8.293E+03 yr
        Cl36    3.9021E-04 [mrem/yr]  at  5.434E+03 yr
        Se79    1.1806E-04 [mrem/yr]  at  9.769E+03 yr
        Np237   4.3299E-10 [mrem/yr]  at  1.000E+04 yr
        U234    2.4389E-10 [mrem/yr]  at  1.000E+04 yr
       At end of TPI, annual dose GW pathway
        Tc99    1.0452E-03 [mrem/yr]
        I129    1.0038E-03 [mrem/yr]
        Se79    1.1786E-04 [mrem/yr]
        Cl36    1.2194E-05 [mrem/yr]
        Np237   4.3299E-10 [mrem/yr]
        U234    2.4389E-10 [mrem/yr]
          sum  2.1791E-03 [mrem/yr]
exec: calling ashplumo
exec: calling ashrmovo
exec: calling dcags
            Highest annual dose from GS
        Pu240  3.8296E+03 [mrem/yr] at  1.900E+03 yr
        Pu239  2.9825E+03 [mrem/yr] at  1.900E+03 yr
        Am241  2.1497E+03 [mrem/yr] at  1.900E+03 yr
        Am243  1.9311E+02 [mrem/yr] at  1.900E+03 yr
        Pu242  1.7055E+01 [mrem/yr] at  1.900E+03 yr
        Np237  1.5592E+01 [mrem/yr] at  1.900E+03 yr
exec: end realizations

exec:  Run Successfully Completed
```

The waste packages affected are still in subarea 2, so the code is working properly.

Results: The code correctly moves the volcano to the subarea specified by the user for the user distribution model, but leaves the volcano in subarea 2 for the geometric model. Therefore, the code is working properly. The files for this test are located in the following directory:
/home/jweldy/tpa40m/TEST/311/test3

Test 4

This test is to ensure that the code returns an error if more WPs are released from a subarea than the total number of WPs in the subarea. This will be checked by

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

setting the number of WPs ejected in subarea 2 to 2000 and then setting the number of WPs failed by magma in subarea 2 to 2000. Since there are only ~1500 WPs in subarea 2, this should result in an error. The screen output will be checked for this test.

The first run set the number of WPs ejected to 2000. The following screen output was recorded:

```
=====================================================
=====================
exec: Welcome to TPA Version 4.0betaM
Job started: Mon Jun 19 16:53:21 2000
=====================================================
=====================
REPOSITORY DESIGN INFORMATION
Subarea  Area      Waste   Number of WP
  #    [m^2]     [MTU]
  1   723591.3   14200.8      1455
  2   784763.0   15303.7      1568
  3   390372.0    7564.0       775
  4   207581.3    4157.8       426
  5   378972.8    7417.6       760
  6   424872.5    8305.8       851
  7   163938.3    3152.5       323
  8   393468.9    7944.6       814

Total Area [acre]        =    856.82238463061
Total Buried Waste [MTU]  =    68046.720000000
Repository AML [MTU/acre] =    79.417532992367

Specified Global Parameters:

        Compliance Period =  10000.0 (yr)
     Maximum Simulation Time =  10000.0 (yr)
      Number Of Realizations =     1
        Number Of Subareas =     8
        Volcanism scenario =     1 (yes=1, no=0)
         Faulting scenario =     0 (yes=1, no=0)
          Seismic scenario =     1 (yes=1, no=0)
   Distance to Receptor Group =    20.0 (km)


**>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED <<<**
**>>> You may not be using the standard chains specified   <<<**
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
**>>> in the invent module.                    <<<**
**>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


***>>> NOTE: When running with volcanism, verify that   <<<***
***>>> the maximum value of the PDF for parameter      <<<***
***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
***>>> equal to the parameter MaximumTime[yr].         <<<***


The specified path for data  = $TPA_DATA/
The specified path for codes = $TPA_TEST/

**To modify global parameters or the path, stop code execution using control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
(see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
By selecting this option, files are written which may require    6 megs of disk space.
(more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: calling seismo
exec: calling volcano
 ***>>> Error in volcano <<<***
 nfailed .gt. nwpinsa
 nfailed =   2030
 wpentrained =     2000.0000000000
 wpfailedindrift =     30.000000000000
 nwpinsa =   1568
```

The code crashed, so therefore, it is working properly. The second run had the following screen output:

```
=================================================================
          ==========
       exec: Welcome to TPA Version 4.0betaM
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Job started: Mon Jun 19 16:55:24 2000

```
=========================================================
        ====================
REPOSITORY DESIGN INFORMATION
Subarea   Area      Waste   Number of WP
  #     [m^2]      [MTU]
  1   723591.3   14200.8       1455
  2   784763.0   15303.7       1568
  3   390372.0    7564.0        775
  4   207581.3    4157.8        426
  5   378972.8    7417.6        760
  6   424872.5    8305.8        851
  7   163938.3    3152.5        323
  8   393468.9    7944.6        814

Total Area [acre]        =    856.82238463061
Total Buried Waste [MTU]  =    68046.720000000
Repository AML [MTU/acre] =    79.417532992367

Specified Global Parameters:

          Compliance Period =  10000.0 (yr)
      Maximum Simulation Time =  10000.0 (yr)
       Number Of Realizations =      1
          Number Of Subareas =      8
          Volcanism scenario =      1 (yes=1, no=0)
           Faulting scenario =      0 (yes=1, no=0)
            Seismic scenario =      1 (yes=1, no=0)
    Distance to Receptor Group =     20.0 (km)


**>>> CAUTION: CHECKING OF NUCLIDES AND CHAINS IS DISABLED <<<**
**>>> You may not be using the standard chains specified   <<<**
**>>> in the invent module.                                <<<**
**>>> (see "CheckNuclidesAndChains(yes=1,no=0)" in tpa.inp)<<<**


***>>> NOTE: When running with volcanism, verify that   <<<***
***>>> the maximum value of the PDF for parameter       <<<***
***>>> TimeOfNextVolcanicEventinRegionOfInterest[yr] is <<<***
***>>> equal to the parameter MaximumTime[yr].          <<<***
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
The specified path for data  = $TPA_DATA/
The specified path for codes = $TPA_TEST/

**To modify global parameters or the path, stop code execution using control-C**

  ***>>> WARNING: THE APPEND OPTION IS SELECTED <<<***
(see "OutputMode(0=None,1=All,2=UserDefined)" in tpa.inp)
For "SelectAppendFiles", a value of 0 (all append files) was set in tpa.inp.
By selecting this option, files are written which may require   6 megs of disk space.
(more disk space could be needed)

-----------------------------------------------------------------------
   subarea   1 of   8        realization    1 of    1
-----------------------------------------------------------------------
exec: calling uzflow
exec: calling nfenv
exec: calling ebsfail
    *** No Corrosion WP Failure ***
exec: calling seismo
exec: calling volcano
 ***>>> Error in volcano <<<***
 nfailed .gt. nwpinsa
 nfailed =   2010
 wpentrained =    10.0000000000000
 wpfailedindrift =    2000.0000000000
 nwpinsa =   1568
```

Again, the code crashed, so it is working properly.

Results: The code crashed when too many waste packages were specified to fail due to the igneous intrusion. Therefore, the code successfully passed the test. Files used in this test are located in the following directory:
/home/jweldy/tpa40m/TEST/311/test4

Test 5

This test is to compare the magnitude of the doses between a mean values run with TPA 3.3 and TPA 4.0 for the direct release only run. Both cases were run for a single realization with all parameters at their mean values. The results in rgssa.tpa were then compared to ensure that the change in dose was reasonable.

Results: The first year dose from volcanism in TPA 4.0 is about two orders of magnitude higher than in TPA 3.3. However, in years after the eruption, the TPA 4.0 dose is only about 5 times as large as the TPA 3.3 dose. The first year dose is so much larger because the

mean value of the number of waste packages failed increased by almost a factor of ten, the first year mass load increased by a factor of a few, and the occupancy time increased by about a factor of two. The later doses are less large because of the time dependence of the mass loading factor, which drops off rapidly with time. The two rgssa.tpa files are listed below.

Mean value input file tpa.inp for TPA Version 3.3 Code.
Parent file is the modified base case data set Rev 3.3, Nov. 1999
TPA 3.3 PVM capable, Job started: Mon Jun 19 17:05:15 2000
AEDE[rem/yr], GroundSurface Pathway

summed over all nuclides, averaged over all realizations

0.461E+04	*0.100E-14*
0.472E+04	*0.100E-14*
0.483E+04	*0.100E-14*
0.495E+04	*0.148E+01*
0.506E+04	*0.122E+01*
0.518E+04	*0.101E+01*
0.531E+04	*0.830E+00*
0.543E+04	*0.679E+00*
0.556E+04	*0.553E+00*
0.570E+04	*0.448E+00*
0.583E+04	*0.362E+00*
0.597E+04	*0.291E+00*
0.611E+04	*0.232E+00*
0.626E+04	*0.185E+00*
0.641E+04	*0.146E+00*
0.656E+04	*0.115E+00*
0.672E+04	*0.899E-01*
0.687E+04	*0.691E-01*
0.704E+04	*0.473E-01*
0.721E+04	*0.323E-01*
0.738E+04	*0.220E-01*
0.755E+04	*0.149E-01*
0.773E+04	*0.101E-01*
0.791E+04	*0.686E-02*
0.810E+04	*0.465E-02*
0.829E+04	*0.315E-02*
0.849E+04	*0.214E-02*
0.869E+04	*0.145E-02*
0.890E+04	*0.990E-03*
0.911E+04	*0.674E-03*
0.932E+04	*0.460E-03*

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

0.954E+04 0.313E-03
0.977E+04 0.213E-03
0.100E+05 0.145E-03

Input file tpa.inp as supplied with TPA Version 4.0betaM Code.
Base case
TPA 4.0betaM, Job started: Mon Jun 19 17:04:42 2000
AEDE[rem/yr], GroundSurface Pathway

summed over all nuclides, averaged over all realizations

0.439E+04 0.100E-14
0.450E+04 0.100E-14
0.461E+04 0.100E-14
0.472E+04 0.100E-14
0.483E+04 0.100E-14
0.495E+04 0.130E+03
0.506E+04 0.791E+01
0.518E+04 0.675E+01
0.531E+04 0.575E+01
0.543E+04 0.489E+01
0.556E+04 0.414E+01
0.570E+04 0.349E+01
0.583E+04 0.294E+01
0.597E+04 0.246E+01
0.611E+04 0.205E+01
0.626E+04 0.170E+01
0.641E+04 0.141E+01
0.656E+04 0.116E+01
0.672E+04 0.951E+00
0.687E+04 0.776E+00
0.704E+04 0.631E+00
0.721E+04 0.510E+00
0.738E+04 0.411E+00
0.755E+04 0.329E+00
0.773E+04 0.263E+00
0.791E+04 0.208E+00
0.810E+04 0.165E+00
0.829E+04 0.129E+00
0.849E+04 0.101E+00
0.869E+04 0.775E-01
0.890E+04 0.586E-01

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

0.911E+04	*0.442E-01*
0.932E+04	*0.332E-01*
0.954E+04	*0.248E-01*
0.977E+04	*0.185E-01*
0.100E+05	*0.137E-01*

The files for these tests are located in the following directory:

/home/jweldy/tpa40m/TEST/311/test5

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Scientific Notebook #170

Issued to: S. Mohanty

Issue Date: Apr. 3, 1996

Account Number: 20-01402-762

Title: Inventory

Participants: J. Weldy

5/16/00 Correction to the Initial Inventory of Se-79 in the Repository

Reason: The current value of the initial inventory of Se-79 is calculated using a half-life of 6.52×10^4 years in the Origen 2.1 computer code. However, recent experiments have identified the Se-79 half-life as 1.1×10^6 years. Since the Origen 2.1 code calculates the quantity of radionuclides in grams/number of atoms and then converts this value to radioactivity using the half-life, the inventory needs to be corrected for this change.

Software used: Origen 2.1 Isotope Generation and Depletion Code

Procedure: A recent paper (Songsheng, et al., 1997) indicates that new measurements of the half-life of Se-79 is 1.1×10^6 years, not 6.5×10^4 as had been previously reported. The acceptance of this paper was checked at the National Nuclear Data Center (http://www.nndc.bnl.gov/) to ensure that the scientific community had accepted this value. The NNDC has incorporated this new value for the half-life of Se-79, so this is the value that should be used in our calculations.

As specified in p. 338 of Croft (1983), Origen 2.1 calculates quantities of radionuclides in units of g-atoms, which is then converted into other units of interest, such as activity. In order to determine the half-life used by the Origen 2.1 code, the output from the run listed below was examined. The inventory of Se-79 at t=0 was 6.998 g/MTU and the inventory at t=1000

years was 6.924 g/MTU. Using the formula:

$$M(t) = M_0 * \exp(-\lambda t)$$

where

M(t) = Mass of radionuclide at time t
Mo = Mass of radionuclide at time 0
λ = Decay constant (1/yr)

This yields a half life of 6.5×10^4 years as the value used in Origen 2.1.

Also, using the output from the run listed below, the mass of Se-79 at t=0 is 6.998 grams/MTU and the activity is 0.4877 Ci/MTU. Using the formula:

$$A = \frac{M * 6.022E23 * \frac{\ln(2)}{T_{1/2}}}{MW * 3.7E10}$$

where

A = Activity (Ci/MTU)
M = Mass (g/MTU)
$T_{1/2}$ = Half-life (sec)
MW = Molecular weight (g/mol)

This yields a half life of 2.05e12 sec which equals 6.5e4 yr.

Since inventory in curies is inversely proportional to half life, the initial inventory used in the TPA Code (0.458 Ci/MTU) should be multiplied by

$$\frac{6.5 * 10^4 \ years}{1.1 * 10^6 \ years}$$

Results: The new initial inventory for Se-79 is 0.0271 Ci/MTU.

References:

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Croff, A.G. ORIGEN2: A Versatile Computer Code for Calculating the Nuclide Compositions and Characteristics of Nuclear Materials. Nuclear Technology. Vol. 62, pp. 335-352. 1983.

Songsheng, J., G. Jingru, J. Shan, L. Chunsheng, C. Anzhi, H. Ming, W. Shaoyong, and L. Shilin. Determination of the half-life of ^{79}Se with the Accelerator Mass Spectrometry Technique. Nuclear Instruments and Methods in Physics Research. 8:123 (1997), pp. 405-409.

Input File - p3.040

```
-1
-1
-1
RDA * BURNUP OF PWR 3.0% UO2 FUEL & ASSY HDWARE, 40,000
      MWD/MT
RDA    ** CROSS SECTION LIBRARY = PWRU50, 6 CYCLE
RDA    *** SCOTT B. LUDWIG, OAK RIDGE NATIONAL
      LABORATORY
RDA    **** (615) 574-7916, FTS 624-7916
RDA    -1 = FRESH PWR FUEL WITH IMPURITIES (1 MT = 1000 KG)
RDA    -2 = FRESH ZIRCALOY COMPOSITION (1 KG)
RDA    -3 = FRESH SS 304 COMPOSITION (1 KG)
RDA    -4 = FRESH SS 302 COMPOSITION (1 KG)
RDA    -5 = FRESH INCONEL COMPOSITION (1 KG)
RDA    -6 = FRESH NICROBRAZE COMPOSITION (1 KG)
RDA    WARNING: VECTORS ARE CHANGED WITH RESPECT TO
      CONTENT.
RDA          THESE CHANGES WILL BE NOTED ON RDA CARDS.
CUT    5 1.0E-10 7 1.0E-10 9 1.0E-10 -1
LIP    0 0 0
RDA      DECAY LIB    XSECT LIB                VAR. XSECT
LIB    0    1 2 3    219 220 221    9   50   0   1      9
RDA     PHOTON LIB
PHO    101 102 103   10
TIT  INITIAL COMP. OF UNIT AMOUNTS OF FUEL AND STRUCTURAL
      MAT'LS
RDA    READ FUEL COMPOSITION INCLUDING IMPURITIES (1000 KG)
INP    -1   1  -1  -1  1  1
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
RDA    READ ZIRCALOY COMPOSITION (1.0 KG)
INP    -2   1  -1  -1  1  1
RDA    READ SS304 COMPOSITION (1.0 KG)
INP    -3   1  -1  -1  1  1
RDA    READ SS302 COMPOSITION (1.0 KG)
INP    -4   1  -1  -1  1  1
RDA    READ INCONEL 718 COMPOSITION (1.0 KG)
INP    -5   1  -1  -1  1  1
RDA    READ NICROBRAZE 50 COMPOSITION (1.0 KG)
INP    -6   1  -1  -1  1  1
TIT    IRRADIATION OF ONE METRIC TON OF PWRU FUEL
MOV     -1   1   0   1.0
PCH      1   1   1
HED      1                                CHARGE
BUP
IRP    266.7    37.5   1   2   4  2   BURNUP=10,000 MWD/MTIHM
DEC     372.7          2   3   4  0   DECAY FOR 106.0 DAYS
IRP    639.3    37.5   3   4   4  0   BURNUP=20,000 MWD/MTIHM
DEC     745.3          4   5   4  0   DECAY FOR 106.0 DAYS
IRP   1012.0    37.5   5   6   4  0   BURNUP=30,000 MWD/MTIHM
DEC    1118.0          6   7   4  0   DECAY FOR 106.0 DAYS
IRP   1384.7    37.5   7   8   4  0   BURNUP=40,000 MWD/MTIHM
BUP
RDA    -10 = IRRADIATED U FUEL AT DISCHARGE
MOV      8   -10     0     1.0
PCH    -10   -10   -10
RDA    IRRADIATION OF ZIRCALOY AT 1.000 FLUX
TIT    IRRADIATION OF ZIRCALOY AT 1.000 FLUX
MOV     -2     1     0   223.0      ZIRCALOY
PCH      1     1     1
HED      1                                CHARGE
IRF    266.7    -1.0   1   2   4  2   BURNUP=10,000 MWD/MTIHM
DEC     372.7          2   3   4  0   DECAY FOR 106.0 DAYS
IRF    639.3    -1.0   3   4   4  0   BURNUP=20,000 MWD/MTIHM
DEC     745.3          4   5   4  0   DECAY FOR 106.0 DAYS
IRF   1012.0    -1.0   5   6   4  0   BURNUP=30,000 MWD/MTIHM
DEC    1118.0          6   7   4  0   DECAY FOR 106.0 DAYS
IRF   1384.7    -1.0   7   8   4  0   BURNUP=40,000 MWD/MTIHM
RDA    -9 = IRRADIATED ZIRCALOY
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
MOV     8  -9    0    1.0
PCH    -9  -9  -9
RDA    IRRADIATION OF INCONEL + NICROBRAZE 50 AT 1.000 FLUX
TIT    IRRADIATION OF INCONEL + NICROBRAZE 50 AT 1.000 FLUX
MOV     -5    1    0  12.8     INCONEL
ADD     -6    1    0   2.6     NICROBRAZE 50
PCH      1    1    1
HED      1                                CHARGE
IRF    266.7   -1.0  1  2  4  2  BURNUP=10,000 MWD/MTIHM
DEC     372.7         2  3  4  0   DECAY FOR 106.0 DAYS
IRF    639.3   -1.0  3  4  4  0  BURNUP=20,000 MWD/MTIHM
DEC     745.3         4  5  4  0   DECAY FOR 106.0 DAYS
IRF   1012.0   -1.0  5  6  4  0  BURNUP=30,000 MWD/MTIHM
DEC    1118.0         6  7  4  0   DECAY FOR 106.0 DAYS
IRF   1384.7   -1.0  7  8  4  0  BURNUP=40,000 MWD/MTIHM
RDA    -8 = IRRADIATED INCONEL AND NICROBRAZE
MOV     8   -8    0    1.0
PCH    -8   -8   -8
RDA    IRRADIATION OF SS 304 AT 1.000 FLUX
TIT    IRRADIATION OF SS 304 AT 1.000 FLUX
MOV     -3    1    0   9.9     SS 304
PCH      1    1    1
HED      1                                CHARGE
IRF    266.7   -1.0  1  2  4  2  BURNUP=10,000 MWD/MTIHM
DEC     372.7         2  3  4  0   DECAY FOR 106.0 DAYS
IRF    639.3   -1.0  3  4  4  0  BURNUP=20,000 MWD/MTIHM
DEC     745.3         4  5  4  0   DECAY FOR 106.0 DAYS
IRF   1012.0   -1.0  5  6  4  0  BURNUP=30,000 MWD/MTIHM
DEC    1118.0         6  7  4  0   DECAY FOR 106.0 DAYS
IRF   1384.7   -1.0  7  8  4  0  BURNUP=40,000 MWD/MTIHM
RDA    -7 = IRRADIATED SS 304
MOV     8   -7    0    1.0
PCH    -7   -7   -7
RDA    IRRADIATION OF SS 304 END PIECES AT 0.011 FLUX
TIT    IRRADIATION OF SS 304 END PIECES AT 0.011 FLUX
MOV     -3    1    0   27.2    SS 304
PCH      1    1    1
HED      1                                CHARGE
IRF    266.7   -0.011  1  2  4  2  BURNUP=10,000 MWD/MTIHM
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
DEC    372.7          2  3  4  0   DECAY FOR 106.0 DAYS
IRF    639.3   -0.011  3  4  4  0  BURNUP=20,000 MWD/MTIHM
DEC    745.3          4  5  4  0   DECAY FOR 106.0 DAYS
IRF   1012.0   -0.011  5  6  4  0  BURNUP=30,000 MWD/MTIHM
DEC   1118.0          6  7  4  0   DECAY FOR 106.0 DAYS
IRF   1384.7   -0.011  7  8  4  0  BURNUP=40,000 MWD/MTIHM
RDA   -6 = IRRADIATED SS 304 END PIECES AT DISCHARGE
MOV    8   -6    0    1.0
PCH   -6   -6   -6
RDA    IRRADIATION OF SS302 PLENUM SPRINGS AT 0.042 FLUX
TIT    IRRADIATION OF SS302 PLENUM SPRINGS AT 0.042 FLUX
MOV    -4    1    0   4.2     SS 302
ADD    -2    1    0   12.0    ZR IN PLENUM
PCH     1    1    1
HED     1                                CHARGE
IRF    266.7   -0.042  1  2  4  2  BURNUP=10,000 MWD/MTIHM
DEC    372.7          2  3  4  0   DECAY FOR 106.0 DAYS
IRF    639.3   -0.042  3  4  4  0  BURNUP=20,000 MWD/MTIHM
DEC    745.3          4  5  4  0   DECAY FOR 106.0 DAYS
IRF   1012.0   -0.042  5  6  4  0  BURNUP=30,000 MWD/MTIHM
DEC   1118.0          6  7  4  0   DECAY FOR 106.0 DAYS
IRF   1384.7   -0.042  7  8  4  0  BURNUP=40,000 MWD/MTIHM
RDA   -5 = IRRADIATED SS 302 IN PLENUM SPRINGS AT DISCHARGE
MOV     8  -5    0    1.0
PCH    -5  -5   -5
RDA    ***** OUTPUT MODULE *****
TIT  TEST OF ORIGEN2 V2.1 - PWR FUEL ASSY-EXTENDED BURNUP
       (PWRU50)
BAS  1 MTIHM 3.0% UO2 FUEL ASSY;BURNUP=40,000 MWD/MTIHM, 6
       CYCLE
OPTL    4*8 7 8 7  8  8  8  14*8
OPTA    4*8 7 8 7  8  8  8  14*8
OPTF    4*8 7 8 7  8  8  8  14*8
MOV    -10   1   0   1.0
ADD     -9   1   0   1.0
ADD     -8   1   0   1.0
ADD     -7   1   0   1.0
ADD     -6   1   0   1.0
ADD     -5   1   0   1.0
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
 HED    1   ASSY DIS
 RDA    ***** DECAY MODULE *****
 DEC    1.0   1   2   5   2
 DEC   10.0   2   3   5   0
 DEC  100.0   3   4   5   0
 DEC    1.0   4   5   7   0
 DEC   10.0   5   6   7   0
 OUT     5    1    -1    0
 END
2 922340  376.0 922350  30000. 922380  969624.   0  0.0  FUEL 3.0%
4 030000  1.0    050000  1.0  060000 89.4   070000 25.0   FUEL IMPU
4 080000 134454. 090000  10.7 110000 15.0   120000  2.0   FUEL IMPU
4 130000  16.7   140000  12.1 150000 35.0   170000  5.3   FUEL IMPU
4 200000  2.0    220000  1.0  230000 3.0    240000  4.0   FUEL IMPU
4 250000  1.7    260000  18.0 270000 1.0    280000 24.0   FUEL IMPU
4 290000  1.0    300000  40.3 420000 10.0   470000 0.1    FUEL IMPU
4 480000  25.0   490000  2.0  500000 4.0    640000 2.5    FUEL IMPU
4 740000  2.0    820000  1.0  830000 0.4    0      0.0    FUEL IMPU
0
4 400000  979.11 500000  16.0   260000   2.25   240000 1.25  ZIRC-4
4 280000  0.02  130000 0.024 050000 0.00033 480000 0.00025   ZIRC-4
4 060000  0.120  270000  0.010  290000   0.020  720000 0.078 ZIRC-4
4 010000  0.013  250000  0.020  070000   0.080  080000 0.950 ZIRC-4
4 160000  0.035  220000  0.020  740000   0.020  230000 0.020 ZIRC-4
5 920000  0.0002      0  0.0                          ZIRC-4
0
4 260000  688.44 240000  190.0  280000   89.2   250000 20.0  SS-304
4 060000  0.8    150000  0.45   160000   0.3    140000 10.0  SS-304
4 070000  1.3    270000  0.8        0   0.0               SS-304
0
4 260000  697.74 240000  180.0  280000   89.2   250000  20.0 SS-302
4 060000  1.5    150000  0.45   160000   0.3    140000  10.0 SS-302
4 070000  1.3    270000  0.8        0   0.0               SS-302
0
4 260000 179.766 240000 189.753 280000 519.625 130000 5.992 INC-718
4 060000  0.4    270000  4.694  290000   0.999 250000 1.997 INC-718
4 420000  29.961 070000  1.3    410000  55.458 160000 0.07  INC-718
4 140000  1.997  220000  7.99        0  0.0               INC-718
0
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
4 260000 0.471 240000 149.709 280000 744.438 400000 0.1 NICR-50
4 130000 0.1 050000 0.05 060000 0.1 270000 0.381 NICR-50
4 250000 0.1 070000 0.066 080000 0.043 150000 103.244 NICR-50
4 160000 0.1 140000 0.511 220000 0.1 740000 0.1 NICR-50
0

Output File - p3.040o.mass

```
1
          ********************************************************
          *                                                      *
          * OOOOO RRRR IIIII GGGGG EEEEE N   N 22222 *
          * O   O R   R   I   G     E     NN  N 22  22 *
          * O   O RRRR    I   G   GG EEEE  N NN N    22  *
          * O   O R   R   I   G   G E     N  NN 22    *
          * OOOOO R   R IIIII GGGGGG EEEEE N   N 2222222 *
          *                                                      *
          *          Version 2.1 (8-1-91)                        *
          *                                                      *
          *                                                      *
          *          OOOOO   AA   K  K                           *
          *          O   O  A A  K K                             *
          *          O   O  AAAA  KKK                            *
          *          O   O  A A  K K                             *
          *          OOOOO  A A  K  K                            *
          *                                                      *
          *     RRRR  III  DDDDD   GGGGG   EEEEE                 *
          *     R   R  I   D   D  G       E                      *
          *     RRRR   I   D   D  G   GG  EEEE                   *
          *     R   R  I   D   D  G   G   E                      *
          *     R   R III  DDDDD   GGGGGG  EEEEE                 *
          *                                                      *
          * N   N  AA  TTTTT  III  OOOOO N   N  AA  L    *
          * NN  N A A   T    I  O   O NN  N A A L    *
          * N NN N  AAAA   T    I  O   O N NN N  AAAA L    *
          * N  NN A A   T    I  O   O N  NN A A L    *
          * N   N A A   T   III  OOOOO N   N A A LLLLL *
          *                                                      *
          * L    AA  BBBB  OOOO RRRR   AA  TTTTT OOOO RRRR  Y   Y *
          * L   A A B   B O   O R   R A A   T   O   O R   R  Y Y *
          * L   AAAA BBBB  O   O RRRR  AAAA   T   O   O RRRR   Y  *
          * L   A A B   B O   O R   R A A   T   O   O R   R  Y  *
          * LLLL A  A BBBB  OOOO R   R A A   T   OOOO R   R  Y  *
          *                                                      *
          *       RSIC CODE PACKAGE NUMBER (CCC-371)             *
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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*                                                    *
*   ORIGEN2 VERSION 2.1 (8-1-91) UPDATES THE FOLLOWING:  *
*                                                    *
*       CCC-371(A) - MAINFRAMES                      *
*       CCC-371(E) - IBM PC (80386 W/80387 OR 80486)  *
*                                                    *
*    ORIGEN2 RUN  DATE: May 16 2000 TIME 10:41:42      *
*                                                    *
*                                                    *
*******************************************************
1                                   OUTPUT UNIT =  6                PAGE   1
ORIGEN2 V2.1 (8-1-91), Run on May 16 2000 at 10:41:42
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****************************** ORIGEN2:  A REVISED AND UPDATED VERSION OF
        THE ORIGEN COMPUTER CODE ******************************

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INTRODUCTION
  THIS TEXT IS INTENDED TO BE A BRIEF OUTLINE OF THE ORIGEN2 COMPUTER
        CODE, WHICH IS A REVISED AND UPDATED VERSION OF THE
  ORIGEN DOCUMENTED IN REPORT ORNL-4628 (MAY 1973).  INCLUDED HERE ARE
        A BRIEF DESCRIPTION OF THE FUNCTIONS OF ORIGEN2, A
    LISTING OF THE MAJOR DATA SOURCES, A LISTING OF THE PUBLISHED
        DOCUMENTATION CONCERNING ORIGEN2, AND AN OUTLINE OF THE
        ORIGEN2
  OUTPUT ORGANIZATION.  ORIGEN2 IS AVAILABLE FROM THE ORNL RADIATION
        SHIELDING INFORMATION CENTER (RSIC) AT THE FOLLOWING
  ADDRESS:
                CODES COORDINATOR
                RADIATION SHIELDING INFORMATION CENTER
                BLDG. 6025
                OAK RIDGE NATIONAL LABORATORY
                OAK RIDGE, TENNESSEE  37830
                PHONE: (615) 574-6176
  QUESTIONS CONCERNING ORIGEN2 SHOULD BE ADDRESSED TO RSIC.
-DESCRIPTION
    ORIGEN2 IS A REVISION AND UPDATE OF THE ORIGEN COMPUTER CODE.
        SPECIFICALLY, THE INPUT, OUTPUT, CONTROL, AND DATA BASE ASPECTS
```

OF ORIGEN HAVE BEEN SIGNIFICANTLY REVISED AND UPDATED TO REFLECT CURRENT INFORMATION AND NEEDS. IT SHOULD BE NOTED THAT THE MATHEMATICAL METHODS USED TO SOLVE THE NUCLIDE BUILDUP, DEPLETION, AND DECAY EQUATIONS ARE ESSENTIALLY UNCHANGED FROM THAT IN ORIGEN. ORIGEN2 IS A COMPUTER CODE DESIGNED TO CALCULATE THE COMPOSITION AND CHARACTERISTICS OF NUCLEAR MATERIALS AS A FUNCTION OF DECAY TIME AND THE CHANGES THE MATERIALS UNDERGO DURING VARIOUS FUEL CYCLE OPERATIONS. INPUT AND OUTPUT FEATURES HAVE BEEN DESIGNED TO FACILITATE FLEXIBILITY IN THE TYPE OF CASES THAT CAN BE CONSIDERED AND IN CONTROLLING THE DETAIL OF THE OUTPUT. FOR FURTHER INFORMATION, THE USER IS REFERRED TO THE DOCUMENTATION LISTED BELOW.

-MAJOR DATA SOURCES

VIRTUALLY ALL ASPECTS OF THE DATA INPUT TO ORIGEN2 HAVE BEEN UPDATED OR REVISED TO REFLECT CURRENT INFORMATION. THE PRINCIPAL SOURCES OF CROSS SECTION DATA WERE THE ENDF/B-IV, ENDF/B-V, AND LENDL COMPILATIONS. DECAY AND PHOTON INFORMATION WERE PRIMARILY BASED ON THE EVALUATED NUCLEAR STRUCTURE DATA FILE (ENSDF) AT ORNL AND ENDF/B-IV. DATA CONCERNING REACTOR AND FUEL CHARACTERISTICS WERE OBTAINED FROM REFERENCE SAFETY ANALYSIS REPORTS AND, WHERE POSSIBLE, THE COMMERCIAL REACTOR

VENDORS.

-DOCUMENTATION

THE FOLLOWING ITEMS CONSTITUTE THE ORIGEN2 DOCUMENTATION PUBLISHED AS OF THE DATE OF THIS CODE PACKAGE:

A.G. CROFF, "ORIGEN2 - A REVISED AND UPDATED VERSION OF THE OAK RIDGE ISOTOPE GENERATION AND DEPLETION CODE", ORNL-5621 (JULY 1980).

A.G. CROFF, "A USER'S MANUAL FOR THE ORIGEN2 COMPUTER CODE", ORNL/TM-7175 (JULY 1980).

A.G. CROFF, M.A. BJERKE, G.W.MORRISON, AND L.M. PETRIE, "REVISED URANIUM-PLUTONIUM CYCLE PWR AND BWR MODELS FOR THE ORIGEN COMPUTER CODE", ORNL/TM-6051 (SEPTEMBER 1978).

A.G. CROFF AND M.A. BJERKE, "ALTERNATIVE FUEL CYCLE PWR MODELS FOR THE ORIGEN COMPUTER CODE", ORNL/TM-7005 (FEB 1980).

A.G. CROFF, R.L. HAESE, AND N.B. GOVE, "UPDATED DECAY AND PHOTON LIBRARIES FOR THE ORIGEN CODE", ORNL/TM-6055 (FEB 1979)

A.G. CROFF, "ORIGEN2: A REVISED AND UPDATED VERSION OF ORIGEN", TRANS. AM. NUCL. SOC., VOL. 34, P. 349-50 (JUNE 1980).

1 OUTPUT UNIT = 6 PAGE 2
ORIGEN2 V2.1 (8-1-91), Run on May 16 2000 at 10:41:42
0**********
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********** ORIGEN2: A REVISED AND UPDATED VERSION OF

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

THE ORIGEN COMPUTER CODE **********

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ORGANIZATION OF ORIGEN2 OUTPUT

PAST EXPERIENCE HAS INDICATED THAT MANY USERS ENCOUNTER CONSIDERABLE DIFFICULTY IN FINDING THE DESIRED INFORMATION IN A

ORIGEN2 OUT PUT WHICH IS SOMETIMES RATHER MASSIVE. THIS SECTION IS INTENDED AS A BRIEF OUTLINE OF THE ORGANIZATION OF ORIGEN2 OUTPUT. FOR DETAILS REFER TO THE USER'S MANUAL (ORNL/TM-7175, SECT. 8.2). THE ORIGEN2 OUTPUT IS EXTREMELY HIERARCHICAL, AND IS ORGANIZED AS FOLLOWS:

0 CARD INPUT ECHO

MISCELLANEOUS INPUT DATA (NEUTRON YIELDS, REPROCESSING LOSSES,ELEMENT CHEMICAL TOXICITIES

LISTING OF ORIGEN2 COMMANDS CURRENTLY BEING EXECUTED

LISTING OF ORIGEN2 DATA LIBRARIES (IF SPECIFIED)

DECAY LIBRARY

ACTIVATION PRODUCTS

ACTINIDES

FISSION PRODUCTS

CROSS SECTION/FISSION PRODUCT YIELD LIBRARY

ACTIVATION PRODUCTS, ACTINIDES, AND FISSION PRODUCTS

PHOTON LIBRARY

ACTIVATION PRODUCTS, ACTINIDES, AND FISSION PRODUCTS

OUTPUT 1

REACTIVITY AND BURNUP DATA

ACTIVATION PRODUCT TABLES

GRAM TABLES (NUCLIDE, ELEMENT, NUCLIDE SUMMARY, ELEMENT SUMMARY)

CURIE TABLES (NUCLIDE, ELEMENT, NUCLIDE SUMMARY, ELEMENT SUMMARY)

ETC. (DEPENDING ON THE OUTPUT OPTIONS SPECIFIED, MANY OF THESE TABLES MAY BE OMITTED

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ACTINIDE TABLES

SAME SUBHEADINGS POSSIBLE AS UNDER ACTIVATION PRODUCT TABLES

FISSION PRODUCT TABLES

SAME SUBHEADINGS POSSIBLE AS UNDER ACTIVATION PRODUCT TABLES

NEUTRON PRODUCTION RATE TABLES: (ALPHA,N) AND SPONTANEOUS FISSION

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

```
      PHOTON TABLES
        ACTIVATION PRODUCTS (SUMMATION AND PRINCIPAL CONTRIBUTORS)
        ACTINIDES (SUMMATION AND PRINCIPAL CONTRIBUTORS)
        FISSION PRODUCTS (SUMMATION AND PRINCIPAL CONTRIBUTORS)
     OUTPUT 2
      SAME GENERAL CONTENT AND ORDER AS OUTPUT 1
      .
      .
      .
     OUTPUT N
      SAME GENERAL CONTENT AND ORDER AS OUTPUT 1
     TABLE OF CONTENTS (UNIT 12) FOR THE ABOVE (UNIT 6) OUTPUT
     VARIABLE CROSS SECTION INFORMATION OUTPUT (UNIT 16)
     DEBUGGING AND OTHER INTERNAL INFORMATION OUTPUT (UNIT 15)
0  THE SCENARIO LISTED ABOVE CONSTITUTES A TYPICAL ORIGEN2 OUTPUT FOR
        MANY CASES.  ONE POSSIBLE MODIFICATION IS THE USE OF AN
  STP COMMAND TO EXECUTE AN ADDITIONAL SET OF INSTRUCTIONS AFTER THE
        FIRST SET HAS BEEN EXECUTED.  IF THIS IS DONE, THE OUTPUT
         WILL BEGIN WITH "MISCELLANEOUS INPUT DATA" IF NSTP=1,
        "ORIGEN2COMMANDS CURRENTLY BEING EXECUTED" IF NSTP=2, OR
        "OUTPUT 1"
  FOR NSTP=3.  ANOTHER OFTEN-USED OPTION IS TO EMPLOY BOTH THE PRIMARY
        (UNIT 6) AND ALTERNATE (UNIT 11) OUTPUT UNITS.  IF BOTH
   ARE ROUTED TO PAPER, THE TABLE OF CONTENTS FOR UNIT 11, WHICH IS ON
        UNIT 13, WILL IMMEDIATELY FOLLOW THE DEBUGGING AND
  INTERNAL INFORMATION (UNIT 15) OUTPUT.  THE "OUTPUT N" TABLES FOR UNIT
        11 WILL BE PRINTED FOLLOWING THE TABLE OF CONTENTS.
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1                                        OUTPUT UNIT =  6                PAGE  35
ORIGEN2 V2.1 (8-1-91), Run on May 16 2000 at 10:41:42

   *EST OF ORIGEN2 V2.1 - PWR FUEL ASSY-EXTENDED BURNUP (PWRU50)
+                                                   FISSION PRODUCTS
      POWER=  1.00000E+00  MW,   BURNUP=  1.00000E+00  MWD,   FLUX=  1.00E+00
        N/CM**2-SEC
0              5 SUMMARY TABLE:  CONCENTRATIONS, GRAMS
                 MTIHM 3.0% UO2 FUEL ASSY;BURNUP=40,000 MWD/MTIHM, 6 CYCLE

       ASSY DIS     1.0YR    10.0YR   100.0YR     1.0KY

 H  3     7.045E-02 6.660E-02 4.019E-02 2.571E-04 0.000E+00
LI  6     1.939E-04 1.939E-04 1.939E-04 1.939E-04 1.939E-04
LI  7     1.229E-05 1.229E-05 1.229E-05 1.229E-05 1.229E-05
BE  9     2.364E-05 2.364E-05 2.364E-05 2.364E-05 2.364E-05
BE 10     1.579E-04 1.579E-04 1.579E-04 1.579E-04 1.578E-04
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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

C 14	3.193E-05	3.192E-05	3.189E-05	3.154E-05	2.829E-05
ZN 72	8.174E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 72	2.487E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 72	2.877E-02	2.888E-02	2.888E-02	2.888E-02	2.888E-02
GA 73	1.648E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 73	5.680E-02	5.682E-02	5.682E-02	5.682E-02	5.682E-02
GE 74	1.227E-01	1.227E-01	1.227E-01	1.227E-01	1.227E-01
GE 75	1.821E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 75	2.451E-01	2.451E-01	2.451E-01	2.451E-01	2.451E-01
GE 76	5.970E-01	5.970E-01	5.970E-01	5.970E-01	5.970E-01
AS 76	3.002E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 76	9.045E-03	9.075E-03	9.075E-03	9.075E-03	9.075E-03
GE 77	2.525E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 77	2.348E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 77	1.198E+00	1.201E+00	1.201E+00	1.201E+00	1.201E+00
GE 78	2.035E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 78	2.192E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 78	2.956E+00	2.956E+00	2.956E+00	2.956E+00	2.956E+00
AS 79	5.112E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 79	6.998E+00	6.998E+00	6.998E+00	6.991E+00	6.924E+00
SE 79M	2.218E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 79	1.521E-04	2.268E-04	8.989E-04	7.616E-03	7.443E-02
SE 80	1.576E+01	1.576E+01	1.576E+01	1.576E+01	1.576E+01
KR 80	3.109E-04	3.110E-04	3.110E-04	3.110E-04	3.110E-04
AS 81	1.009E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 81	3.800E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 81M	3.035E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 81	2.496E+01	2.496E+01	2.496E+01	2.496E+01	2.496E+01
KR 81	3.675E-05	3.675E-05	3.675E-05	3.674E-05	3.663E-05
AS 82	5.457E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 82	3.877E+01	3.877E+01	3.877E+01	3.877E+01	3.877E+01
BR 82	6.213E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 82M	7.256E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 82	1.475E+00	1.481E+00	1.481E+00	1.481E+00	1.481E+00
AS 83	6.077E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 83	4.144E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 83M	3.071E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 83	6.592E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 83	4.441E+01	4.442E+01	4.442E+01	4.442E+01	4.442E+01
KR 83M	5.067E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 84	2.437E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 84	2.454E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 84M	2.051E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 84	1.318E+02	1.318E+02	1.318E+02	1.318E+02	1.318E+02
SE 85	2.688E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 85M	9.795E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

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1                                        OUTPUT UNIT =  6                PAGE  46
ORIGEN2 V2.1 (8-1-91), Run on May 16 2000 at 10:41:42

   *EST OF ORIGEN2 V2.1 - PWR FUEL ASSY-EXTENDED BURNUP (PWRU50)
+                                                   FISSION PRODUCTS
      POWER=  1.00000E+00  MW,   BURNUP=  1.00000E+00  MWD,   FLUX=  1.00E+00
        N/CM**2-SEC
0              7 SUMMARY TABLE:  RADIOACTIVITY,  CURIES
                 MTIHM 3.0% UO2 FUEL ASSY;BURNUP=40,000 MWD/MTIHM, 6 CYCLE

       ASSY DIS     1.0YR    10.0YR   100.0YR     1.0KY

 H  3     6.801E+02 6.430E+02 3.880E+02 2.483E+00 0.000E+00
BE 10     3.530E-06 3.530E-06 3.530E-06 3.530E-06 3.528E-06
 C 14     1.424E-04 1.423E-04 1.422E-04 1.406E-04 1.261E-04
CO 72     1.681E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NI 72     3.238E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CU 72     6.448E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZN 72     7.654E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GA 72     7.681E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CO 73     5.481E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NI 73     2.695E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CU 73     8.232E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZN 73     1.373E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GA 73     1.450E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GE 73M    1.452E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CO 74     1.032E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NI 74     1.553E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CU 74     1.043E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZN 74     2.496E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GA 74     2.686E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NI 75     6.264E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CU 75     1.014E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZN 75     4.456E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GA 75     5.435E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GE 75     5.515E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GE 75M    2.549E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NI 76     1.582E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CU 76     7.315E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZN 76     7.137E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GA 76     1.109E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00
AS 76     4.706E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
NI 77     2.716E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
CU 77     3.369E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
ZN 77     7.700E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GA 77     1.931E+03 0.000E+00 0.000E+00 0.000E+00 0.000E+00
GE 77     9.096E+02 0.000E+00 0.000E+00 0.000E+00 0.000E+00
```

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

GE 77M	1.952E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 77	2.463E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 77M	7.401E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 78	3.165E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 78	1.194E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 78	7.205E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 78	3.232E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 78	5.642E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 78	5.828E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 79	3.772E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 79	5.099E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 79	3.799E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 79	1.163E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 79	1.352E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 79	4.877E-01	4.877E-01	4.877E-01	4.872E-01	4.826E-01
SE 79M	1.358E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Scientific Notebook #170 Issued to: S. Mohanty

Issue Date: Apr. 3, 1996 Account Number: 20-01402-762

Title: Modifications to ASHRMOVO and DCAGW to correct the formula to calculate the leaching factor

Participants: J. Weldy

9/11/00 - Correction of formula to calculate the leaching factor in DCAGW and ASHRMOVO

Rationale: The formula used to calculate the leaching factor in ASHRMOVO and DCAGW is based on the following formula in Napier et al., 1988, which is taken from Baes and Sharp, 1981:

$$\lambda_l = \frac{V_w}{d(1+\frac{\rho K_d}{\theta})}$$

where,

λ = leaching factor (1/yr)
V_w = Infiltration rate of water (m/yr)
d = Thickness of rooting zone (m)
ρ = Density of soil (g/cm^3)
θ = Soil volumetric water content

However, in 1983, Baes and Sharp published a paper which documented the calculation of the leaching factor that resulted in a slightly different formula than in Baes and Sharp, 1981:

$$\lambda_l = \frac{V_w / \theta}{d(1+\frac{\rho K_d}{\theta})}$$

where all symbols are the same as above

The difference in the formulae is that the 1981 paper used the infiltration rate of

the water to compare the rate of movement of the contaminant whereas the 1983 paper used the more appropriate velocity of water in the subsurface. As such, the TPA code will be modified to utilize the formula developed in Baes and Sharp, 1983.

Objective:

Modify ASHRMOVO and DCAGW to calculate the leaching factor using the formula in Baes and Sharp, 1983.

Lines modified: ASHRMOVO

Line 658 - modified from

```
dll(i)=(precip*(1.d0-fpe)*fpsat+dirr*1.d0-
        fie)*fisat)/(depthsoil*(1.d0+rhosoil/theta*dkd(i)))
```

to

```
dll(i)=(precip*(1.d0-fpe)*fpsat+dirr*1.d0-
        fie)*fisat)/(depthsoil*theta*(1.d0+rhosoil/theta*dkd(i)))
```

Lines modified: DCAGW

Line 1834 - modified from

```
r2=(rain+water-et)/((doss/100)*1+sbd/svwc*retcoef))
```

to

```
r2=(rain+water-et)/(svwc*(doss/100)*1+sbd/svwc*retcoef))
```

TESTING

To ensure that the changes were implemented correctly, two tests were conducted, one to test the changes to dcagw.f and one to test the changes to ashrmovo.f

For the dcagw test, the calculated leaching factors are directly written to the file

gftrans.inp. Therefore, one realization of the code was run and the results for several nuclides in gftrans.inp were compared to results calculated using an Excel spreadsheet. The TPA files used for the test are located in the directory /home/jweldy/tpa40/dev/tpa41test/dcagwtest and the Excel spreadsheet is located on Kraken at d:\personal\excel files\Leachtest41.xls. The results are as follows:

There is very good agreement here, so the modifications are considered successful.

Radio nuclide	Kd (cm3/g)	Leaching Factor (1/yr)	TPA Calc Leaching Factor - DCAGW (1/yr)	Precip rate (m/yr)	Irrigation rate (m/yr)	Evapo rate (m/yr)	Depth of Soil (m)	Soil Volumetric Water Content	Soil Density (g/cm3)
Cm	4062	8.81E-04	8.80E-04	0.085	1.52	0.8	0.15	0.35	1.5
Pu	547.7	6.53E-03	6.50E-03						
U	34.8	1.02E-01	1.00E-01						
Am	1914	1.87E-03	1.90E-03						
Np	5	6.84E-01	6.90E-01						
Th	3200	1.12E-03	1.10E-03						
Ra	497	7.20E-03	7.20E-03						
Pb	269.8	1.32E-02	1.30E-02						
Cs	273.9	1.31E-02	1.30E-02						
I	1	2.90E+00	2.90E+00						
Tc	0.1	1.07E+01	1.10E+01						
Ni	403	8.87E-03	8.90E-03						
Cl	0.25	7.40E+00	7.40E+00						
C	5	6.84E-01	6.80E-01						
Se	56.1	6.35E-02	6.30E-02						
Nb	160	2.23E-02	2.20E-02						

The ASHRMOVO tests are more tricky because the calculated leaching factor is not directly output. The best way to determine the leaching factor is to set the erosion rate to zero and do a best fit curve on the dose through time

curve, which will then only be affected by leaching and radioactive decay. If the test radionuclides have a long enough half-life, the exponential curve fit should yield the leaching factor in the exponent. The TPA files used for the test are located in the directory /home/jweldy/tpa40/dev/tpa41test/ashrmovotest and the Excel spreadsheet is located on Kraken at d:\personal\excel files\Leachtest41.xls. The results are as follows:

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Radio nuclide	Kd (cm3/g)	Leaching Factor (1/yr)	TPA Calc lambda (leach+rad) - ASHRMOVO (1/yr)	lambda rad (1/yr) / notes	lambda leach	Solubility (mol/L)	N (mol/m2)	S*R/lambda	Ci/MTU
Cm	4000	**1.81E-04**	3.27E-04	0.000145772	**1.81E-04**	1.00E-06	**2.20E-04**	**8.40E-04**	0.015
Pu	550	**1.32E-03**	**1.30E-03**	solubility limited		5.00E-06	**2.93E+00**	**5.78E-04**	200
U	35	2.05E-02	1.35E-03	solubility limited		4.50E-05	**4.54E-03**	**3.33E-04**	0.31
Am	1900	**3.81E-04**	4.75E-04	9.4152E-05	**3.81E-04**				
Np	5	1.37E-01	5.77E-04	solubility limited		1.00E-04	**1.46E-02**	**1.11E-04**	1
Th	3200	**2.26E-04**	2.36E-04	9.19293E-06	**2.27E-04**				
Ra	500	1.45E-03	3.16E-04	buildup					
Pb	270	2.68E-03	3.19E-04	buildup					
Cs	280	**2.58E-03**	**2.59E-03**						
I	1	5.64E-01	high						
Tc	0.1	1.88E+00	high						
Ni	400	**1.81E-03**	**1.82E-03**			2.00E-03	**3.66E-02**	**1.68E-01**	2.5
Cl	0.25	1.35E+00	high						
C	5	1.37E-01	high						
Se	150	**4.82E-03**	**4.78E-03**						
Nb	160	**4.52E-03**	**4.55E-03**						

Precip rate (m/yr)	Irrigation rate (m/yr)	Fraction of irrig lost to ET	Depth of Soil (m)	Soil Volumetric Water Content	Soil Density (g/cm3)	Fraction of precip lost to ET	Fraction of year blanket is sat due to precip	Fraction of year blanket is sat due to irrig	Recharge rate of water (m/yr)	MTU/m2
0.085	1.52	0.5	0.15	0.4	1.4	0.68	0.0054	0.2	0.15214688	1.17E-06

Again, there is very good agreement here, so the test is considered successful.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
References:

Baes, C.F. and R.D. Sharp. Predicting Radionuclide Leaching from Root Zone Soil From Assessment Applications. CONF-81606. Oak Ridge, TN: Oak Ridge National Laboratory. 1981

Baes, C.F. and R.D. Sharp. A Proposal for Estimation of Soil Leaching and Leaching Constants for Use in Assessment Models. Journal of Environmental Quality, Vol. 12, No. 1. 1983

Napier, B.A., R. Peloquin, D. Strenge, J. Ramsdell. GENII – The Hanford Environmental Radiation Dosimetry Software System. PNL-6584. Richland, WA: Pacific Northwest Laboratory. 1988.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762
Scientific Notebook #170 Issued to: S. Mohanty

Issue Date: Apr. 3, 1996 Account Number: 20-01402-762

Title: Testing of the modification to DCAGW to initialize the variable dKGvalue - PA-SCR-324

Participants: J. Weldy

9/12/00 - Description of tests conducted to ensure that the variable dKGvalue is initialized properly in DCAGW

Rationale:

The code was modified because in multiple realization runs, the variable dKGvalue was not being initialized properly and therefore, the time of the pluvial switch was not staying fixed at the year specified in the tpa.inp file.

Methodology:

The fix will be tested by running the code for 10 realizations with the original file with the input file modified to make the time of the switch to pluvial conditions obvious (by reducing the pluvial pumping rate significantly) and observing when the switch to pluvial conditions occurs by looking at the dose in rgwsr.tpa. The same 10 realizations will be run for the corrected code to ensure that the year of the switch to pluvial conditions occurs at year 13000 and then current conditions return in year 77500. This is the only location in the code that the variable dKGvalue is used, so this single test is sufficient to ensure that the code is working properly. The TPA files used for the test and the results of the tests (in the Excel spreadsheet dcagw2test1) are stored on vulcan at /home/jweldy/tpa40/dev/tpa41test/dcagw2 and the results are summarized below.

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

Results:

Year	Dose 1 (rem/yr)	Dose 2 (rem/yr)	Dose 1 (rem/yr)	Dose 2 (rem/yr)	Dose 1 (rem/yr)	Dose 2 (rem/yr)	Dose 1 (rem/yr)	Dose 2 (rem/yr)	Dose 1 (rem/yr)	Dose 2 (rem/yr)	
2.31e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* Note that Years in Pluvial Climate are in Bold
4.67e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* If code is Functioning Properly, Pluvial Climate
7.09e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* Should be Between 13000 and 77500 Years
9.57e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* For Every Realization
1.21e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
1.47e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
1.74e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.01e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.28e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.57e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

2.86e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
3.16e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
3.46e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
3.78e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
4.09e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
4.42e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
4.76e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
5.10e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	9.37e-12	1.00e-15	1.00e-15
5.45e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.11e-09	1.00e-15	1.00e-15
5.81e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	3.60e-07	1.00e-15	1.00e-15
6.17e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	3.63e-06	1.00e-15	1.00e-15
6.55e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.68e-05	1.00e-15	1.00e-15
6.93e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	5.26e-05	1.00e-15	1.00e-15
7.33e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.16e-04	1.00e-15	1.00e-15
7.73e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.89e-04	1.00e-15	1.00e-15
8.14e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.38e-04	1.00e-15	1.00e-15
8.56e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.36e-04	1.00e-15	1.00e-15
9.00e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.97e-04	1.00e-15	1.00e-15
9.44e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.41e-04	1.00e-15	1.00e-15
9.89e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	9.21e-05	1.00e-15	1.00e-15
1.04e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	5.77e-05	1.00e-15	1.00e-15
1.08e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	3.59e-05	1.00e-15	1.00e-15
1.13e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.28e-05	1.00e-15	1.00e-15
1.18e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.42e-05	1.00e-15	1.00e-15
1.23e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	8.68e-06	1.00e-15	1.00e-15
1.28e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	5.36e-06	1.00e-15	1.00e-15
1.34e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	3.10e-06	1.00e-15	1.00e-15
1.39e+03	1.00e-15	2.09e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.67e-06	1.00e-15	1.00e-15
1.45e+03	1.00e-15	6.66e-12	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.69e-09	8.73e-07	1.00e-15	1.00e-15

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

1.50e+03	1.00e-15	3.51e-10	1.00e-15	1.00e-15	1.00e-15	1.00e-15	9.43e-08	4.70e-07	1.00e-15	1.00e-15
1.56e+03	1.00e-15	2.89e-09	1.00e-15	1.00e-15	1.00e-15	1.00e-15	6.88e-07	2.37e-07	1.00e-15	2.70e-05
1.62e+03	1.00e-15	8.49e-09	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.85e-06	1.14e-07	1.00e-15	2.53e-04
1.68e+03	1.00e-15	1.12e-08	1.00e-15	1.69e-09	1.00e-15	1.00e-15	3.06e-06	5.45e-08	1.00e-15	5.18e-04
1.74e+03	1.00e-15	8.39e-09	1.00e-15	3.86e-07	1.00e-15	1.00e-15	3.96e-06	2.76e-08	1.00e-15	4.92e-04
1.81e+03	1.00e-15	5.13e-09	1.00e-15	2.21e-05	1.00e-15	1.00e-15	4.57e-06	1.65e-08	1.00e-15	4.09e-04
1.87e+03	1.00e-15	3.53e-09	1.00e-15	8.03e-05	1.00e-15	1.00e-15	5.03e-06	1.23e-08	1.00e-15	3.23e-04
1.94e+03	1.00e-15	3.62e-09	1.00e-15	1.52e-04	1.00e-15	1.00e-15	5.37e-06	1.13e-08	1.00e-15	2.48e-04
2.01e+03	1.00e-15	4.22e-09	1.00e-15	1.89e-04	1.00e-15	5.16e-08	5.64e-06	1.15e-08	1.00e-15	1.88e-04
2.08e+03	1.00e-15	5.39e-09	1.00e-15	1.78e-04	1.00e-15	2.04e-05	5.83e-06	1.22e-08	1.00e-15	1.45e-04
2.15e+03	1.00e-15	6.81e-09	1.00e-15	1.42e-04	1.00e-15	9.32e-05	5.93e-06	1.31e-08	1.00e-15	1.12e-04
2.23e+03	1.00e-15	8.32e-09	1.00e-15	1.04e-04	1.00e-15	1.28e-04	5.95e-06	1.40e-08	1.00e-15	8.87e-05
2.30e+03	1.00e-15	9.88e-09	1.00e-15	7.46e-05	1.00e-15	1.36e-04	5.91e-06	1.44e-08	1.00e-15	7.22e-05
2.38e+03	1.00e-15	1.13e-08	1.00e-15	5.33e-05	1.00e-15	1.32e-04	5.86e-06	1.49e-08	1.00e-15	6.11e-05
2.46e+03	1.00e-15	1.26e-08	1.00e-15	3.83e-05	1.00e-15	1.21e-04	5.86e-06	1.55e-08	1.00e-15	5.36e-05
2.54e+03	1.00e-15	1.38e-08	1.00e-15	2.79e-05	1.00e-15	1.07e-04	5.96e-06	1.60e-08	1.00e-15	4.86e-05
2.62e+03	1.00e-15	1.47e-08	1.00e-15	2.11e-05	1.00e-15	9.20e-05	6.15e-06	1.64e-08	1.00e-15	4.49e-05
2.70e+03	1.00e-15	1.53e-08	1.00e-15	1.66e-05	1.00e-15	7.70e-05	6.42e-06	1.66e-08	1.00e-15	4.21e-05
2.79e+03	1.00e-15	1.58e-08	1.00e-15	1.35e-05	1.00e-15	6.31e-05	6.70e-06	1.68e-08	1.00e-15	3.98e-05
2.88e+03	1.00e-15	1.60e-08	1.00e-15	1.15e-05	1.00e-15	5.08e-05	6.97e-06	1.71e-08	1.00e-15	3.78e-05
2.97e+03	1.00e-15	1.61e-08	1.00e-15	1.01e-05	1.00e-15	4.03e-05	7.17e-06	1.73e-08	1.00e-15	3.61e-05
3.06e+03	1.00e-15	1.61e-08	1.00e-15	9.19e-06	1.00e-15	3.14e-05	7.30e-06	1.75e-08	1.00e-15	3.45e-05
3.16e+03	1.00e-15	1.61e-08	1.00e-15	8.50e-06	1.00e-15	2.42e-05	7.35e-06	1.77e-08	1.00e-15	3.31e-05
3.25e+03	1.00e-15	1.61e-08	1.00e-15	8.00e-06	1.00e-15	1.84e-05	7.32e-06	1.79e-08	1.00e-15	3.19e-05
3.35e+03	1.00e-15	1.61e-08	1.00e-15	7.60e-06	1.00e-15	1.38e-05	7.25e-06	1.82e-08	1.00e-15	3.07e-05
3.45e+03	1.00e-15	1.61e-08	1.00e-15	7.27e-06	1.00e-15	1.03e-05	7.16e-06	1.86e-08	1.00e-15	2.96e-05
3.56e+03	1.00e-15	1.61e-08	1.00e-15	6.99e-06	1.00e-15	7.52e-06	7.06e-06	1.92e-08	1.00e-15	2.85e-05
3.66e+03	1.83e-13	1.61e-08	1.44e-15	6.73e-06	1.00e-15	5.46e-06	6.96e-06	2.01e-08	1.00e-15	2.75e-05
3.77e+03	1.94e-10	1.61e-08	7.20e-13	6.49e-06	1.00e-15	3.93e-06	6.86e-06	2.13e-08	1.00e-15	2.67e-05

3.88e+03	4.01e-08	1.62e-08	1.33e-08	6.28e-06	1.00e-15	2.81e-06	6.76e-06	2.30e-08	1.00e-15	2.60e-05
4.00e+03	3.89e-07	1.62e-08	2.92e-07	6.07e-06	1.00e-15	2.03e-06	6.67e-06	2.54e-08	1.00e-15	2.53e-05
4.12e+03	1.50e-06	1.62e-08	6.14e-07	5.87e-06	1.00e-15	1.53e-06	6.59e-06	2.86e-08	1.00e-15	2.47e-05
4.24e+03	3.21e-06	1.62e-08	4.74e-07	5.69e-06	1.00e-15	1.25e-06	6.51e-06	3.28e-08	1.00e-15	2.42e-05
4.36e+03	4.68e-06	1.62e-08	2.63e-07	5.52e-06	1.00e-15	1.12e-06	6.43e-06	3.85e-08	1.00e-15	2.35e-05
4.48e+03	4.85e-06	1.62e-08	2.27e-07	5.35e-06	1.00e-15	1.11e-06	6.36e-06	4.60e-08	1.00e-15	2.29e-05
4.61e+03	3.77e-06	1.63e-08	4.49e-07	5.19e-06	1.00e-15	1.19e-06	6.30e-06	5.57e-08	1.00e-15	2.23e-05
4.74e+03	2.36e-06	1.63e-08	9.02e-07	5.03e-06	1.00e-15	1.33e-06	6.24e-06	6.82e-08	1.00e-15	2.17e-05
4.88e+03	1.29e-06	1.63e-08	1.37e-06	4.90e-06	1.00e-15	1.53e-06	6.19e-06	8.40e-08	1.00e-15	2.11e-05
5.01e+03	6.87e-07	1.64e-08	1.64e-06	4.80e-06	1.00e-15	1.76e-06	6.15e-06	1.04e-07	1.00e-15	2.06e-05
5.15e+03	3.95e-07	1.64e-08	1.71e-06	4.82e-06	1.00e-15	2.03e-06	6.11e-06	1.28e-07	1.00e-15	2.01e-05
5.30e+03	2.53e-07	1.65e-08	1.69e-06	5.15e-06	1.00e-15	2.32e-06	6.07e-06	1.58e-07	1.00e-15	1.96e-05
5.44e+03	1.80e-07	1.65e-08	1.64e-06	6.07e-06	1.00e-15	2.64e-06	6.04e-06	1.95e-07	1.00e-15	1.91e-05
5.59e+03	1.38e-07	1.66e-08	1.58e-06	8.05e-06	1.00e-15	2.98e-06	6.02e-06	2.38e-07	1.00e-15	1.86e-05
5.75e+03	1.13e-07	1.67e-08	1.53e-06	1.13e-05	1.00e-15	3.33e-06	6.00e-06	2.88e-07	1.00e-15	1.82e-05
5.91e+03	9.79e-08	1.68e-08	1.47e-06	1.55e-05	1.00e-15	3.72e-06	5.98e-06	3.47e-07	1.00e-15	1.77e-05
6.07e+03	8.80e-08	1.68e-08	1.41e-06	2.03e-05	1.00e-15	4.15e-06	5.97e-06	4.15e-07	1.00e-15	1.72e-05
6.23e+03	8.17e-08	1.69e-08	1.36e-06	2.49e-05	1.00e-15	4.65e-06	5.97e-06	4.90e-07	1.00e-15	1.69e-05
6.40e+03	7.73e-08	1.70e-08	1.31e-06	2.87e-05	1.00e-15	5.18e-06	5.96e-06	5.75e-07	1.00e-15	1.65e-05
6.58e+03	7.43e-08	1.71e-08	1.26e-06	3.16e-05	1.00e-15	5.69e-06	5.97e-06	6.66e-07	1.00e-15	1.61e-05
6.75e+03	7.20e-08	1.72e-08	1.21e-06	3.36e-05	1.00e-15	6.16e-06	5.98e-06	7.64e-07	1.00e-15	1.58e-05
6.93e+03	7.01e-08	1.73e-08	1.16e-06	3.51e-05	1.00e-15	6.61e-06	5.99e-06	8.67e-07	1.00e-15	1.55e-05
7.12e+03	6.86e-08	1.75e-08	1.11e-06	3.62e-05	1.00e-15	7.07e-06	6.01e-06	9.73e-07	1.00e-15	1.52e-05
7.31e+03	6.72e-08	1.76e-08	1.06e-06	3.73e-05	1.00e-15	7.54e-06	6.04e-06	1.08e-06	1.00e-15	1.49e-05
7.50e+03	6.59e-08	1.78e-08	1.02e-06	3.82e-05	1.00e-15	8.01e-06	6.07e-06	1.18e-06	1.00e-15	1.46e-05
7.70e+03	6.47e-08	1.79e-08	9.71e-07	3.92e-05	1.00e-15	8.50e-06	6.10e-06	1.28e-06	1.00e-15	1.43e-05
7.91e+03	6.36e-08	1.81e-08	9.28e-07	4.02e-05	3.28e-10	9.00e-06	6.14e-06	1.37e-06	1.00e-15	1.40e-05
8.11e+03	6.25e-08	1.82e-08	8.87e-07	4.12e-05	1.95e-08	9.52e-06	6.19e-06	1.45e-06	1.00e-15	1.38e-05
8.33e+03	6.14e-08	1.84e-08	8.47e-07	4.21e-05	8.68e-08	1.00e-05	6.24e-06	1.52e-06	1.00e-15	1.35e-05

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

8.54e+03	6.04e-08	1.86e-08	8.08e-07	4.32e-05	2.16e-07	1.06e-05	6.29e-06	1.56e-06	1.00e-15	1.33e-05
8.77e+03	5.94e-08	1.88e-08	7.71e-07	4.42e-05	4.14e-07	1.12e-05	6.35e-06	1.59e-06	1.00e-15	1.30e-05
9.00e+03	5.91e-08	1.90e-08	7.35e-07	4.52e-05	6.57e-07	1.17e-05	6.41e-06	1.60e-06	1.00e-15	1.28e-05
9.23e+03	6.40e-08	1.92e-08	7.01e-07	4.63e-05	9.32e-07	1.23e-05	6.48e-06	1.58e-06	1.00e-15	1.26e-05
9.47e+03	9.13e-08	1.95e-08	6.68e-07	4.75e-05	1.33e-06	1.29e-05	6.55e-06	1.55e-06	1.00e-15	1.23e-05
9.71e+03	1.72e-07	1.97e-08	6.36e-07	4.87e-05	1.92e-06	1.36e-05	6.62e-06	1.49e-06	1.00e-15	1.21e-05
9.96e+03	3.19e-07	2.00e-08	6.06e-07	4.99e-05	2.65e-06	1.42e-05	6.70e-06	1.41e-06	1.00e-15	1.19e-05
1.02e+04	5.12e-07	2.03e-08	5.77e-07	5.12e-05	3.46e-06	1.49e-05	6.79e-06	1.32e-06	1.00e-15	1.17e-05
1.05e+04	7.20e-07	2.06e-08	5.49e-07	5.25e-05	4.37e-06	1.56e-05	6.88e-06	1.22e-06	1.00e-15	1.15e-05
1.08e+04	9.32e-07	2.09e-08	5.23e-07	5.39e-05	5.38e-06	1.64e-05	6.97e-06	1.11e-06	1.00e-15	1.13e-05
1.10e+04	1.14e-06	2.12e-08	4.98e-07	5.54e-05	6.47e-06	1.71e-05	7.07e-06	9.92e-07	1.00e-15	1.11e-05
1.13e+04	1.36e-06	2.15e-08	4.74e-07	5.70e-05	7.60e-06	1.79e-05	7.17e-06	8.74e-07	1.00e-15	1.09e-05
1.16e+04	1.57e-06	2.19e-08	4.52e-07	5.86e-05	8.58e-06	1.87e-05	7.28e-06	7.58e-07	1.00e-15	1.07e-05
1.19e+04	1.78e-06	2.23e-08	4.31e-07	6.03e-05	9.41e-06	1.96e-05	7.39e-06	6.48e-07	1.00e-15	1.05e-05
1.22e+04	1.99e-06	2.27e-08	4.10e-07	6.21e-05	1.02e-05	2.04e-05	7.51e-06	5.45e-07	1.00e-15	1.03e-05
1.25e+04	2.21e-06	2.31e-08	3.91e-07	6.40e-05	1.08e-05	2.14e-05	7.64e-06	4.51e-07	1.00e-15	1.01e-05
1.28e+04	2.43e-06	2.35e-08	3.73e-07	6.60e-05	1.15e-05	2.23e-05	7.77e-06	3.68e-07	1.00e-15	9.88e-06
1.31e+04	**2.53e+01**	2.40e-08	**7.23e+00**	**3.07e+02**	1.21e-05	2.33e-05	7.91e-06	2.96e-07	1.00e-15	8.50e-06
1.35e+04	**2.74e+01**	2.44e-08	**6.90e+00**	**3.17e+02**	1.26e-05	2.43e-05	8.06e-06	2.35e-07	1.00e-15	3.67e-06
1.38e+04	**2.96e+01**	2.49e-08	**6.59e+00**	**3.27e+02**	1.26e-05	**3.15e+02**	8.21e-06	1.84e-07	1.00e-15	1.93e-06
1.42e+04	**3.17e+01**	2.54e-08	**6.29e+00**	**3.38e+02**	1.19e-05	**3.29e+02**	8.37e-06	1.43e-07	1.00e-15	1.58e-06
1.45e+04	**3.40e+01**	2.60e-08	**6.01e+00**	**3.50e+02**	1.08e-05	**3.44e+02**	8.54e-06	1.11e-07	1.00e-15	1.50e-06
1.49e+04	**3.62e+01**	2.65e-08	**5.75e+00**	**3.62e+02**	9.52e-06	**3.59e+02**	8.72e-06	8.58e-08	1.00e-15	1.48e-06
1.52e+04	**3.85e+01**	2.71e-08	**5.50e+00**	**3.75e+02**	8.28e-06	**3.75e+02**	8.90e-06	6.68e-08	1.00e-15	1.46e-06
1.56e+04	**4.09e+01**	2.77e-08	**5.27e+00**	**3.89e+02**	7.26e-06	**3.91e+02**	9.09e-06	5.29e-08	1.00e-15	1.43e-06
1.60e+04	**4.34e+01**	2.83e-08	**5.06e+00**	**4.03e+02**	6.38e-06	**4.08e+02**	9.29e-06	4.29e-08	1.00e-15	1.38e-06
1.64e+04	**4.59e+01**	2.89e-08	**4.87e+00**	**4.18e+02**	5.55e-06	**4.26e+02**	9.50e-06	3.60e-08	1.00e-15	1.33e-06
1.68e+04	**4.85e+01**	2.92e-08	**4.69e+00**	**4.34e+02**	4.85e-06	**4.44e+02**	9.72e-06	3.13e-08	1.00e-15	1.28e-06
1.72e+04	**5.11e+01**	2.98e-08	**4.53e+00**	**4.51e+02**	4.37e-06	**4.64e+02**	9.95e-06	2.83e-08	1.00e-15	1.23e-06

1.77e+04	5.40e+01	3.05e-08	4.36e+00	4.68e+02	5.55e+01	4.84e+02	1.02e-05	2.65e-08	1.00e-15	1.18e-06
1.81e+04	5.76e+01	3.13e-08	4.20e+00	4.87e+02	5.25e+01	5.04e+02	1.04e-05	2.55e-08	1.00e-15	1.65e+01
1.85e+04	6.10e+01	5.82e-01	4.05e+00	5.06e+02	5.22e+01	5.26e+02	1.07e-05	3.59e-01	1.00e-15	1.58e+01
1.90e+04	6.39e+01	5.97e-01	3.91e+00	5.26e+02	5.40e+01	5.48e+02	1.10e-05	3.59e-01	1.00e-15	1.51e+01
1.95e+04	6.70e+01	6.11e-01	3.77e+00	5.47e+02	5.78e+01	5.72e+02	1.13e-05	3.63e-01	1.00e-15	1.45e+01
1.99e+04	7.01e+01	6.26e-01	3.65e+00	5.68e+02	6.36e+01	5.96e+02	1.15e-05	3.70e-01	1.00e-15	1.38e+01
2.04e+04	7.34e+01	6.41e-01	3.53e+00	5.91e+02	7.15e+01	6.20e+02	1.18e-05	3.78e-01	1.00e-15	1.32e+01
2.09e+04	7.67e+01	6.56e-01	3.42e+00	6.14e+02	8.04e+01	6.46e+02	1.22e-05	3.87e-01	1.00e-15	1.26e+01
2.15e+04	8.02e+01	6.71e-01	3.31e+00	6.38e+02	8.94e+01	6.72e+02	1.25e-05	3.97e-01	1.00e-15	1.20e+01
2.20e+04	8.38e+01	6.85e-01	3.21e+00	6.63e+02	9.79e+01	6.99e+02	1.28e-05	4.08e-01	1.00e-15	1.14e+01
2.25e+04	8.75e+01	7.00e-01	3.12e+00	6.89e+02	1.05e+02	7.27e+02	1.31e-05	4.20e-01	1.00e-15	1.08e+01
2.31e+04	9.14e+01	7.15e-01	3.03e+00	7.15e+02	1.12e+02	7.56e+02	1.64e+02	4.32e-01	1.00e-15	1.03e+01
2.36e+04	9.53e+01	7.30e-01	2.94e+00	7.42e+02	1.17e+02	7.85e+02	1.68e+02	4.45e-01	1.00e-15	9.74e+00
2.42e+04	9.75e+01	7.44e-01	2.86e+00	7.69e+02	1.22e+02	8.14e+02	1.73e+02	4.58e-01	1.00e-15	9.22e+00
2.48e+04	9.26e+01	7.58e-01	2.78e+00	7.95e+02	1.25e+02	8.45e+02	1.77e+02	4.72e-01	1.00e-15	8.72e+00
2.54e+04	8.45e+01	7.72e-01	2.71e+00	7.93e+02	1.27e+02	8.75e+02	1.82e+02	4.87e-01	1.00e-15	8.23e+00
2.60e+04	7.69e+01	7.85e-01	2.64e+00	7.29e+02	1.28e+02	9.06e+02	1.86e+02	5.02e-01	1.00e-15	7.76e+00
2.66e+04	7.00e+01	7.98e-01	2.57e+00	6.47e+02	1.29e+02	9.37e+02	1.91e+02	5.18e-01	1.00e-15	7.31e+00
2.73e+04	6.36e+01	8.10e-01	2.50e+00	5.72e+02	1.30e+02	9.68e+02	1.96e+02	5.35e-01	1.00e-15	6.87e+00
2.80e+04	5.78e+01	8.22e-01	2.44e+00	5.07e+02	1.31e+02	9.99e+02	2.01e+02	5.52e-01	1.00e-15	6.45e+00
2.86e+04	5.25e+01	8.33e-01	2.38e+00	4.50e+02	1.32e+02	1.03e+03	2.05e+02	5.70e-01	1.00e-15	6.05e+00
2.93e+04	4.78e+01	8.43e-01	2.33e+00	3.99e+02	1.33e+02	1.06e+03	2.10e+02	5.89e-01	1.00e-15	5.66e+00
3.00e+04	4.34e+01	8.53e-01	2.28e+00	3.56e+02	1.34e+02	1.09e+03	2.15e+02	6.08e-01	1.00e-15	5.30e+00
3.08e+04	3.95e+01	8.62e-01	2.22e+00	3.18e+02	1.35e+02	1.12e+03	2.20e+02	6.29e-01	1.00e-15	4.94e+00
3.15e+04	3.60e+01	8.70e-01	2.18e+00	2.85e+02	1.35e+02	1.15e+03	2.25e+02	6.49e-01	1.00e-15	4.60e+00
3.23e+04	3.29e+01	8.75e-01	2.13e+00	2.57e+02	1.36e+02	1.18e+03	2.29e+02	6.71e-01	1.00e-15	4.28e+00
3.30e+04	3.00e+01	7.84e-01	2.08e+00	2.32e+02	1.37e+02	1.20e+03	2.34e+02	6.93e-01	1.00e-15	3.98e+00
3.38e+04	2.75e+01	6.35e-01	2.04e+00	2.11e+02	1.38e+02	1.23e+03	2.39e+02	7.17e-01	1.00e-15	3.69e+00
3.47e+04	2.52e+01	5.17e-01	2.00e+00	1.93e+02	1.39e+02	1.26e+03	2.43e+02	7.53e-01	1.00e-15	3.41e+00

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

3.55e+04	2.32e+01	4.25e-01	1.96e+00	1.78e+02	1.41e+02	1.28e+03	2.47e+02	8.54e-01	1.00e-15	3.15e+00
3.63e+04	2.14e+01	3.55e-01	1.93e+00	1.64e+02	1.43e+02	1.30e+03	2.52e+02	1.26e+00	1.00e-15	2.92e+00
3.72e+04	1.99e+01	3.01e-01	1.89e+00	1.53e+02	1.45e+02	1.32e+03	2.56e+02	2.77e+00	1.00e-15	4.22e+00
3.81e+04	1.85e+01	2.60e-01	1.85e+00	1.43e+02	1.48e+02	1.34e+03	2.60e+02	7.35e+00	1.00e-15	3.30e+01
3.90e+04	1.72e+01	2.29e-01	1.82e+00	1.35e+02	1.51e+02	1.36e+03	2.63e+02	1.87e+01	1.00e-15	1.53e+02
4.00e+04	1.61e+01	2.06e-01	1.79e+00	1.28e+02	1.56e+02	1.38e+03	2.67e+02	4.28e+01	1.00e-15	2.71e+02
4.09e+04	1.51e+01	1.88e-01	1.76e+00	1.22e+02	1.60e+02	1.39e+03	2.71e+02	8.37e+01	1.00e-15	3.07e+02
4.19e+04	1.43e+01	1.75e-01	1.73e+00	1.17e+02	1.66e+02	1.41e+03	2.74e+02	1.43e+02	1.00e-15	3.22e+02
4.29e+04	1.35e+01	1.65e-01	1.71e+00	1.12e+02	1.72e+02	1.42e+03	2.77e+02	2.17e+02	1.00e-15	3.38e+02
4.39e+04	1.29e+01	1.57e-01	1.68e+00	1.08e+02	1.79e+02	1.43e+03	2.80e+02	2.99e+02	1.00e-15	3.59e+02
4.50e+04	1.23e+01	1.51e-01	1.65e+00	1.04e+02	1.87e+02	1.44e+03	2.83e+02	3.81e+02	1.00e-15	3.83e+02
4.61e+04	1.18e+01	1.47e-01	1.63e+00	9.85e+01	1.96e+02	1.45e+03	2.86e+02	4.59e+02	1.00e-15	4.11e+02
4.72e+04	1.13e+01	1.43e-01	1.61e+00	9.51e+01	2.05e+02	1.46e+03	2.89e+02	5.32e+02	1.00e-15	4.44e+02
4.83e+04	1.09e+01	1.40e-01	1.59e+00	9.22e+01	2.15e+02	1.47e+03	2.91e+02	6.02e+02	1.00e-15	4.82e+02
4.95e+04	1.06e+01	1.38e-01	1.57e+00	8.22e+01	2.25e+02	1.48e+03	2.94e+02	6.71e+02	1.00e-15	5.25e+02
5.06e+04	1.02e+01	1.36e-01	1.56e+00	6.45e+01	2.36e+02	1.48e+03	2.96e+02	7.42e+02	1.00e-15	5.72e+02
5.18e+04	9.97e+00	1.34e-01	1.53e+00	4.83e+01	2.46e+02	1.49e+03	2.98e+02	1.86e+04	1.30e-01	6.23e+02
5.31e+04	9.73e+00	1.32e-01	1.51e+00	3.59e+01	2.56e+02	1.50e+03	3.00e+02	4.22e+04	3.96e+02	6.77e+02
5.43e+04	9.51e+00	1.31e-01	1.49e+00	2.65e+01	2.66e+02	1.50e+03	3.02e+02	3.75e+04	6.97e+02	7.35e+02
5.56e+04	9.31e+00	1.29e-01	1.48e+00	1.95e+01	2.75e+02	1.51e+03	3.04e+02	3.55e+04	1.07e+03	7.95e+02
5.70e+04	9.13e+00	1.28e-01	1.46e+00	1.42e+01	2.83e+02	3.13e+04	3.05e+02	3.47e+04	3.88e+03	8.57e+02
5.83e+04	8.97e+00	1.26e-01	1.44e+00	1.04e+01	2.90e+02	5.44e+04	3.07e+02	3.48e+04	6.49e+03	9.18e+02
5.97e+04	8.82e+00	1.25e-01	1.42e+00	7.54e+00	2.97e+02	8.70e+04	3.08e+02	3.58e+04	8.44e+03	9.78e+02
6.11e+04	8.68e+00	1.24e-01	1.40e+00	5.48e+00	3.03e+02	1.22e+05	3.09e+02	3.69e+04	9.88e+03	1.04e+03
6.26e+04	8.55e+00	1.23e-01	1.38e+00	3.99e+00	3.07e+02	1.53e+05	3.10e+02	3.74e+04	1.09e+04	1.09e+03
6.41e+04	8.43e+00	1.22e-01	1.37e+00	2.92e+00	3.12e+02	1.80e+05	3.10e+02	3.73e+04	1.16e+04	1.14e+03
6.56e+04	8.32e+00	1.21e-01	1.35e+00	2.78e+03	3.15e+02	2.02e+05	3.09e+02	3.68e+04	1.21e+04	1.18e+03
6.72e+04	8.21e+00	1.19e-01	1.34e+00	4.05e+03	3.18e+02	2.20e+05	3.08e+02	2.88e+04	1.23e+04	1.22e+03
6.87e+04	8.13e+00	1.18e-01	1.33e+00	6.11e+03	3.20e+02	2.33e+05	2.53e-05	1.68e+04	1.24e+04	1.25e+03

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

7.04e+04	**8.06e+00**	**5.85e+01**	**1.31e+00**	**2.58e+04**	**3.22e+02**	**2.42e+05**	2.50e-05	**1.03e+04**	**1.24e+04**	**1.27e+03**
7.21e+04	**8.00e+00**	**1.61e+02**	**1.30e+00**	**4.49e+04**	**3.23e+02**	**2.47e+05**	2.47e-05	**7.91e+03**	1.32e-03	**1.29e+03**
7.38e+04	**7.96e+00**	1.22e-05	**1.29e+00**	**5.76e+04**	2.09e-05	**2.47e+05**	2.42e-05	4.06e-04	1.30e-03	9.21e-05
7.55e+04	**7.93e+00**	1.34e-05	**1.27e+00**	**6.58e+04**	2.09e-05	**2.44e+05**	2.36e-05	3.22e-04	1.26e-03	9.27e-05
7.73e+04	**7.91e+00**	1.37e-05	**1.61e+00**	**7.09e+04**	2.09e-05	1.95e-02	2.29e-05	2.37e-04	1.22e-03	9.31e-05
7.91e+04	8.27e-07	1.35e-05	1.60e-04	1.64e-02	2.09e-05	1.86e-02	2.21e-05	1.75e-04	1.18e-03	9.33e-05
8.10e+04	8.28e-07	1.31e-05	2.52e-04	1.67e-02	2.06e-05	1.67e-02	8.30e-05	1.42e-04	1.13e-03	9.34e-05
8.29e+04	8.30e-07	1.25e-05	2.66e-04	1.69e-02	1.99e-05	1.47e-02	3.08e-04	1.28e-04	1.07e-03	9.35e-05
8.49e+04	8.33e-07	1.16e-05	2.67e-04	1.69e-02	1.85e-05	1.32e-02	5.30e-04	1.23e-04	1.01e-03	9.35e-05
8.69e+04	8.38e-07	1.05e-05	2.61e-04	1.67e-02	1.68e-05	1.17e-02	7.39e-04	1.26e-04	9.56e-04	9.40e-05
8.90e+04	8.44e-07	9.53e-06	2.51e-04	1.65e-02	1.55e-05	1.04e-02	9.29e-04	2.32e-04	9.01e-04	9.41e-05
9.11e+04	8.52e-07	8.66e-06	2.44e-04	1.61e-02	1.44e-05	9.13e-03	1.10e-03	1.10e-03	8.52e-04	9.41e-05
9.32e+04	8.59e-07	8.00e-06	2.46e-04	1.51e-02	1.36e-05	8.02e-03	1.25e-03	3.75e-03	8.12e-04	9.41e-05
9.54e+04	8.67e-07	7.59e-06	2.52e-04	1.37e-02	1.29e-05	7.06e-03	1.39e-03	7.21e-03	7.85e-04	9.38e-05
9.77e+04	8.75e-07	7.47e-06	2.67e-04	1.25e-02	1.23e-05	6.29e-03	1.53e-03	9.62e-03	7.79e-04	9.32e-05
1.00e+05	8.83e-07	7.53e-06	2.88e-04	1.18e-02	1.18e-05	5.72e-03	1.65e-03	1.07e-02	7.98e-04	9.21e-05
1.10e+05	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15

It can be seen that in the original code, the time of the pluvial switch jumps around. In the corrected version of the code, the following results can be seen:

Year	Dose 1 (rem/yr)	Dose 2 (rem/yr)	Dose 3 (rem/yr)	Dose 4 (rem/yr)	Dose 5 (rem/yr)	Dose 6 (rem/yr)	Dose 7 (rem/yr)	Dose 8 (rem/yr)	Dose 9 (rem/yr)	Dose 10 (rem/yr)

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

2.31e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* Note that Years in Pluvial Climate are in Bold
4.67e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* If code is Functioning Properly, Pluvial Climate
7.09e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* Should be Between 13000 and 77500 Years
9.57e+01	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	* For Every Realization
1.21e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
1.47e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
1.74e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.01e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.28e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.57e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
2.86e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
3.16e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
3.46e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
3.78e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
4.09e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	
4.42e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

4.76e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15
5.10e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	9.37e-12	1.00e-15	1.00e-15
5.45e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.12e-09	1.00e-15	1.00e-15
5.81e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	4.12e-07	1.00e-15	1.00e-15
6.17e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	4.12e-06	1.00e-15	1.00e-15
6.55e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.83e-05	1.00e-15	1.00e-15
6.93e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	5.60e-05	1.00e-15	1.00e-15
7.33e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.22e-04	1.00e-15	1.00e-15
7.73e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.98e-04	1.00e-15	1.00e-15
8.14e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.50e-04	1.00e-15	1.00e-15
8.56e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.49e-04	1.00e-15	1.00e-15
9.00e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.10e-04	1.00e-15	1.00e-15
9.44e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.53e-04	1.00e-15	1.00e-15
9.89e+02	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.02e-04	1.00e-15	1.00e-15
1.04e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	6.57e-05	1.00e-15	1.00e-15
1.08e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	4.18e-05	1.00e-15	1.00e-15
1.13e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.70e-05	1.00e-15	1.00e-15
1.18e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.70e-05	1.00e-15	1.00e-15
1.23e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.04e-05	1.00e-15	1.00e-15
1.28e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	6.46e-06	1.00e-15	1.00e-15
1.34e+03	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	3.74e-06	1.00e-15	1.00e-15
1.39e+03	1.00e-15	2.09e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.02e-06	1.00e-15	1.00e-15
1.45e+03	1.00e-15	6.67e-12	1.00e-15	1.00e-15	1.00e-15	1.00e-15	3.53e-09	1.05e-06	1.00e-15	1.00e-15
1.50e+03	1.00e-15	3.51e-10	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.13e-07	5.66e-07	1.00e-15	1.00e-15
1.56e+03	1.00e-15	2.92e-09	1.00e-15	1.00e-15	1.00e-15	1.00e-15	8.14e-07	2.85e-07	1.00e-15	4.11e-05
1.62e+03	1.00e-15	8.72e-09	1.00e-15	1.00e-15	1.00e-15	1.00e-15	2.18e-06	1.37e-07	1.00e-15	3.85e-04
1.68e+03	1.00e-15	1.15e-08	1.00e-15	4.23e-09	1.00e-15	1.00e-15	3.60e-06	6.45e-08	1.00e-15	7.85e-04
1.74e+03	1.00e-15	8.58e-09	1.00e-15	9.62e-07	1.00e-15	1.00e-15	4.69e-06	3.19e-08	1.00e-15	7.29e-04
1.81e+03	1.00e-15	5.22e-09	1.00e-15	5.45e-05	1.00e-15	1.00e-15	5.45e-06	1.82e-08	1.00e-15	5.82e-04

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

1.87e+03	1.00e-15	3.60e-09	1.00e-15	1.91e-04	1.00e-15	1.00e-15	6.03e-06	1.30e-08	1.00e-15	4.47e-04
1.94e+03	1.00e-15	3.69e-09	1.00e-15	3.46e-04	1.00e-15	1.00e-15	6.47e-06	1.16e-08	1.00e-15	3.39e-04
2.01e+03	1.00e-15	4.28e-09	1.00e-15	4.15e-04	1.00e-15	7.32e-08	6.81e-06	1.17e-08	1.00e-15	2.54e-04
2.08e+03	1.00e-15	5.45e-09	1.00e-15	3.90e-04	1.00e-15	3.03e-05	7.05e-06	1.23e-08	1.00e-15	1.94e-04
2.15e+03	1.00e-15	6.87e-09	1.00e-15	3.19e-04	1.00e-15	1.34e-04	7.19e-06	1.32e-08	1.00e-15	1.49e-04
2.23e+03	1.00e-15	8.37e-09	1.00e-15	2.43e-04	1.00e-15	1.78e-04	7.22e-06	1.40e-08	1.00e-15	1.17e-04
2.30e+03	1.00e-15	9.93e-09	1.00e-15	1.79e-04	1.00e-15	1.86e-04	7.18e-06	1.45e-08	1.00e-15	9.45e-05
2.38e+03	1.00e-15	1.13e-08	1.00e-15	1.29e-04	1.00e-15	1.80e-04	7.11e-06	1.50e-08	1.00e-15	7.98e-05
2.46e+03	1.00e-15	1.27e-08	1.00e-15	9.35e-05	1.00e-15	1.65e-04	7.10e-06	1.55e-08	1.00e-15	7.00e-05
2.54e+03	1.00e-15	1.38e-08	1.00e-15	6.80e-05	1.00e-15	1.46e-04	7.18e-06	1.60e-08	1.00e-15	6.33e-05
2.62e+03	1.00e-15	1.48e-08	1.00e-15	5.10e-05	1.00e-15	1.25e-04	7.35e-06	1.65e-08	1.00e-15	5.84e-05
2.70e+03	1.00e-15	1.54e-08	1.00e-15	3.97e-05	1.00e-15	1.05e-04	7.59e-06	1.67e-08	1.00e-15	5.47e-05
2.79e+03	1.00e-15	1.58e-08	1.00e-15	3.21e-05	1.00e-15	8.61e-05	7.85e-06	1.69e-08	1.00e-15	5.17e-05
2.88e+03	1.00e-15	1.60e-08	1.00e-15	2.70e-05	1.00e-15	6.96e-05	8.08e-06	1.71e-08	1.00e-15	4.91e-05
2.97e+03	1.00e-15	1.62e-08	1.00e-15	2.37e-05	1.00e-15	5.53e-05	8.26e-06	1.74e-08	1.00e-15	4.68e-05
3.06e+03	1.00e-15	1.62e-08	1.00e-15	2.14e-05	1.00e-15	4.33e-05	8.36e-06	1.75e-08	1.00e-15	4.48e-05
3.16e+03	1.00e-15	1.62e-08	1.00e-15	1.97e-05	1.00e-15	3.35e-05	8.38e-06	1.77e-08	1.00e-15	4.30e-05
3.25e+03	1.00e-15	1.62e-08	1.00e-15	1.85e-05	1.00e-15	2.56e-05	8.32e-06	1.79e-08	1.00e-15	4.14e-05
3.35e+03	1.00e-15	1.62e-08	1.00e-15	1.76e-05	1.00e-15	1.93e-05	8.22e-06	1.83e-08	1.00e-15	3.99e-05
3.45e+03	1.00e-15	1.62e-08	1.00e-15	1.68e-05	1.00e-15	1.44e-05	8.09e-06	1.87e-08	1.00e-15	3.84e-05
3.56e+03	1.00e-15	1.62e-08	1.00e-15	1.61e-05	1.00e-15	1.06e-05	7.95e-06	1.93e-08	1.00e-15	3.70e-05
3.66e+03	1.84e-13	1.62e-08	1.54e-15	1.55e-05	1.00e-15	7.73e-06	7.82e-06	2.02e-08	1.00e-15	3.58e-05
3.77e+03	1.95e-10	1.62e-08	7.51e-13	1.49e-05	1.00e-15	5.58e-06	7.69e-06	2.14e-08	1.00e-15	3.47e-05
3.88e+03	4.04e-08	1.62e-08	1.40e-08	1.44e-05	1.00e-15	4.00e-06	7.56e-06	2.31e-08	1.00e-15	3.37e-05
4.00e+03	3.93e-07	1.62e-08	3.10e-07	1.39e-05	1.00e-15	2.89e-06	7.45e-06	2.55e-08	1.00e-15	3.28e-05
4.12e+03	1.51e-06	1.62e-08	6.55e-07	1.35e-05	1.00e-15	2.14e-06	7.33e-06	2.87e-08	1.00e-15	3.20e-05
4.24e+03	3.27e-06	1.62e-08	5.06e-07	1.30e-05	1.00e-15	1.68e-06	7.23e-06	3.30e-08	1.00e-15	3.12e-05
4.36e+03	4.79e-06	1.63e-08	2.81e-07	1.26e-05	1.00e-15	1.42e-06	7.13e-06	3.87e-08	1.00e-15	3.04e-05
4.48e+03	5.00e-06	1.63e-08	2.36e-07	1.23e-05	1.00e-15	1.33e-06	7.03e-06	4.62e-08	1.00e-15	2.95e-05

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

4.61e+03	3.92e-06	1.63e-08	4.56e-07	1.19e-05	1.00e-15	1.34e-06	6.95e-06	5.60e-08	1.00e-15	2.87e-05
4.74e+03	2.48e-06	1.63e-08	9.11e-07	1.15e-05	1.00e-15	1.44e-06	6.87e-06	6.85e-08	1.00e-15	2.80e-05
4.88e+03	1.37e-06	1.64e-08	1.38e-06	1.12e-05	1.00e-15	1.61e-06	6.80e-06	8.44e-08	1.00e-15	2.72e-05
5.01e+03	7.36e-07	1.64e-08	1.65e-06	1.09e-05	1.00e-15	1.83e-06	6.73e-06	1.04e-07	1.00e-15	2.65e-05
5.15e+03	4.26e-07	1.65e-08	1.73e-06	1.07e-05	1.00e-15	2.09e-06	6.68e-06	1.29e-07	1.00e-15	2.58e-05
5.30e+03	2.74e-07	1.65e-08	1.70e-06	1.09e-05	1.00e-15	2.38e-06	6.62e-06	1.59e-07	1.00e-15	2.52e-05
5.44e+03	1.93e-07	1.66e-08	1.65e-06	1.16e-05	1.00e-15	2.69e-06	6.58e-06	1.96e-07	1.00e-15	2.45e-05
5.59e+03	1.48e-07	1.66e-08	1.59e-06	1.35e-05	1.00e-15	3.03e-06	6.54e-06	2.39e-07	1.00e-15	2.39e-05
5.75e+03	1.20e-07	1.67e-08	1.54e-06	1.66e-05	1.00e-15	3.39e-06	6.51e-06	2.90e-07	1.00e-15	2.33e-05
5.91e+03	1.03e-07	1.68e-08	1.48e-06	2.07e-05	1.00e-15	3.78e-06	6.48e-06	3.49e-07	1.00e-15	2.27e-05
6.07e+03	9.22e-08	1.69e-08	1.43e-06	2.54e-05	1.00e-15	4.23e-06	6.45e-06	4.17e-07	1.00e-15	2.21e-05
6.23e+03	8.52e-08	1.69e-08	1.37e-06	2.99e-05	1.00e-15	4.74e-06	6.43e-06	4.93e-07	1.00e-15	2.16e-05
6.40e+03	8.05e-08	1.70e-08	1.32e-06	3.36e-05	1.00e-15	5.29e-06	6.42e-06	5.78e-07	1.00e-15	2.11e-05
6.58e+03	7.71e-08	1.71e-08	1.27e-06	3.64e-05	1.00e-15	5.81e-06	6.41e-06	6.70e-07	1.00e-15	2.06e-05
6.75e+03	7.46e-08	1.73e-08	1.21e-06	3.83e-05	1.00e-15	6.29e-06	6.41e-06	7.69e-07	1.00e-15	2.02e-05
6.93e+03	7.27e-08	1.74e-08	1.16e-06	3.97e-05	1.00e-15	6.75e-06	6.42e-06	8.73e-07	1.00e-15	1.97e-05
7.12e+03	7.10e-08	1.75e-08	1.12e-06	4.08e-05	1.00e-15	7.22e-06	6.43e-06	9.79e-07	1.00e-15	1.93e-05
7.31e+03	6.96e-08	1.76e-08	1.07e-06	4.17e-05	1.00e-15	7.69e-06	6.44e-06	1.09e-06	1.00e-15	1.89e-05
7.50e+03	6.82e-08	1.78e-08	1.02e-06	4.26e-05	1.00e-15	8.17e-06	6.47e-06	1.19e-06	1.00e-15	1.86e-05
7.70e+03	6.70e-08	1.79e-08	9.78e-07	4.35e-05	1.00e-15	8.67e-06	6.49e-06	1.29e-06	1.00e-15	1.82e-05
7.91e+03	6.58e-08	1.81e-08	9.35e-07	4.43e-05	3.30e-10	9.18e-06	6.53e-06	1.38e-06	1.00e-15	1.78e-05
8.11e+03	6.46e-08	1.83e-08	8.93e-07	4.52e-05	1.96e-08	9.70e-06	6.56e-06	1.46e-06	1.00e-15	1.75e-05
8.33e+03	6.35e-08	1.84e-08	8.53e-07	4.62e-05	8.72e-08	1.02e-05	6.61e-06	1.53e-06	1.00e-15	1.72e-05
8.54e+03	6.24e-08	1.86e-08	8.14e-07	4.71e-05	2.17e-07	1.08e-05	6.65e-06	1.57e-06	1.00e-15	1.69e-05
8.77e+03	6.14e-08	1.88e-08	7.77e-07	4.81e-05	4.16e-07	1.14e-05	6.71e-06	1.60e-06	1.00e-15	1.66e-05
9.00e+03	6.11e-08	1.90e-08	7.40e-07	4.91e-05	6.61e-07	1.20e-05	6.77e-06	1.61e-06	1.00e-15	1.62e-05
9.23e+03	6.60e-08	1.93e-08	7.06e-07	5.01e-05	9.37e-07	1.26e-05	6.83e-06	1.59e-06	1.00e-15	1.60e-05
9.47e+03	9.36e-08	1.95e-08	6.72e-07	5.12e-05	1.33e-06	1.32e-05	6.89e-06	1.55e-06	1.00e-15	1.57e-05
9.71e+03	1.75e-07	1.98e-08	6.41e-07	5.23e-05	1.93e-06	1.38e-05	6.97e-06	1.50e-06	1.00e-15	1.54e-05

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

9.96e+03	3.24e-07	2.00e-08	6.10e-07	5.35e-05	2.67e-06	1.45e-05	7.04e-06	1.42e-06	1.00e-15	1.51e-05
1.02e+04	5.19e-07	2.03e-08	5.81e-07	5.47e-05	3.48e-06	1.52e-05	7.12e-06	1.33e-06	1.00e-15	1.48e-05
1.05e+04	7.30e-07	2.06e-08	5.53e-07	5.60e-05	4.39e-06	1.59e-05	7.21e-06	1.23e-06	1.00e-15	1.46e-05
1.08e+04	9.45e-07	2.09e-08	5.27e-07	5.74e-05	5.42e-06	1.67e-05	7.30e-06	1.12e-06	1.00e-15	1.43e-05
1.10e+04	1.16e-06	2.12e-08	5.02e-07	5.88e-05	6.52e-06	1.74e-05	7.39e-06	9.98e-07	1.00e-15	1.40e-05
1.13e+04	1.37e-06	2.16e-08	4.78e-07	6.03e-05	7.65e-06	1.82e-05	7.49e-06	8.79e-07	1.00e-15	1.38e-05
1.16e+04	1.59e-06	2.19e-08	4.55e-07	6.19e-05	8.65e-06	1.91e-05	7.60e-06	7.63e-07	1.00e-15	1.35e-05
1.19e+04	1.80e-06	2.23e-08	4.34e-07	6.35e-05	9.48e-06	1.99e-05	7.71e-06	6.52e-07	1.00e-15	1.32e-05
1.22e+04	2.02e-06	2.27e-08	4.14e-07	6.53e-05	1.02e-05	2.08e-05	7.82e-06	5.48e-07	1.00e-15	1.30e-05
1.25e+04	2.24e-06	2.31e-08	3.94e-07	6.71e-05	1.09e-05	2.17e-05	7.95e-06	4.54e-07	1.00e-15	1.27e-05
1.28e+04	2.46e-06	2.35e-08	3.76e-07	6.91e-05	1.16e-05	2.27e-05	8.08e-06	3.70e-07	1.00e-15	1.25e-05
1.31e+04	**2.54e+01**	**4.35e-01**	**7.32e+00**	**3.27e+02**	**1.65e+02**	**2.95e+02**	**1.01e+02**	**4.59e+00**	**1.00e-15**	**1.70e+02**
1.35e+04	**2.75e+01**	**4.44e-01**	**6.98e+00**	**3.36e+02**	**1.73e+02**	**3.08e+02**	**1.03e+02**	**3.64e+00**	**1.00e-15**	**6.37e+01**
1.38e+04	**2.96e+01**	**4.53e-01**	**6.66e+00**	**3.46e+02**	**1.74e+02**	**3.22e+02**	**1.04e+02**	**2.84e+00**	**1.00e-15**	**3.08e+01**
1.42e+04	**3.18e+01**	**4.62e-01**	**6.37e+00**	**3.57e+02**	**1.64e+02**	**3.36e+02**	**1.06e+02**	**2.20e+00**	**1.00e-15**	**2.46e+01**
1.45e+04	**3.40e+01**	**4.72e-01**	**6.08e+00**	**3.69e+02**	**1.49e+02**	**3.51e+02**	**1.08e+02**	**1.69e+00**	**1.00e-15**	**2.33e+01**
1.49e+04	**3.63e+01**	**4.82e-01**	**5.82e+00**	**3.81e+02**	**1.31e+02**	**3.66e+02**	**1.10e+02**	**1.30e+00**	**1.00e-15**	**2.29e+01**
1.52e+04	**3.86e+01**	**4.93e-01**	**5.57e+00**	**3.94e+02**	**1.14e+02**	**3.82e+02**	**1.12e+02**	**1.01e+00**	**1.00e-15**	**2.26e+01**
1.56e+04	**4.10e+01**	**5.04e-01**	**5.33e+00**	**4.07e+02**	**1.00e+02**	**3.99e+02**	**1.15e+02**	**7.88e-01**	**1.00e-15**	**2.21e+01**
1.60e+04	**4.35e+01**	**5.15e-01**	**5.12e+00**	**4.22e+02**	**8.83e+01**	**4.16e+02**	**1.17e+02**	**6.34e-01**	**1.00e-15**	**2.13e+01**
1.64e+04	**4.60e+01**	**5.25e-01**	**4.92e+00**	**4.37e+02**	**7.68e+01**	**4.35e+02**	**1.20e+02**	**5.26e-01**	**1.00e-15**	**2.05e+01**
1.68e+04	**4.86e+01**	**5.32e-01**	**4.75e+00**	**4.53e+02**	**6.72e+01**	**4.53e+02**	**1.22e+02**	**4.54e-01**	**1.00e-15**	**1.97e+01**
1.72e+04	**5.12e+01**	**5.41e-01**	**4.58e+00**	**4.69e+02**	**6.07e+01**	**4.73e+02**	**1.25e+02**	**4.08e-01**	**1.00e-15**	**1.90e+01**
1.77e+04	**5.42e+01**	**5.55e-01**	**4.41e+00**	**4.87e+02**	**5.62e+01**	**4.93e+02**	**1.28e+02**	**3.81e-01**	**1.00e-15**	**1.82e+01**
1.81e+04	**5.77e+01**	**5.69e-01**	**4.25e+00**	**5.05e+02**	**5.32e+01**	**5.15e+02**	**1.31e+02**	**3.67e-01**	**1.00e-15**	**1.75e+01**
1.85e+04	**6.11e+01**	**5.84e-01**	**4.10e+00**	**5.24e+02**	**5.28e+01**	**5.37e+02**	**1.34e+02**	**3.61e-01**	**1.00e-15**	**1.68e+01**
1.90e+04	**6.41e+01**	**5.98e-01**	**3.95e+00**	**5.44e+02**	**5.46e+01**	**5.60e+02**	**1.37e+02**	**3.61e-01**	**1.00e-15**	**1.60e+01**
1.95e+04	**6.71e+01**	**6.13e-01**	**3.82e+00**	**5.65e+02**	**5.83e+01**	**5.83e+02**	**1.41e+02**	**3.65e-01**	**1.00e-15**	**1.53e+01**
1.99e+04	**7.03e+01**	**6.27e-01**	**3.69e+00**	**5.87e+02**	**6.41e+01**	**6.08e+02**	**1.44e+02**	**3.71e-01**	**1.00e-15**	**1.47e+01**

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

2.04e+04	7.35e+01	6.42e-01	3.57e+00	6.10e+02	7.20e+01	6.33e+02	1.48e+02	3.80e-01	1.00e-15	1.40e+01
2.09e+04	7.69e+01	6.57e-01	3.46e+00	6.33e+02	8.09e+01	6.59e+02	1.52e+02	3.89e-01	1.00e-15	1.33e+01
2.15e+04	8.04e+01	6.72e-01	3.35e+00	6.57e+02	8.99e+01	6.86e+02	1.55e+02	3.99e-01	1.00e-15	1.27e+01
2.20e+04	8.40e+01	6.87e-01	3.25e+00	6.82e+02	9.84e+01	7.14e+02	1.59e+02	4.10e-01	1.00e-15	1.21e+01
2.25e+04	8.77e+01	7.02e-01	3.15e+00	7.08e+02	1.06e+02	7.42e+02	1.64e+02	4.22e-01	1.00e-15	1.15e+01
2.31e+04	9.16e+01	7.17e-01	3.06e+00	7.34e+02	1.12e+02	7.71e+02	1.68e+02	4.34e-01	1.00e-15	1.09e+01
2.36e+04	9.55e+01	7.31e-01	2.98e+00	7.61e+02	1.18e+02	8.01e+02	1.72e+02	4.47e-01	1.00e-15	1.03e+01
2.42e+04	9.77e+01	7.46e-01	2.90e+00	7.89e+02	1.22e+02	8.31e+02	1.76e+02	4.60e-01	1.00e-15	9.78e+00
2.48e+04	9.28e+01	7.60e-01	2.82e+00	8.15e+02	1.26e+02	8.62e+02	1.81e+02	4.74e-01	1.00e-15	9.25e+00
2.54e+04	8.47e+01	7.73e-01	2.74e+00	8.12e+02	1.28e+02	8.93e+02	1.86e+02	4.89e-01	1.00e-15	8.73e+00
2.60e+04	7.71e+01	7.87e-01	2.67e+00	7.47e+02	1.29e+02	9.24e+02	1.90e+02	5.04e-01	1.00e-15	8.23e+00
2.66e+04	7.01e+01	8.00e-01	2.60e+00	6.64e+02	1.30e+02	9.56e+02	1.95e+02	5.20e-01	1.00e-15	7.75e+00
2.73e+04	6.37e+01	8.12e-01	2.53e+00	5.89e+02	1.31e+02	9.87e+02	2.00e+02	5.37e-01	1.00e-15	7.29e+00
2.80e+04	5.79e+01	8.24e-01	2.47e+00	5.22e+02	1.32e+02	1.02e+03	2.05e+02	5.54e-01	1.00e-15	6.85e+00
2.86e+04	5.27e+01	8.35e-01	2.41e+00	4.64e+02	1.33e+02	1.05e+03	2.09e+02	5.72e-01	1.00e-15	6.42e+00
2.93e+04	4.79e+01	8.45e-01	2.36e+00	4.13e+02	1.34e+02	1.08e+03	2.14e+02	5.91e-01	1.00e-15	6.01e+00
3.00e+04	4.35e+01	8.55e-01	2.30e+00	3.69e+02	1.35e+02	1.11e+03	2.19e+02	6.10e-01	1.00e-15	5.62e+00
3.08e+04	3.96e+01	8.64e-01	2.25e+00	3.30e+02	1.35e+02	1.14e+03	2.24e+02	6.30e-01	1.00e-15	5.24e+00
3.15e+04	3.61e+01	8.72e-01	2.20e+00	2.96e+02	1.36e+02	1.17e+03	2.29e+02	6.51e-01	1.00e-15	4.88e+00
3.23e+04	3.29e+01	8.77e-01	2.15e+00	2.68e+02	1.36e+02	1.20e+03	2.33e+02	6.73e-01	1.00e-15	4.54e+00
3.30e+04	3.01e+01	7.86e-01	2.11e+00	2.43e+02	1.37e+02	1.23e+03	2.38e+02	6.95e-01	1.00e-15	4.22e+00
3.38e+04	2.76e+01	6.37e-01	2.07e+00	2.21e+02	1.38e+02	1.26e+03	2.43e+02	7.19e-01	1.00e-15	3.91e+00
3.47e+04	2.53e+01	5.18e-01	2.03e+00	2.03e+02	1.40e+02	1.28e+03	2.47e+02	7.55e-01	1.00e-15	3.62e+00
3.55e+04	2.33e+01	4.26e-01	1.99e+00	1.87e+02	1.41e+02	1.30e+03	2.51e+02	8.59e-01	1.00e-15	3.34e+00
3.63e+04	2.15e+01	3.56e-01	1.95e+00	1.73e+02	1.43e+02	1.33e+03	2.56e+02	1.28e+00	1.00e-15	3.10e+00
3.72e+04	1.99e+01	3.02e-01	1.91e+00	1.62e+02	1.45e+02	1.35e+03	2.60e+02	2.84e+00	1.00e-15	4.50e+00
3.81e+04	1.85e+01	2.61e-01	1.87e+00	1.52e+02	1.48e+02	1.37e+03	2.64e+02	7.60e+00	1.00e-15	3.53e+01
3.90e+04	1.72e+01	2.30e-01	1.84e+00	1.43e+02	1.52e+02	1.39e+03	2.68e+02	1.94e+01	1.00e-15	1.64e+02
4.00e+04	1.61e+01	2.07e-01	1.81e+00	1.36e+02	1.56e+02	1.41e+03	2.71e+02	4.44e+01	1.00e-15	2.90e+02

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

4.09e+04	1.52e+01	1.89e-01	1.78e+00	1.30e+02	1.61e+02	1.42e+03	2.75e+02	8.68e+01	1.00e-15	3.29e+02
4.19e+04	1.43e+01	1.76e-01	1.75e+00	1.24e+02	1.66e+02	1.44e+03	2.78e+02	1.48e+02	1.00e-15	3.45e+02
4.29e+04	1.36e+01	1.65e-01	1.73e+00	1.20e+02	1.73e+02	1.45e+03	2.82e+02	2.25e+02	1.00e-15	3.62e+02
4.39e+04	1.29e+01	1.58e-01	1.70e+00	1.16e+02	1.80e+02	1.46e+03	2.85e+02	3.10e+02	1.00e-15	3.84e+02
4.50e+04	1.23e+01	1.52e-01	1.67e+00	1.09e+02	1.88e+02	1.47e+03	2.88e+02	3.96e+02	1.00e-15	4.10e+02
4.61e+04	1.18e+01	1.47e-01	1.65e+00	1.01e+02	1.96e+02	1.48e+03	2.91e+02	4.76e+02	1.00e-15	4.41e+02
4.72e+04	1.13e+01	1.43e-01	1.63e+00	9.64e+01	2.06e+02	1.49e+03	2.93e+02	5.52e+02	1.00e-15	4.76e+02
4.83e+04	1.09e+01	1.40e-01	1.61e+00	9.35e+01	2.16e+02	1.50e+03	2.96e+02	6.25e+02	1.00e-15	5.17e+02
4.95e+04	1.06e+01	1.38e-01	1.59e+00	8.33e+01	2.26e+02	1.51e+03	2.98e+02	6.97e+02	1.00e-15	5.62e+02
5.06e+04	1.03e+01	1.36e-01	1.57e+00	6.54e+01	2.36e+02	1.51e+03	3.00e+02	7.71e+02	1.00e-15	6.13e+02
5.18e+04	1.00e+01	1.34e-01	1.55e+00	4.89e+01	2.47e+02	1.52e+03	3.03e+02	1.94e+04	1.42e-01	6.67e+02
5.31e+04	9.75e+00	1.32e-01	1.53e+00	3.64e+01	2.57e+02	1.53e+03	3.05e+02	4.42e+04	4.32e+02	7.26e+02
5.43e+04	9.53e+00	1.31e-01	1.51e+00	2.69e+01	2.67e+02	1.53e+03	3.07e+02	3.94e+04	7.62e+02	7.88e+02
5.56e+04	9.33e+00	1.29e-01	1.49e+00	1.97e+01	2.76e+02	1.54e+03	3.08e+02	3.74e+04	1.13e+03	8.52e+02
5.70e+04	9.15e+00	1.28e-01	1.47e+00	1.44e+01	2.84e+02	4.04e+04	3.10e+02	3.65e+04	3.96e+03	9.18e+02
5.83e+04	8.99e+00	1.27e-01	1.45e+00	1.05e+01	2.91e+02	6.94e+04	3.11e+02	3.66e+04	6.59e+03	9.84e+02
5.97e+04	8.84e+00	1.25e-01	1.43e+00	7.64e+00	2.98e+02	1.02e+05	3.13e+02	3.76e+04	8.56e+03	1.05e+03
6.11e+04	8.70e+00	1.24e-01	1.42e+00	5.55e+00	3.04e+02	1.38e+05	3.14e+02	3.87e+04	1.00e+04	1.11e+03
6.26e+04	8.57e+00	1.23e-01	1.40e+00	4.04e+00	3.08e+02	1.69e+05	3.14e+02	3.91e+04	1.10e+04	1.17e+03
6.41e+04	8.45e+00	1.22e-01	1.39e+00	2.96e+00	3.13e+02	1.96e+05	3.14e+02	3.90e+04	1.17e+04	1.22e+03
6.56e+04	8.34e+00	1.21e-01	1.37e+00	6.38e+03	3.16e+02	2.18e+05	3.14e+02	3.85e+04	1.22e+04	1.27e+03
6.72e+04	8.23e+00	1.20e-01	1.36e+00	9.38e+03	3.19e+02	2.36e+05	3.13e+02	3.01e+04	1.24e+04	1.30e+03
6.87e+04	8.15e+00	1.19e-01	1.34e+00	1.14e+04	3.21e+02	2.49e+05	3.11e+02	1.75e+04	1.25e+04	1.34e+03
7.04e+04	8.08e+00	5.90e+01	1.33e+00	3.12e+04	3.23e+02	2.58e+05	3.08e+02	1.06e+04	1.25e+04	1.36e+03
7.21e+04	8.02e+00	1.62e+02	1.31e+00	5.05e+04	3.24e+02	2.63e+05	3.03e+02	8.08e+03	1.24e+04	1.38e+03
7.38e+04	7.98e+00	2.16e+02	1.30e+00	6.33e+04	3.25e+02	2.63e+05	2.97e+02	6.80e+03	1.21e+04	1.39e+03
7.55e+04	7.95e+00	2.39e+02	1.29e+00	7.16e+04	3.26e+02	2.59e+05	2.90e+02	5.49e+03	1.18e+04	1.40e+03
7.73e+04	7.93e+00	2.46e+02	1.64e+00	7.67e+04	3.26e+02	2.52e+05	2.81e+02	4.15e+03	1.15e+04	1.41e+03
7.91e+04	8.36e-07	1.35e-05	1.65e-04	1.73e-02	2.09e-05	1.96e-02	2.24e-05	1.77e-04	1.21e-03	9.84e-05

Scientific Notebook #170-10e
James Weldy
12/27/00
20-1402-762

8.10e+04	8.37e-07	1.31e-05	2.57e-04	1.76e-02	2.07e-05	1.74e-02	8.72e-05	1.44e-04	1.15e-03	9.85e-05
8.29e+04	8.39e-07	1.25e-05	2.70e-04	1.77e-02	1.99e-05	1.53e-02	3.17e-04	1.30e-04	1.10e-03	9.86e-05
8.49e+04	8.43e-07	1.16e-05	2.70e-04	1.77e-02	1.85e-05	1.35e-02	5.40e-04	1.25e-04	1.04e-03	9.86e-05
8.69e+04	8.48e-07	1.05e-05	2.63e-04	1.76e-02	1.69e-05	1.20e-02	7.52e-04	1.27e-04	9.80e-04	9.93e-05
8.90e+04	8.54e-07	9.54e-06	2.54e-04	1.73e-02	1.55e-05	1.06e-02	9.44e-04	2.35e-04	9.23e-04	9.94e-05
9.11e+04	8.61e-07	8.67e-06	2.46e-04	1.69e-02	1.45e-05	9.33e-03	1.12e-03	1.12e-03	8.73e-04	9.94e-05
9.32e+04	8.68e-07	8.01e-06	2.48e-04	1.59e-02	1.36e-05	8.19e-03	1.27e-03	3.81e-03	8.32e-04	9.93e-05
9.54e+04	8.76e-07	7.60e-06	2.54e-04	1.46e-02	1.29e-05	7.21e-03	1.41e-03	7.31e-03	8.05e-04	9.91e-05
9.77e+04	8.84e-07	7.47e-06	2.69e-04	1.34e-02	1.24e-05	6.42e-03	1.55e-03	9.76e-03	7.99e-04	9.85e-05
1.00e+05	8.92e-07	7.54e-06	2.90e-04	1.26e-02	1.18e-05	5.84e-03	1.68e-03	1.09e-02	8.18e-04	9.73e-05
1.10e+05	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15	1.00e-15

The time of switch to pluvial conditions no longer jumps around. Therefore, the fix has been implemented successfully.

Scientific Notebook #170-10e
James Weldy
20-1402-761

Issued to: S. Mohanty

Issue Date: Apr. 3, 1996

Account Number: 20-01402-761

Title: Dose from Criticality

Participants: J. Weldy

1-10-01

An analysis was performed to assess the consequences of a criticality event on the repository system. Ignoring the probability of occurrence for now, the goal of this analysis is to determine what the consequences are if a criticality event does occur. Two separate analyses will be conducted to determine this effect. First, the consequences of a steady-state criticality will be determined. The consequences associated with a steady-state criticality include an increase in radionuclide inventory in the waste packages that go critical and an increase in the temperature inside and around the critical waste packages. Second, the consequences of a transient criticality will be calculated. To avoid having to perform detailed calculations involving exactly how much power is generated and how much damage will be done by the event, an extreme case will be evaluated. The consequences that will be assessed will be the mechanical damage to the fuel, surrounding waste packages, drip shield, and invert around the critical waste package.

1. Steady-State Criticality

The steady-state criticality event will be modeled as a 10,000 year steady-state criticality that starts at year 5000. It is assumed that all waste packages that are initially defective go critical (an average of about 32) and that all waste packages that go critical are under drips (otherwise they could not go critical). The changes to the reference input file and data files include the following:

<u>Changes to tpa.inp to model only the waste packages that go critical</u>

- Turn seismicity off to avoid failing any additional waste packages

- Reduce the value of AA_1_1 by 3 orders of magnitude to prevent any corrosion failures
- Reduce the value of CoefforLocCorrOfOuterOverpack to 2.5e-8 to prevent any corrosion failures
- Set the SubareaWetFraction to 1
- Set the time of failure of the initially defective waste packages to 5000 years
- Increase the gap fraction by the percent increase in radionuclide inventory to assume that all radionuclides created by the criticality event are created in the gap (conservative) to match DOE analyses. See Table 1 for the new gap inventories for each radionuclide.

Changes to the file burnup.dat to model a steady-state criticality

- Modify the values of heat generation to produce a heat increase of about 25 degrees C between the years 5000 and 15000. The 25 degree C increase in temperature is taken from calculations performed by the DOE in the Disposal Criticality Topical Report (U.S. Department of Energy, 1998). Specifically, change the heat generation rate at year 5000 to 56.54 W/MTIHM for BWR fuel and 64.1 W/MTHM for PWR fuel. Change the heat generation rate at year 10000 to 35.52 W/MTIHM for BWR fuel and 46.27 W/MTIHM for PWR fuel. Add a line in the file for year 15000 and set the heat generation rate to 25.00 W/MTIHM for BWR fuel and 28.00 W/MTIHM for PWR fuel.

Changes to the file wpflow.dat to model a steady-state criticality

- Reduce the value of Fmult to 0 between t=7000 years and t=15000 years. While the criticality event is occurring, all of the water that enters the waste package will be evaporated, so there will be no release from the waste package. The value is set to 0 at 7000 years instead of 5000 years to allow the waste package to fill up so releases will occur immediately after the event ends. This will result in some small releases at early times when SFWettedFraction_2 is sampled as a low value, but the releases will be minor and will not significantly affect the results.

Changes to the file nuclides.dat to model a steady-state criticality

- The goal is to get an increase in inventory at 15000 years that matches the 10,000 year criticality inventory increase in Table C-16 of the Topical Report for all TPA nuclides. For all radionuclides that are not daughter

products in a chain decay series, this just means that the inventory at 10 years is increased by that same percentage. Chain nuclides need to consider effects of parent decay on inventory. If the inventory from the parent decay dominates the amount of radionuclide present at 15,000 years, only the inventory of the parent needs to be increased by the appropriate percentage. If the inventory of the daughter dominates, only the inventory of the daughter needs to be increased. If the contribution of the parent and daughter are comparable, changes to inventory will have to be divided between the two. Since ^{129}I and ^{99}Tc both increase in inventory by 4.1% after a 10,000 year criticality, it is assumed that all fission products/activation products increases by this same percentage. To be conservative, assume that actinide that are not listed in the Table increase by 4.1% as well.

Radionuclide	15000 year inventory dominated by:	Base Inventory (Ci/MTU)	% Increase	Post-Criticality Inventory (Ci/MTU)
Cm-246	self	7.62e-2	4.1	7.93e-2
U-238	self	0.316	No change - decreases with burnup (conservative)	0.316
Cm-245	self	0.366	2.1	0.374
Am-241	parent (Cm-245)	No change	No change	No change
Np-237	parent (Am-241)	No change	No change	No change
Am-243	self	26.4	4.1	27.5

Pu-239	self	369	4.1	384
Pu-240	self	544	4.1	566
U-234	50% self, 50% Pu-238	1.18	No change - increase Pu-238 inventory by 25%	1.18
Th-230	parent (U-234)	No change	No change	No change
Ra-226	parent (Th-230)	No change	No change	No change
Pb-210	parent (Ra-226)	No change	No change	No change
Cs-135	self	0.536	4.1	0.558
I-129	self	3.57e-2	4.1	3.72e-2
Tc-99	self	14.5	4.1	15.1
Ni-59	self	2.44	4.1	2.54
C-14	self	1.44	4.1	1.50
Se-79	self	0.458	4.1	0.477
Nb-94	self	0.848	4.1	0.883
Cl-36	self	1.15e-2	4.1	1.2e-2

2. Transient Criticality

The transient criticality will be modeled as an extreme event in which the fuel maintains its geometry and sufficient water remains in the waste package to generate a very large pressure pulse. This pressure pulse is assumed to be sufficient to very quickly degrade the spent fuel inside of the waste package, cause serious damage to the waste package such that the water contact model is a flow-through model, fail one waste package on either side of the

critical waste package, and blast a hole in the invert material below the waste packages such that the performance of the invert is bypassed. The drip shield above the waste package would also be failed by the blast, but would have to already be failed for the waste package to accumulate water and go critical. The total number of fissions will be limited enough that changes in radionuclide inventory or long-term heat generation can be ignored.

The calculation requires two runs of the TPA code to perform the modeling - one for the waste package in which the transient criticality occurs and one for the two additional waste packages that are failed by the transient criticality. The results of the analysis can be added together along with the base case dose to compare the results to the base case.

<u>Changes to tpa.inp to model the waste package in which the criticality event occurs:</u>

- Reduce AA_1_1 and CoefForLocCorrOfOuterOverpack by 3 orders of magnitude to ensure that there are no corrosion failures
- Turn off seismicity to ensure that there are no seismic failures
- Set the SubareaWetFraction to 1 because the waste package has to be located under a drip to go critical
- Set the failure time of the initially defective waste packages to 5000 years. This time is simply an assumption, but is set considering that it will take a long period of time to fail the drip shield and fill up the waste package with water
- Set the defective fraction of waste packages to 4.3e-4 to ensure that only 1 waste package is failed initially (located in Subarea 2)
- Set the Invert Bypass Option to 1, which causes the code to bypass the invert and not take any credit for the performance of the invert
- Set the waste package failure type for initially defective waste packages to a flow-through model, since it is assumed that substantial damage is done to the waste package
- Change the fuel dissolution model (IModel) to model 3 (User-specified Leach Rate)
- Increase the User Specified Leach Rate by 4 orders of magnitude to ensure that all the fuel fully degrades within one TPA Code time step

<u>Changes to tpa.inp to model the two waste packages next to the waste package in which the criticality occurs:</u>

- Reduce AA_1_1 and CoefForLocCorrOfOuterOverpack by 3 orders of

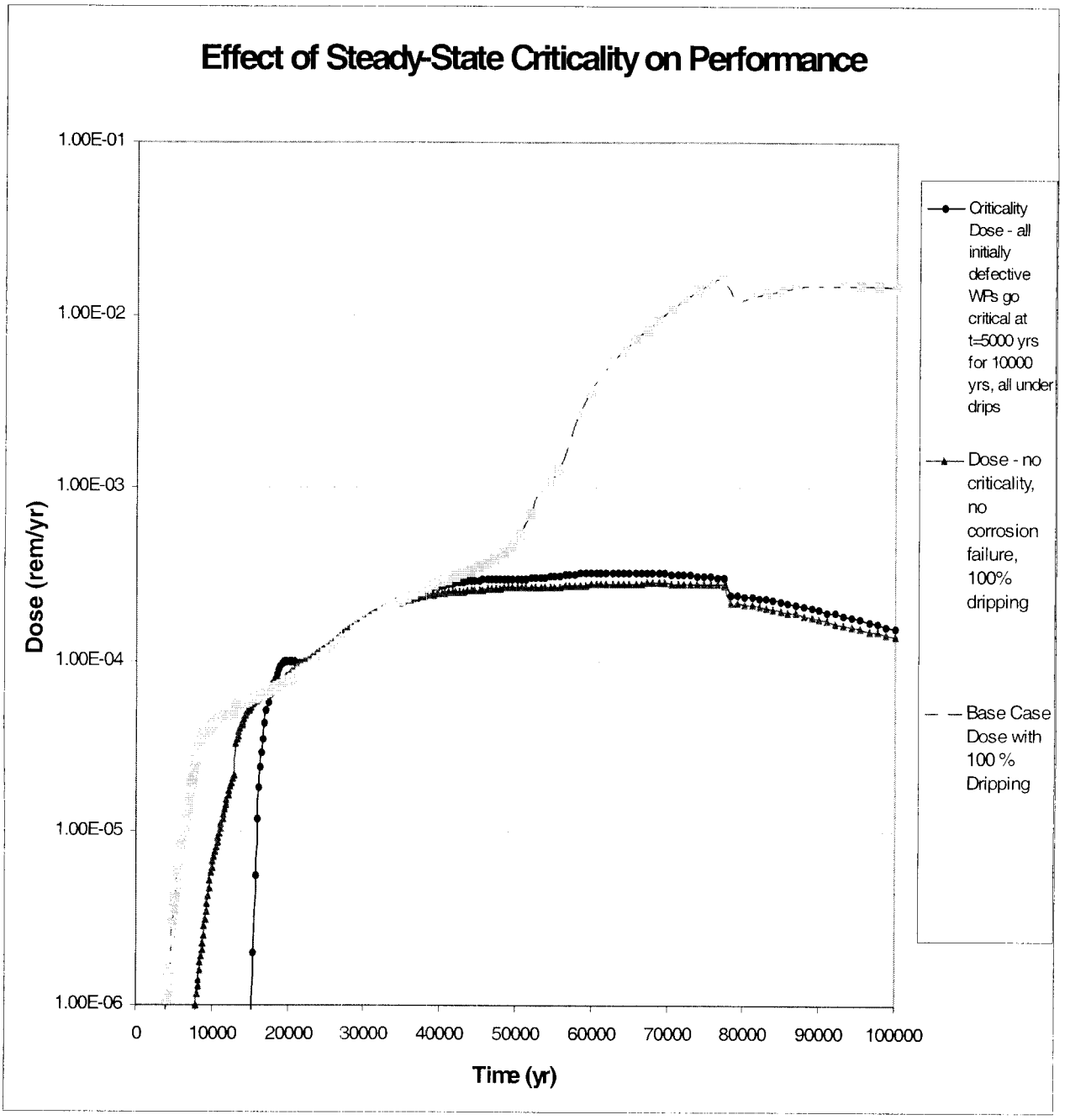
magnitude to ensure that there are no corrosion failures

- Turn off seismicity to ensure that there are no seismic failures
- Set the failure time of the initially defective waste packages to 5000 years.
- Set the defective fraction of waste packages to 4.5e-4 to ensure that only 2 waste packages are failed initially (one located in Subarea 2 and one located in Subarea 1)
- Set the Invert Bypass Option to 1, which causes the code to bypass the invert and not take any credit for the performance of the invert

Results

Scientific Notebook #170-10e
James Weldy
20-1402-761

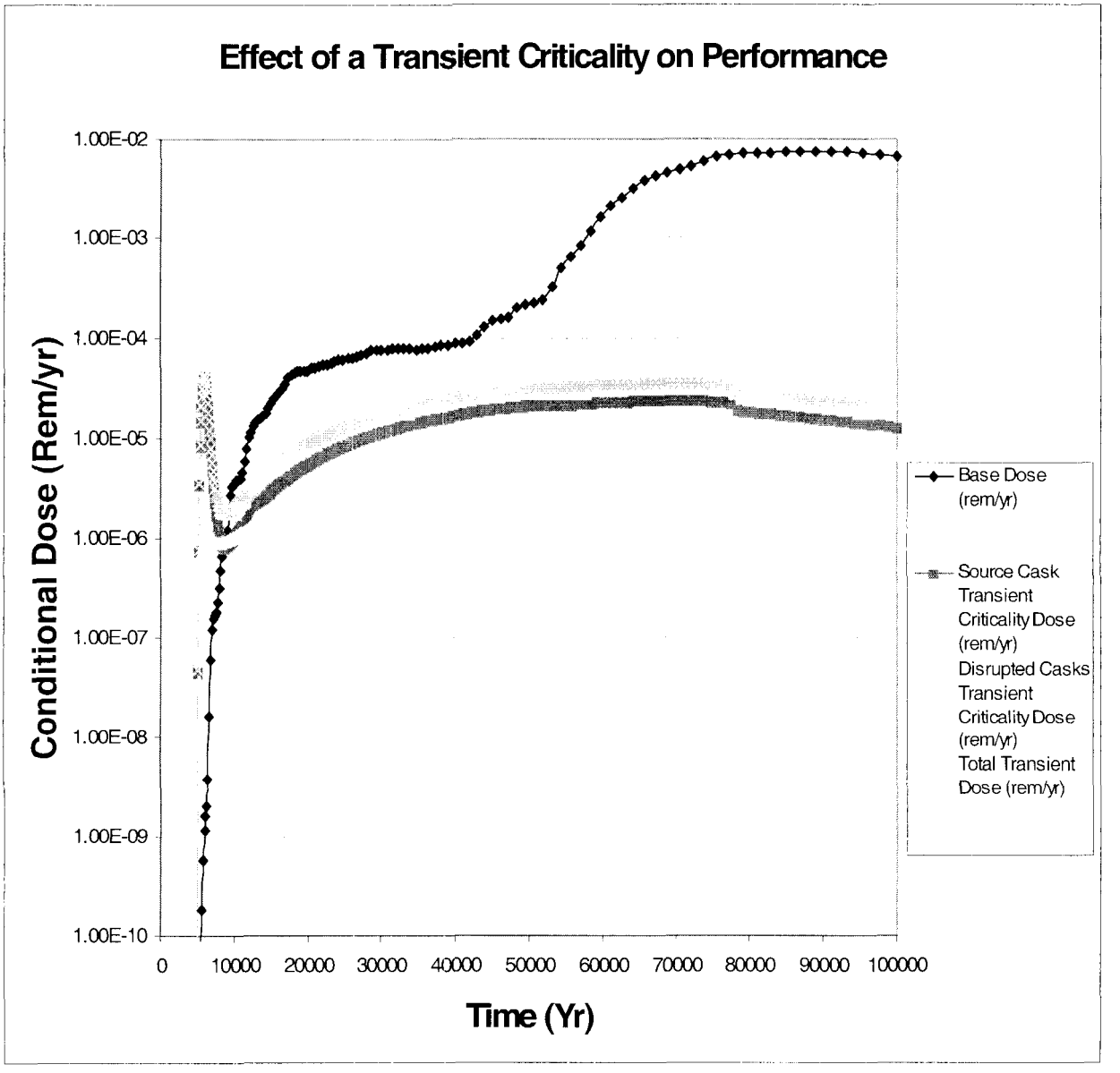
- Steady state criticality



Scientific Notebook #170-10e
James Weldy
20-1402-761

- Transient Criticality

It appears that even without the probability of occurrence factored into the results,



the effects of a steady-state criticality are relatively minor on the overall performance of the repository. Transient criticality effects are larger

immediately after the event, primarily due to the assumption that the fuel is destroyed by the event, and causes the dose to increase by a couple orders of magnitude. However, incorporating the probability of occurrence of a transient criticality into the results would likely cause the consequences of transient criticality to have little effect on the expected annual dose, especially considering that the base dose here does not include the volcanism scenario, which dominates the risk from the repository over the first 10,000 years.

INITIALS JRW

state criticality are relatively minor on the overall performance of the repository. Transient criticality effects are larger immediately after the event, primarily due to the assumption that the fuel is destroyed by the event, and causes the dose to increase by a couple orders of magnitude. However, incorporating the probability of occurrence of a transient criticality into the results would likely cause the consequences of transient criticality to have little effect on the expected annual dose, especially considering that the base dose here does not include the volcanism scenario, which dominates the risk from the repository over the first 10,000 years.

255 JRW 12-2-05

Entries into Scientific Notebook #170 for pages 242 - ~~254~~ have been made by James Weldy.

No original text entered into this Scientific Notebook has been removed.

James R. Weldy date 7-9-01

~~254~~ 255-A JRW 12-2-05

Scientific Notebook #170-10e
James Weldy
20-1402-761
Issued to: S. Mohanty

Issue Date: Apr. 3, 1996

Account Number: 20-01402-761

Title: Dose from Criticality

Participants: J. Weldy

4-10-01

An analysis was performed to assess the consequences of a criticality event on the repository system. Ignoring the probability of occurrence for now, the goal of this analysis is to determine what the consequences are if a criticality event does occur. Two separate analyses will be conducted to determine this effect. First, the consequences of a steady-state criticality will be determined. The consequences associated with a steady-state criticality include an increase in radionuclide inventory in the waste packages that go critical and an increase in the temperature inside and around the critical waste packages. Second, the consequences of a transient criticality will be calculated. To avoid having to perform detailed calculations involving exactly how much power is generated and how much damage will be done by the event, an extreme case will be evaluated. The consequences that will be assessed will be the mechanical damage to the fuel, surrounding waste packages, drip shield, and invert around the critical waste package. This is a revised calculation from the previously documented one, which has been modified to explicitly calculate the sustainable power level and inventory increase instead of relying on DOE numbers.

1. Steady-State Criticality

From the TPA 4.1 User's Guide (Mohanty, et al., 2000) and Sonntag and van Wylen (1991), the power level in the waste package can be calculated by:

$$ {}_1Q_2 = {}_1W_2 + \dot{m}(h_2 - h_1) + P_{atm}(v_2 - v_1) \quad (1) $$

Neglect the volume change as it will be negligible compared to the other factors.

Scientific Notebook #170-10e
James Weldy
20-1402-761

From the TPA 4.1 User's Guide (Mohanty, et al., 2000), the heat loss can be calculated by:

$$ {}_1W_2 = (G_{cond} + G_{conv} + G_{rad})(T_{wp} - T_{rock}) \quad (2) $$

The effective heat transfer coefficients can be calculated from the following formulae also in the TPA User's Guide:

$$ G_{conv} = f_c \frac{2\pi k_{eff-nc}(L_{wp} + 2\delta)}{\ln(\frac{D_{rw}}{D_{wp}})} \quad (3) $$

where,

f_c	=	fractional area not covered by the floor = 0.75 (Mohanty, et al., 2000)
$k_{effi-nc}$	=	effective thermal conductivity for natural convection = 0.9 W/m-C (Mohanty, et al., 2000)
D_{rw}	=	Diameter of drift = 5.5 m (TSPA-SR)
D_{wp}	=	Diameter of waste package = 1.579 m (TSPA-SR)
L_{wp}	=	Length of waste package = 5.275 m (TSPA-SR)
δ	=	Spacing between waste package = 0.1 m (TSPA-SR)

$$ G_{cond} = (1 - f_c) \frac{2\pi k_{floor}(L_{wp} + 2\delta)}{\ln(\frac{D_{rw}}{D_{wp}})} $$

(4)

where,

f_c = fractional area not covered by the floor = 0.75 (Mohanty, et al., 2000)

k_{floor} = thermal conductivity of floor = 0.6 W/m-C (Incropera and DeWitt, 1995)

$$G_{rad} = f_c \frac{4\sigma(273.15 + T_{rock})^3}{\frac{1-\varepsilon_{wp}}{\varepsilon_{wp}\pi D_{wp} L_{wp}} + \frac{1}{F_{wp-rw}\pi D_{wp}(L_{wp} + 2\delta)} + \frac{1-\varepsilon_{rw}}{\varepsilon_{rw}\pi D_{rw}(L_{wp} + 2\delta)}} \quad (5)$$

where,

σ = Stefan-Boltzman constant = 5.67e-8 W/m^2K^4 (Mohanty, et al., 2000)

ε_{wp} = emissivity of the waste package = 0.87 (Mohanty, et al., 2000)

F_{wp-rw} =radiative view factor from the WP to the rock wall = 1 (Mohanty, et al., 2000)

T_{rock} = Temperature of the rock (C)

Use a rock wall temperature at t=5000 years of 70 C from TPA results and an increase in the temperature of the waste package due to the criticality of 30 C from DOE calcs (DOE, 1998 - Disposal Criticality Topical Report). A reasonably conservative value for the flow rate of water into the waste package is 0.1 m3/yr (TSPA-SR, TPA code results). Obtain enthalpy values for 70 C water and 100 C steam from Sonntag and van Wylen (1991), Table A.1.2SI. This results in the calculation of a power level of 4.78 kW.

Use this power level in ORIGEN2 calculations for 10,000 years to calculate the inventory generation for this event (note that the ORIGEN2 calculations do not currently account for differences

in moderator density or temperatures between a reactor and a waste package at this time, which could have a moderate effect on the results). The input and output files for the ORIGEN2 calculations are p3.040repb and p3.040repbo.

The steady-state criticality event will be modeled as a 10,000 year steady-state criticality that starts at year 5000. It is assumed that all waste packages that are initially defective go critical (an average of about 32) and that all waste packages that go critical are under drips (otherwise they could not go critical). The changes to the reference input file and data files include the following:

Changes to tpa.inp to model only the waste packages that go critical

- Turn seismicity off to avoid failing any additional waste packages
- Reduce the value of AA_1_1 by 3 orders of magnitude to prevent any corrosion failures
- Reduce the value of CoefforLocCorrOfOuterOverpack to 2.5e-8 to prevent any corrosion failures
- Set the SubareaWetFraction to 1
- Set the time of failure of the initially defective waste packages to 5000 years
- Increase the gap fraction by the percent increase in radionuclide inventory to assume that all radionuclides created by the criticality event are created in the gap (conservative) to match DOE analyses.

Changes to the file burnup.dat to model a steady-state criticality

- Modify the values of heat generation to produce a heat increase of about 25 degrees C between the years 5000 and 15000. The 25 degree C increase in temperature is taken from calculations performed by the DOE in the Disposal Criticality Topical Report (U.S. Department of Energy, 1998). Specifically, change the heat generation rate at year 5000 to 56.54 W/MTIHM for BWR fuel and 64.1 W/MTHM for PWR fuel. Change the heat generation rate at year 10000 to 35.52 W/MTIHM for BWR fuel and 46.27 W/MTIHM for PWR fuel. Add a line in the file for year 15000 and set the heat generation rate to 25.00 W/MTIHM for BWR fuel and 28.00 W/MTIHM for PWR fuel.

Changes to the file wpflow.dat to model a steady-state criticality

- Reduce the value of Fmult to 0 between t=7000 years and t=15000 years. While the criticality event is occurring, all of the water that enters the waste package will be evaporated, so there will be no release from the waste package. The value is set to 0 at 7000 years instead of 5000 years to allow the waste package to fill up so releases will occur immediately after the event ends. This will result in some small releases at early times when

SFWettedFraction_2 is sampled as a low value, but the releases will be minor and will not significantly affect the results.

Changes to the file nuclides.dat to model a steady-state criticality

- The goal is to get an increase in inventory at 15000 years that matches the 10,000 year criticality inventory increase calculated using ORIGEN2.1 for all TPA nuclides. For all radionuclides that are not daughter products in a chain decay series, this just means that the inventory at 10 years is increased by that same percentage. Chain nuclides need to consider effects of parent decay on inventory. If the inventory from the parent decay dominates the amount of radionuclide present at 15,000 years, only the inventory of the parent needs to be increased by the appropriate percentage. If the inventory of the daughter dominates, only the inventory of the daughter needs to be increased. If the contribution of the parent and daughter are comparable, changes to inventory will have to be divided between the two.

Radionuclide	15000 year inventory dominated by:	Base Inventory (Ci/MTU)	% Increase	Post-Criticality Inventory (Ci/MTU)
Cm-246	self	7.62e-2	374	0.361
U-238	self	0.315	-1.1	0.3115
Cm-245	self	0.366	Leave same - not important to performance.	No change
Am-241	parent (Cm-245)	2080	**Leave same - not important to performance.**	**No change**

Np-237	parent (Am-241)	**0.434**	**71 - 1.65 Ci/MTU from parents, need to increase initial inventory to raise to 2.823 Ci/MTU at 15000 years**	**1.173**
Am-243	self	26.4	313.7	109.2
Pu-239	self	369	28.8	475.4
Pu-240	self	544	160.2	1415
U-234	50% self, 50% Pu-238	**1.18**	**251 - 2.636 Ci/MTU from parents, need to increase initial inventory to raise to 9.267 Ci/MTU at 15000 years**	**6.63**

Th-230	parent (U-234)	**No change**	**No change**	**No change - inventory will be wrong due to U-234 change. Model separately if necessary.**
Ra-226	parent (Th-230)	**No change**	**No change**	**No change - inventory will be wrong due to U-234 change. Model separately if necessary.**
Pb-210	parent (Ra-226)	**No change**	**No change**	**No change - inventory will be wrong due to U-234 change. Model separately if necessary.**
Cs-135	self	0.536	87.4	1.00

I-129	self	3.57e-2	22.1	4.36e-2
Tc-99	self	14.5	11.5	16.2
Ni-59	self	2.44	45	3.54
C-14	self	1.44	310.3	5.91
Se-79	self	0.458	11.2	0.509 (corrected to 0.03 due to half-life change)
Nb-94	self	0.848	65.1	1.4
Cl-36	self	1.15e-2	31.5	1.47e-2

2. Transient Criticality

The transient criticality will be modeled as an extreme event in which the fuel maintains its geometry and sufficient water remains in the waste package to generate a very large pressure pulse. This pressure pulse is assumed to be sufficient to very quickly degrade the spent fuel inside of the waste package, cause serious damage to the waste package such that the water contact model is a flow-through model, fail one waste package on either side of the critical waste package, and blast a hole in the invert material below the waste packages such that the performance of the invert is bypassed. The drip shield above the waste package would also be failed by the blast, but would have to already be failed for the waste package to accumulate water and go critical. The total number of fissions will be limited enough that changes in radionuclide inventory or long-term heat generation can be ignored.

The calculation requires two runs of the TPA code to perform the modeling - one for the waste package in which the transient criticality occurs and one for the two additional waste packages that are failed by the transient criticality. The results of the analysis can be added together along with the base case dose to compare the results to the base case.

<u>Changes to tpa.inp to model the waste package in which the criticality event occurs:</u>

- Reduce AA_1_1 and CoefForLocCorrOfOuterOverpack by 3 orders of magnitude to ensure that there are no corrosion failures
- Turn off seismicity to ensure that there are no seismic failures

Scientific Notebook #170-10e
James Weldy
20-1402-761

- Set the SubareaWetFraction to 1 because the waste package has to be located under a drip to go critical
- Set the failure time of the initially defective waste packages to 5000 years. This time is simply an assumption, but is set considering that it will take a long period of time to fail the drip shield and fill up the waste package with water
- Set the defective fraction of waste packages to 4.3e-4 to ensure that only 1 waste package is failed initially (located in Subarea 2)
- Set the Invert Bypass Option to 1, which causes the code to bypass the invert and not take any credit for the performance of the invert
- Set the waste package failure type for initially defective waste packages to a flow-through model, since it is assumed that substantial damage is done to the waste package
- Change the fuel dissolution model (IModel) to model 3 (User-specified Leach Rate)
- Increase the User Specified Leach Rate by 4 orders of magnitude to ensure that all the fuel fully degrades within one TPA Code time step

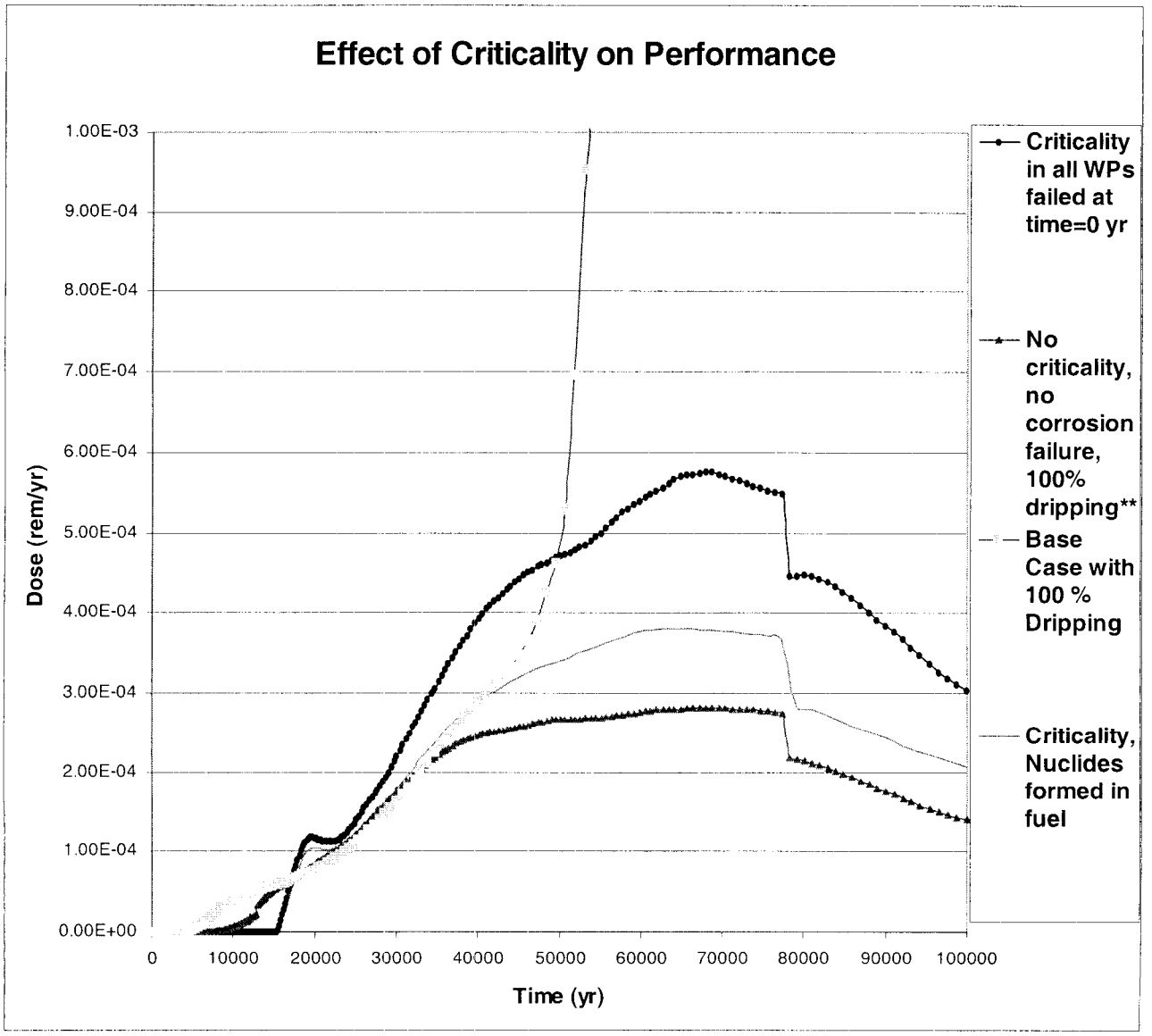
<u>Changes to tpa.inp to model the two waste packages next to the waste package in which the criticality occurs:</u>

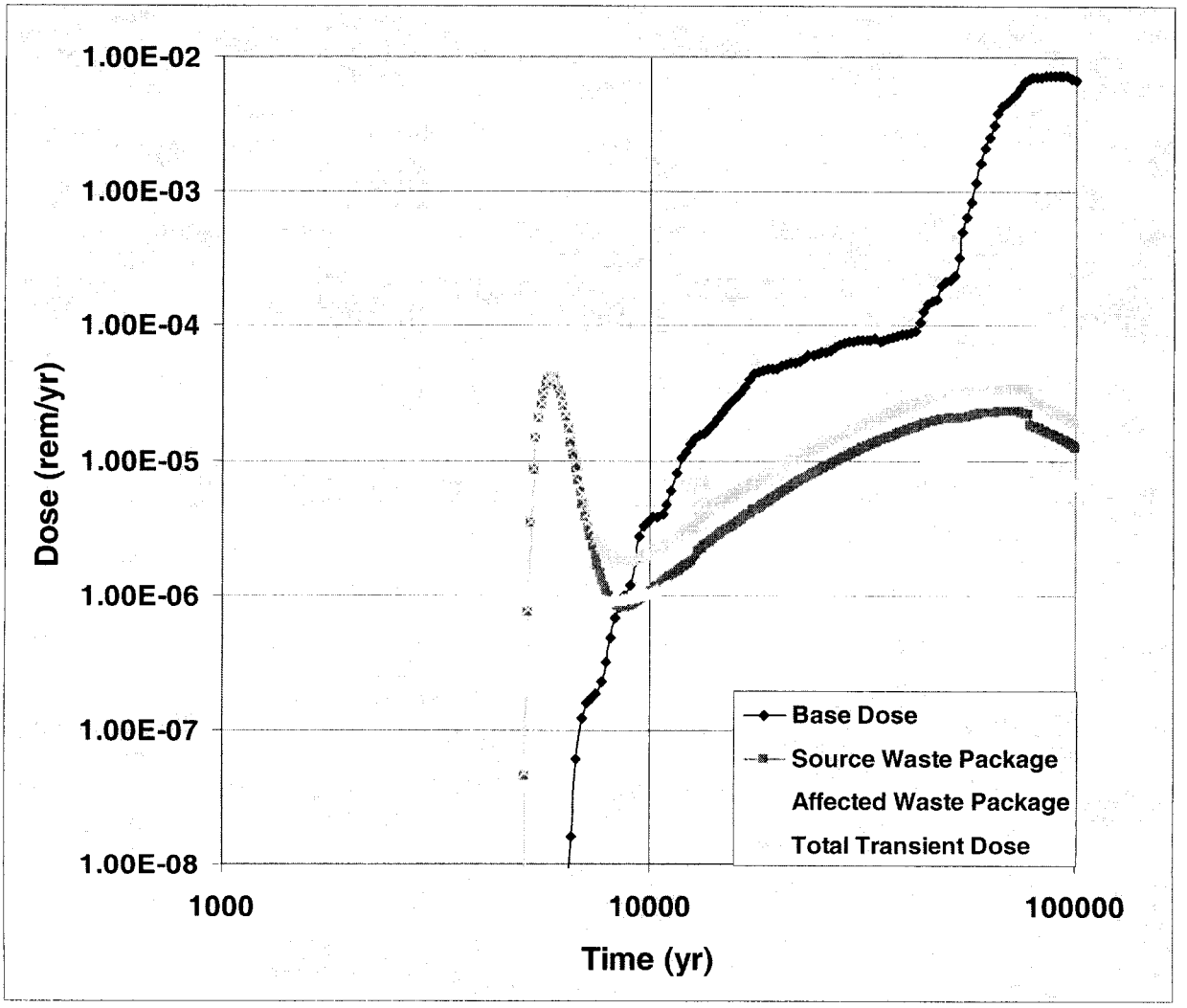
- Reduce AA_1_1 and CoefForLocCorrOfOuterOverpack by 3 orders of magnitude to ensure that there are no corrosion failures
- Turn off seismicity to ensure that there are no seismic failures
- Set the failure time of the initially defective waste packages to 5000 years.
- Set the defective fraction of waste packages to 4.5e-4 to ensure that only 2 waste packages are failed initially (one located in Subarea 2 and one located in Subarea 1)
- Set the Invert Bypass Option to 1, which causes the code to bypass the invert and not take any credit for the performance of the invert

Results

Scientific Notebook #170-10e
James Weldy
20-1402-761

- Steady state criticality





- Transient criticality

It appears that even without the probability of occurrence factored into the results, the effects of a steady-state criticality are relatively minor on the overall performance of the repository. Transient criticality effects are larger immediately after the event, primarily due to the assumption that the fuel is destroyed by the event, and causes the dose to increase by a couple orders of magnitude. However, incorporating the probability of occurrence of a transient

criticality into the results would likely cause the consequences of transient criticality to have little effect on the expected annual dose, especially considering that the base dose here does not include the volcanism scenario, which dominates the risk from the repository over the first 10,000 years.

Scientific Notebook 170-10e
James Weldy
20-1402-762

Scientific Notebook #170-10e

Issued to: S. Mohanty

Issue Date: Apr. 3, 1996

Account Number: 20-01402-762

Title: Dose from Swamp Coolers

Participants: J. Weldy, O. Povetko

7/18/01 Calculation of Dose from Swamp Coolers

Reason: The External Review of the TPA code identified a concern that dose from the use of evaporative coolers by members of the receptor group in Amargosa Valley could lead to significant dose.

Software used: MCNP version 4A Radiation Shielding and Transport Code

Procedure: There are two potential exposure pathways that the use of evaporative coolers could contribute to. First, the radionuclides may collect on the pad through which the water flows and evaporates during the lifetime of the pad and contribute to a direct exposure pathway. Second, as the radionuclides build up on the pad, some fraction of the material on the pad may 'flake-off' and be released to the air to contribute to an inhalation dose.

To calculate the dose from inhalation, the following data were used:

From the web site, http://www.bigofan.com/products.html the characteristics of a medium sized fan were determined - including an air flow rate of 5000 cubic feet per minute and a water tank size of 14 gallons. Assuming an average water use of 5 volumes of water tanks per day (which is confirmed by the results of a survey documented at: http://www.ci.phoenix.az.us/WATER/evapcool.html , allowed the daily volume of water used to be calculated. Based on the definition of a member of the critical group, it was assumed that the receptor is indoors for 55% of the day (Laplante and Poor, 1997). It was also assumed that the evaporative cooler was in use

JRW 12-2-09

for 7 months of the year (Cannon Center for Research, 1997). Inhalation Dose Conversion Factors for different radionuclides were taken from Federal Guidance Report 11 (Eckerman, 1988). Finally, it was assumed that 1% of the material that collected on the pad would flake-off and be available to contribute to the inhalation pathway. Based on this input data, the dose to a member of the critical group from the airborne pathways would be:

$$Dose = \frac{Concentration(pCi/L) \times Water\,Use(L/yr)}{Air\,Flow(m^3/yr)} \times Breathing\,Rate(m^3/yr) \times f_{indoors} \times f_{use} \times DCF(rem/pCi)$$

To calculate the dose from direct exposure, the following methodology was used. The water use was the same as above and it was assumed that the pads were replaced every 10 years. http://www.bigofan.com/products.html indicates that the high-quality pads will last much longer than regular pads, which generally are recommended to be replaced every year. Therefore, assume that these pads last 10 years. For simplicity, dose was only calculated in the 10th year, after radionuclides had built up to their maximum concentration. Further, it was assumed that while the receptor was located inside the house, they were always 2 m away from a roof-mounted evaporative cooler and that they were not exposed at all while inside. The shielding calculations were performed using MCNP-4A (Los Alamos National Laboratory, 1995), and included the roof and the steel walls of the cooler. The files used in the calculations are contained in the directory /project/mcnp/povetko/Evaporative_Cooler.

The sum of the external and the inhalation dose was compared to the current values of the DCFs from Laplante, et al. (1997) to determine whether this pathway would be a significant contributor to the overall dose from groundwater releases of radionuclides. The results of the calculation are summarized in the following tables:

~~205~~ 267
JRW 12-2-09

Scientific Notebook 170-10e
James Weldy
20-1402-762

Radionuclide	Inhalation DCF (rem/Ci)	Breathing Rate (m3/sec)	Large Fan - Quantity of water evaporated (L/day)	Medium Fan - Quantity of water evaporated (L/day)	Small Fan - Quantity of water evaporated (L/day)	Large Fan Air flow rate (L/day)	Medium Fan Air flow rate (L/day)	Small Fan Air flow rate (L/day)	Fraction of day exposed to fan	Fraction of year that evaporative cooling is used	Dose - Medium fan (rem/yr/pCi/L)
C 14	0.00E+00	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	0.00E+00
PD107	8.10E+02	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	3.55E-09
NI 59	1.32E+03	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.80E-09
C 14	2.09E+03	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	9.14E-09
NI 63	3.10E+03	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.36E-08
CS135	4.55E+03	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.99E-08
TC 99	8.33E+03	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	3.65E-08
SE 79	9.84E+03	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	4.31E-08
SN121M	1.15E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.04E-08
PD107	1.28E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.59E-08
CL 36	2.19E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	9.61E-08
MO 93	2.84E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.25E-07
SM151	3.00E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.31E-07
AG108M	3.01E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.32E-07
CS137	3.19E+04	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.40E-07

JRW 12-2-05

Scientific Notebook 170-10e
James Weldy
20-1402-762

I129	1.74E+05	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	7.60E-07
AG108M	2.83E+05	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.24E-06
ZR 93	3.21E+05	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.41E-06
NB 94	4.14E+05	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.82E-06
SR 90	1.30E+06	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.69E-06
PU241	8.25E+06	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	3.62E-05
RA226	8.58E+06	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	3.76E-05
PB210	1.36E+07	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.95E-05
U238	1.18E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.19E-04
U235	1.23E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.38E-04
U236	1.25E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.50E-04
U234	1.32E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.80E-04
U233	1.35E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.93E-04
CM244	2.48E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.09E-03
CM243	3.07E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.35E-03
TH230	3.26E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.43E-03
PU238	3.92E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.72E-03
PU242	4.11E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.80E-03
AM242M	4.26E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.86E-03
PU239	4.29E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.88E-03
PU240	4.29E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.88E-03
AM243	4.40E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.93E-03
AM241	4.44E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.95E-03
CM246	4.51E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.98E-03
CM245	4.55E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	1.99E-03
NP237	5.40E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	2.37E-03
U232	6.59E+08	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	2.89E-03
PA231	1.28E+09	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	5.63E-03
TH229	2.15E+09	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	9.40E-03
AC227	6.70E+09	3.33E-04	378.5	264.95	56.775	3.91E+08	2.04E+08	8.97E+07	0.55	0.58333	2.93E-02

~~207~~ 270 JRW 12-2-05

Scientific Notebook 170-10e
James Weldy
20-1402-762

Radionuclide	Dose - Dose Medium fan (rem/yr/pCi/L)	Direct Current Exposure (rem/yr/pCi/L)	DCF (rem/yr/pCi/L)	Evaporative Cooler Dose/Current DCF
TC 99	3.65E-08	5.82E-11	4.80E-06	8.81E-05
I129	7.60E-07	1.30E-07	1.30E-03	1.06E-04
NB 94	1.82E-06	1.07E-04	6.60E-05	6.19E-01
NP237	2.37E-03	1.21E-06	9.10E-03	2.73E-03

Results:

It appears that the additional pathway from the use of evaporative coolers would not significantly increase the dose from the radionuclides that are the most significant contributors to dose in the TPA code (Tc-99, I-129, and Np-237). Other radionuclides, such as Nb-94, with a more significant external exposure component could be affected more by the inclusion of the evaporative cooler pathway.

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← page turn when received for review JRW 11-09-05

1 ~~209~~ 272 JRW 12-2-05

Entries into Scientific Notebook #170 for pages ~~266~~ - ~~286~~ have been made by James Weldy.

No original text entered into this Scientific Notebook has been removed.

James L. Weldy date 10-1-01

I have reviewed this scientific notebook and find it in compliance with QAP-0.0-1
James Winterle
11-9-05

~~286~~ ~~209~~ 272 JRW 12-2-05