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USER'S MANUAL, VERSION 1.00 FOR MONTEBURNS, VERSION 3.01

by

David I. Poston and Holly R. Trelue

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User's Manual, Version 1.00

for

Monteburns, Version 3.01

June 16, 1998

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ABSTRACT

Monteburns is a fully automated tool that links the Monte Carlo transport code MCNP with the radioactive decay and burnup code ORIGEN2. *Monteburns* produces a large number of criticality and burnup results based on various material feed/removal specifications, power(s), and time intervals. The program processes input from the user that specifies the system geometry, initial material compositions, feed/removal specifications, and other code-specific parameters. Various results from MCNP, ORIGEN2, and other calculations are then output successively as the code runs. The principle function of *monteburns* is to transfer one-group cross section and flux values from MCNP to ORIGEN2, and then transfer the resulting material compositions (after irradiation and/or decay) from ORIGEN2 back to MCNP in a repeated, cyclic fashion. The basic requirement of the code is that the user have a working MCNP input file and other input parameters; all interaction with ORIGEN2 and other calculations are performed by *monteburns*.

This report serves as a user's manual for *monteburns*. It describes how the code functions, what input the user must provide, the calculations performed by the code, and it presents the format required for input files, as well as samples of these files. *Monteburns* is still in a developmental stage; thus, additions and/or changes may be made over time, and the user's manual will change as well. This is the first version of the user's manual (valid for *monteburns* version 3.01); users should contact the authors to inquire if a more recent version is available..

1.0 INTRODUCTION

As computational power continues to increase, it is becoming more practical to utilize Monte Carlo methods in performing burnup calculations. Currently, there is no Monte Carlo transport code widely available that computes burnup, therefore two existing codes must be linked. *Monteburns* was designed to link the Monte Carlo N-Particle Transport Code MCNP¹ and the radioactive decay and burnup code ORIGEN2². The primary function of MCNP is to calculate 1-group cross sections and fluxes that are used by ORIGEN2 in burnup calculations, and in some cases provide criticality and neutron economy information. After performing burnup calculations, ORIGEN2 then passes isotopic compositions of materials back to MCNP to begin another burnup cycle.

Monteburns is a UNIX c-shell script that executes MCNP, ORIGEN2, and the FORTRAN77 code *monteb.f*. *Monteburns* and *monteb.f* manipulate the input and output from MCNP and ORIGEN2 to form a completely automated burnup tool. The input to *monteburns* begins with a working MCNP input file (*monteburns* does not require a specific format for this MCNP file). Other input includes material feed and removal information, and other code-specific variables used to perform burnup calculations in ORIGEN2 concurrently with flux/cross section calculations in MCNP. Final results are reported as a combination of the output from the aforementioned codes. The name *monteburns* was chosen because it is a **Monte Carlo burnup** tool (although it is not a coincidence that Montgomery "Monte" Burns is the owner of a nuclear power plant on a popular television show).

1.1 Points of Contact

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¹ MCNP is a trademark of Los Alamos National Laboratory [Ref. 1] and available through the Radiation Safety Information Computational Center (RSICC) as code CCC-660.

² ORIGEN2 [Ref. 2] is a popular radioactive decay and buildup code produced by Oak Ridge National Laboratory and distributed by the Radiation Safety Information Computational Center (RSICC) as code CCC-371.

2.0 REQUIRED USER TRAINING AND/OR BACKGROUND

To run *monteburns*, a user currently **MUST** have:

- Access to a UNIX platform,
- Working versions of MCNP and ORIGEN2 and the corresponding cross section sets.
- A sufficient understanding of MCNP to create a **working** MCNP input file with desired parameters.
- The ability to compile and/or execute a FORTRAN77 program on the UNIX platform,
- The ability to execute a c-shell file on the UNIX platform.

3.0 DESCRIPTION OF MONTEBURNS

Monteburns is a UNIX c-shell command file that frequently interacts with a FORTRAN77 program, *monteb.f*. It is designed to link the Monte Carlo code MCNP with the radioactive decay and burnup code ORIGEN2. *Monteburns* produces a large number of criticality and burnup results based on various material feed/removal specifications, power(s), and time intervals. The program processes input from the user that specifies the system geometry, initial material compositions, feed/removal specifications, and other code-specific parameters. Various results from MCNP, ORIGEN2, and other calculations are then output successively as the code runs.

Monteburns performs one or more MCNP and ORIGEN2 runs for each user-specified time step. The number of MCNP/ORIGEN2 runs per time step is specified by the user (multiple runs per time step increases accuracy but significantly increases execution time). The user can also specify continuous or discrete (all at one time) material feed and/or removal at each time step. The results obtained from *monteburns* are more accurate if long irradiation periods are broken up into smaller lengths of time, because the physics and composition of materials in the system may change significantly per unit time. The user can specify that the time-steps be divided into even smaller segments for use in ORIGEN2. This is desirable because smaller time steps (especially at the beginning of a system's life) produce more accurate results than longer time steps in ORIGEN2. In addition, there is virtually no penalty on execution time by using smaller time steps in ORIGEN2 because almost all of the execution time lies with MCNP.

The user must generate two to four different input files before he/she executes *monteburns*. The two required input files he/she must generate are the MCNP input file (designated here by *** but can be any name up to 7 characters), and a general *monteburns* input file (this must have the same prefix *** with an extension of ".inp" for a name of ***.inp). For most burnup scenarios the user must also generate a feed input file, which contains detailed instructions for *monteburns* at each step (i.e. material feed/removal, power, time interval). The only case in which a feed input file is not required is for a constant power burn with no material feed or removal. Finally, one other input file is also used by *monteburns*, *mbxs.inp*, which is a cross section "map" for *monteburns*. A sample of this file is included with the *monteburns* source code package; this sample file can be modified as requirements dictate (see Section 5.4 for more information).

3.1 Description of Monteburns

The primary way in which MCNP and ORIGEN2 interact through *monteburns* is that MCNP provides 1-group microscopic cross sections to ORIGEN2 for burnup calculations. After ORIGEN2 and MCNP have been run, then results for each burn step are written into output files, and the isotopic compositions from ORIGEN2 are used to generate an MCNP input file for the next burn step. To increase the accuracy

of the burnup calculation, a "predictor" step is used, in which ORIGEN2 is run 1/2 way through the designated burn step. One-group cross sections are then calculated at the midpoint of the burn step by MCNP. This assumes that the isotopics of the system at the midpoint are a reasonable approximation of the isotopics over the entire burn step (actually it is only important that the neutron flux energy spectrum is representative of the entire burn step). The user must be aware of this assumption, and consequently, ensure that burn intervals are not too long. *Monteburns* prints out a neutron flux spectrum and the grams of a number of isotopes present for each predictor and each outer burn step in an output file; if there is a large difference between the predictor and the actual burn step, then a shorter burn time should be considered. After the predictor step is executed, then ORIGEN2 is re-executed with the new 1-group cross sections. Executing multiple predictor steps will increase the accuracy of the burnup calculation because the 1-group cross sections used to perform the predictor step will approach the 1-group cross sections calculated by the predictor step (i.e. they will converge). For most applications studied thus far, one predictor step has provided sufficient accuracy. In addition, *monteburns* automatically adds an extra predictor step for the initial burn step, because the actual 1-group cross sections for a system may be vastly different from those supplied in the chosen default ORIGEN2 library (this problem can be partially avoided by providing an initial library that has been previously generated by *monteburns* for a similar system instead of using one of the ORIGEN2 default libraries). For all subsequent burn steps, *monteburns* uses the modified 1-group cross section library from the previous burn step, thus an extra predictor step is not required.

The other key factor in balancing accuracy with execution time is determining the number of isotopes for which 1-group cross sections should be calculated. For some isotopes it may be important to modify the 1-group cross section, while for others, the default ORIGEN2 value may be used with little effect on the solution. Thus, it would be inefficient to calculate a 1-group cross section for every isotope included in the associated MCNP libraries, although this can be done if desired. Isotopes are deemed "important" in two ways. The first way is to explicitly list an isotope in the *monteburns* input file; this insures that 1-group cross sections will be calculated for this isotope during each burn step (and that this isotope will be included in the primary *monteburns* output). The other way in which an isotope is deemed "important" is based on a user input variable called the "importance fraction."

If an isotope contributes a fraction to the system neutron absorption, fission, mass fraction, or atom fraction that is higher than the importance fraction, then this isotope is deemed "important," and a modified 1-group cross section will be calculated. If the value of the importance fraction is relatively large, then few isotopes besides the ones initially designated in the user input will be tagged as "important." If the value of the importance fraction is relatively small, then numerous isotopes will be tagged (primarily fission products and higher actinides). The neutron absorption and fission fractions calculated for an isotope are based on the initial ORIGEN2 library (unless that isotope has been previously deemed

"important," in which case a 1-group MCNP cross section already exists). Thus, it is advised that the initial ORIGEN2 library be somewhat representative of the system, or "important" isotopes may not be properly addressed. The only way to absolutely avoid this problem is to track every isotope or to generate a problem specific library (with a previous run of *monteburns*) that replaces the original default ORIGEN2 library. For any isotopes that are deemed "important" but do not have a cross section identifier listed in *mbxs.inp*, *monteburns* will give a warning that the cross section is not found, will continue to use the default ORIGEN2 cross section, and, most importantly, will not transfer the material to MCNP. MCNP cross sections for several fission products do not exist; therefore, *monteburns* contains the option to lump all fission products together as one sum (except for those fission products, if any, designated as "important" in the *monteburns* input file). These lumped fission products are then given an MCNP cross section that is based on two general fission product cross sections in MCNP - average fission product from Uranium-235 and average fission product from Plutonium-239 (these have the identifiers 45117 and 46119 respectively (see Ref. 3, Appendix G for more information), and they must be defined in *mbxs.inp*). The level to which the ^{239}Pu cross section is used is based on the relative fission rate of transuranic isotopes to that of uranium ones.

There are a number of elements in MCNP for which "natural" cross sections exist. However, ORIGEN2 does not recognize natural elements, so *monteburns* contains data to break natural elements into individual isotopes. If a natural cross section exists in the MCNP input file, *monteburns* separates this element into its isotopic components, and then ORIGEN2 burns these isotopes individually (with the default ORIGEN2 library cross sections). After the ORIGEN2 burn, *monteburns* then lumps them back into the element's natural isotopics for use in MCNP. Although this may not be completely correct because the initial ORIGEN2 cross section would not be modified by MCNP (i.e. not fully representative of the material), it is dictated by the lack of MCNP cross sections for many individual isotopes. Whenever possible, it is recommended that the user specify the individual isotopes in the MCNP input file as opposed to the natural element (although for many elements the individual isotope cross sections do not exist). This will allow the isotopics of the element to change as the material burns, and it will also allow for the 1-group cross sections to be modified if any of the isotopes are deemed "important."

It should also be noted that *monteburns* does not currently perform any direct temperature-dependent calculations. The user is advised to use a code such as NJOY³ to process temperature-dependent cross section libraries, which can then be used by MCNP to process temperature-dependent data. Additionally, *monteburns* is currently designed to work with MCNP4B, but it also works with MCNP4A and probably any earlier versions as well. *Monteburns* is also designed to work with either a "kcode"/"ksrc" (criticality) source definition in MCNP (see Ref. 3 for more information) or a "sdef"/"src" definition (for other types of transport calculations).

³ Versions of NJOY are available at the Radiation Safety Information Computational Center (RSICC) as codes PSR-171 and PSR-355.

Overall, *monteburns* acts as a pre- and post-processor for both MCNP4B and ORIGEN2. Although the program is fully automated (except for the creation of input files), it is advised that the user be familiar with nuclear terminology, decay and burnup codes, and Monte Carlo codes such as MCNP to understand the output and to verify that the correct data was obtained. Figure 1 is a flow chart of the processes that *monteburns* follows. Table 1 describes the procedure followed in the execution of *monteburns* (excluding the file management steps) where *** is the base name of the various input files associated with *monteburns* and # is the number of the current outer burn step. Table 2 then summarizes the function of each file used in *monteburns*.

Fig. 1. *Monteburns* Flow Chart

TABLE 1
PROCEDURE

Step	Process	Input ^a	Output ^a
1	Read input parameters from ***.inp input file (the primary <i>monteburns</i> input file)	***.inp = mb.inp ./tmpfile/params	Values of certain variables are output to the screen.
2	Create ORIGEN2 input files for each burn step (monteb 5)	***.feed = feed orig21 = ORIGEN2 decay library orig** = ORIGEN2 cross section library (** = ID#) ./tmpfile/param_\$.#	/tmpfile/mbori_\$.# fort.9.0 mb9 mb9t_\$.out ./tmpfile/params2
3	Modify MCNP input file to include commands specific to <i>monteburns</i> (monteb 1)	***	mbmc mbmc.skl mat_\$.inp mb* (* = 1 to 13) mb*t_\$.out
4	Run the MCNP input processor on the initial MCNP input file to obtain the initial composition of the materials to be burned.	*** = mbmc	mbmco mbmcr mbmcs
5	Create flux tally descriptions for MCNP input file (monteb 2)	mbmco	tal2_\$.inp mb6t_\$.out
6	Write ORIGEN2 composition input file, fort.7 based on initial MCNP deck, and separate natural isotopes from non-actinides and other isotopes (monteb 4)	mbmco mbxs.inp natelem	fort_\$.7 mnat_\$.tmp mcnp_\$.inp
7	For a restart case, obtain files from previous runs	/tmpfile/fort9_\$.# /tmpfile/fort7_\$.# /tmpfile/mbmc.# /tmpfile/mbinp.#	fort_\$.9 fort_\$.7 mbmc mb.inp
8	Determine which material is in each region and organize files respectively	/tmpfile/params2 feed mnat_\$.tmp fort_\$.7	/tmpfile/param3_\$. mnat_\$.tmp fort_\$.7
9	Rewrite input information, including number of outer step currently being processed (monteb 9)	***.inp = mb.inp	mb.inp

TABLE 1 (cont)^a

10	Add discrete feed to ORIGEN2 composition input file (monteb b)	fort_\$.7 /tmpfile/param2 feed natelem	fort_\$.7.tmp /tmpfile/param_\$.# fort.tmp
11	Modify previous MCNP input file by adding discrete feed (monteb 7b)	fort_\$.7 fort_\$.9 mbxs.inp mnat_\$.tmp	mb7_\$.out mat_\$.inp
12	Run MCNP to determine effect(s) of discrete feed	mbmc.skl mat_\$.inp	mbmco
13	Obtain criticality values from MCNP output file (monteb 6b)	mbmco /tmpfile/params2 feed	mb11_\$.out
14	Run ORIGEN2 for predictor step(s) (i.e. 1/2 way through each step)	/tmpfile/mbori_\$.# = mbori_\$. /tmpfile/params2 feed fort_\$.4 fort_\$.9	mboro fort_\$.7.tem fort_\$.7 fort_\$.9
15	Modify previous MCNP input file by adding new compositions and tally isotopes if deemed "important" (monteb 7m)	fort_\$.7 fort_\$.9 mbxs.inp mnat_\$.tmp mcnp_\$.inp	mb4_\$.out mb7_\$.out mat_\$.inp f9err_\$.
16	Create full MCNP input file from user-generated version, including detailed tally information (monteb 3)	mbmc.skl mat_\$.inp tall1-3_\$.inp	mbmc
17	Run MCNP to calculate 1-group cross sections and flux (and criticality values)	mbmc	mbmco
18	Modify ORIGEN2 cross section file with new cross section and flux values obtained by MCNP (monteb 6m)	mbmco fort_\$.7 fort_\$.9 /tmpfile/mbori_\$.# /tmpfile/params2 feed	mb1-3_\$.out mb6_\$.out mb8_\$.out mb11.out fort_\$.9 /tmpfile/mbori_\$.# tmp

TABLE 1 (cont) ^a

19	Run ORIGEN2 for entire step. Print results 1/2 way to compare with predictor step(s) and then perform discrete removal.	/tmpfile/mbori_\$. # = mbori_\$. /tmpfile/params2 feed fort_\$.4 fort_\$.9	mboro fort_\$.7.tem fort_\$.7 fort_\$.9
20	Modify previous MCNP input file by adding new compositions of materials (monteb 7e)	fort_\$.7 fort_\$.9 mbxs.inp mnat_\$.tmp mcnp_\$.inp	mb7_\$.out mat_\$.inp
21	Run MCNP to determine effect(s) of discrete feed. Rewrite input information, including number of outer step currently being processed (monteb 9)	mbmc.skl mat_\$.inp ***.inp = mb.inp	mbmco mb.inp
22	Obtain criticality values from MCNP output file (monteb 6e)	mbmco /tmpfile/params2 feed	mb11_\$.out
23	Output results of ORIGEN2 (monteb 8)	fort_\$.7 mb9t_\$.out	mb9_\$.out mb10 mb12_\$.out mb5tx_\$.out
24	Calculate the amount of material burned and produced based on feed and inventory information (monteb z)	mb5t_\$.out mb5tx_\$.out mb9t_\$.out /tmpfile/params2 feed	mb9_\$.out mb10t_\$.out
25	Save information for a restart case	fort_\$.9 fort_\$.7 mbmc mb.inp	/tmpfile/fort9_\$.# /tmpfile/fort7_\$.# /tmpfile/mbmc.# /tmpfile/mbinp.#
26	Reduce resulting number of input files to two	mb#t_\$.out mb#	***.mbchk ***.mbout

^aThe following symbols apply for the table: # = number of current outer burn step, \$ = *monteburns* material number of current material being analyzed (may or may not be equal to MCNP material number (see Section 5.2 for more information)), *** = base name of files

TABLE 2
SUMMARY OF FILES USED IN MONTEBURNS

<i>File</i>	<i>Description ^{a, b}</i>
*** mbmc mbmc.skl /tmpfile/mbmc.#	MCNP input file created by user (user can choose any name *** that meets MCNP requirements: i.e. no more than 7 characters) Name of MCNP input file used by <i>monteburns</i> (initially = ***) Skeleton MCNP input file (based on ***) Name of MCNP input files saved for restart runs (# = outer burn step)
mat_\$.inp	Contains modified MCNP material cards after each outer burn step
tal1_\$.inp tal2_\$.inp tal3_\$.inp	These three files contain commands that are used to generate the flux spectrum, cross section, and other tallies in MCNP. These files are merged with the MCNP input file before MCNP is run (except for intermediate criticality only runs).
mbxs.inp	This file lists the default MCNP cross section library to be used for each isotope if is not already identified.
mbmco mbmcr mbmcs	Default name of MCNP output files
***.feed feed	Optional input file created by user, contains feed/removal and time-step information Name of default feed file used in <i>monteburns</i> (initially = ***.feed)
***.inp mb.inp /tmpfile/mbinp.#	Input file created by user, contains code specific variables Name of default input file used in <i>monteburns</i> (initially = ***.inp) Name of input files saved for restart runs
fort_\$.9 fort_\$.9.tmp fort.9.0 fort_\$.9.# /tmpfile/fort9_\$.#	Contains values from the ORIGEN2 decay and cross section libraries. This file goes through various temporary stages, which include replacing ORIGEN2 cross section values with ones obtained from MCNP. The variations listed to the left represent the temporary files, the last of which is used for restart runs
f9err_\$.	Displays errors incurred from finding cross section values in fort_\$.9
fort_\$.4 fort_\$.7 fort_\$.7.tmp fort_\$.7.tem /tmpfile/fort7_\$.#	Contains the names of isotopes and their number densities that will be processed in ORIGEN2, units are in gram-atoms (fort.4 = ORIGEN2 input, fort.7 = ORIGEN2 output, # = outer burn step)

TABLE 2 (cont)

orig21 orig##	'orig21' is the identifier of the ORIGEN2 decay library ## then identifies the cross section library requested by the user
mcnp_\$.inp	Contains a list of isotopes/elements in the initial MCNP input file
mnat_\$.tmp	Contains a list of natural elements from the initial MCNP input file
mbori_\$ mbori_\$.tmp /tmpfile/mbori_\$.#	Working ORIGEN2 input file Temporary ORIGEN2 input files (# = outer burn step)
mboro /tmpfile/params /tmpfile/params2 /tmpfile/param3_\$ /tmpfile/param_\$.# fort.tmp	Working ORIGEN2 output file Temporary files used by <i>monteburns</i> to read input parameters and to determine if discrete feed exists or not for each outer burn step (#).
mb0_\$.out mb1&mb1t_\$.out, mb2&mb2t_\$.out, mb3&mb3t_\$.out, mb4&4t_\$.out, mb5_\$.out, mb5t_\$.out,mb5 mb5t&mb5tx_\$.out mb6&mb6t_\$.out, mb7&mb7t_\$.out, mb8&mb8t_\$.out, mb9&mb9t_\$.out, mb10_\$.out,mb10 mb11&mb11t_\$.out mb12&mb12t_\$.out mb13&mb13t_\$.out ***.mbchk, ***.mbout	Individual output files from <i>monteburns</i> error messages mcnp results: k_{eff} , nu, flux, variance, and cross sections n,gamma for automatic and important ("tracked") isotopes n,fission for tracked isotopes inventory of tracked isotopes at 1/2 step (predicted) inventory of tracked isotopes at 1/2 step (actual) inventory of tracked isotopes at 1/2 step (with precision for more calc) flux spectrum during steps materials sent back to mcnp each time it is run fission-to-capture ratio feed and burnup of tracked isotopes, total actinide, and final summary feed and burnup rates mcnp results: day (time of cumulative irradiation), k_{eff} , and variance inventory of materials at the beginning of each step k_{eff} at beginning of each step Final output files from <i>monteburns</i>

^aThe bolded file names represent those supplied by the user^bThe following symbols apply for the table: # = number of current outer burn step, \$ = number of current material being analyzed, *** = base name of files

3.2 MCNP Description

MCNP is a neutral particle transport code that uses the Monte Carlo technique. The Monte Carlo technique is a statistical method in which estimates for particle characteristics are obtained through multiple computer simulations of the behavior of individual particles in the system. A Monte Carlo code generates such a statistical history for a particle based on random samples from probability distributions. These distributions are used in calculations to determine the type of interaction the particle undergoes at each point in its life, the resulting energy of the particle if it scatters, the number of particles that "leak" from the system due to geometry constraints, and the number of neutrons produced if it causes a fission. The probability of the particle to behave in a certain manner (scatter, absorb, fission) can be obtained from the cross section values of the material(s) with which the particle will interact. Thus, a Monte Carlo code can model the series of events that occur in the lives of a large number of particles to determine the flux of different types of particles in various regions in a system. These fluxes can then be used to tally a wide variety of information (reaction rates, heating rates, doses, etc.) for the system. Additionally, the value of the effective multiplication factor, k_{eff} , for a system (the ratio of the number neutrons in the system a particular time to the number of neutrons that existed in the previous generation) can be calculated using MCNP.

3.3 ORIGEN2 Description

ORIGEN2 performs burnup calculations for *monteburns* using the matrix exponential method [Ref. 2]. It considers time-dependent formulation, destruction, and decay concurrently [Ref. 4]. These calculations require: 1) the initial compositions and amounts of material, 2) 1-group microscopic cross sections for each isotope, 3) material feed and removal rates (if desired), 4) the length of the irradiation period(s), and 5) the flux or power of the irradiation. This information must be given by the user in the input files discussed in Section 5.0.

Input files for ORIGEN2 are complicated to write, and output files generated by ORIGEN2 are bulky and complicated to read. Thus, *monteburns* eliminates the user's need to create his/her own ORIGEN2 input files and to extract information from ORIGEN2 output files. *Monteburns* provides a "cross section and decay information" file, *fort.9*, a file with material compositions, *fort.4*, and a skeleton ORIGEN2 file, *mboi*, which contains commands and continuous feed and removal information.

3.4 Calculations

A number of calculations are performed by *monteburns*. They are divided into six different categories and are presented below. These categories are: energy per fission, flux normalization, reactor physics constants, effective multiplication factor, power, and fractional importance.

3.4.1 Energy per Fission

The user has two options of how to calculate the amount of energy produced per fission for a system. First, he/she can enter the desired Q-value (the average for the entire system) into the *monteburns* input file, or second, the user can enter a Q-value for U-235 the he/she thinks is most representative for the nuclear system being evaluated (preceded by a negative sign in the input file), and the code will calculate the average Q. In this case, the following equations are used by *monteburns* to calculate the amount of energy produced per fission for each material (see Equation 4 for the Q-value for the entire system) according to the distribution of various actinides in the material.

$$Q_{fis} = |Q_{U-235}| * Q_{rat} \quad (1)$$

where: Q_{fis} = total amount of recoverable energy produced per fission
 Q_{U-235} = recoverable energy per fission for U-235 (input by user - recommended value is 200 MeV)
 Q_{rat} = weighting factor to include recoverable fission energy for all actinides present

$$Q_{rat} = \sum_{i=1}^n q_{rat}(i) * f_{rat}(i) \quad (2)$$

where: n = number of isotopes being considered
 $q_{rat}(i)$ = ratio of recoverable energy per fission for isotope i divided by the recoverable energy per fission for U-235 (see Table 3)⁶
 $f_{rat}(i)$ = ratio of fissions resulting from isotope i to total number of fissions (see Equation 3 below)

$$f_{rat}(i) = \frac{\sigma_f(i) * n(i)}{\sum_{i=1}^n (\sigma_f(i) * n(i))} \quad (3)$$

where: $\sigma_f(i)$ = 1-group microscopic fission cross section of isotope i
 $n(i)$ = number density of isotope i in the system
 (in units of gram-atoms)

Next, the average energy produced per fission for the system as a whole can be calculated.

$$Q_{ave} = \frac{\sum_{j=1}^m (Q_{fis}^j * \phi_n^j * \Sigma_f^j * V^j)}{\sum_{j=1}^m (\phi_n^j * \Sigma_f^j * V^j)} \quad (4)$$

where: Q_{ave} = the average recoverable energy per fission for all materials

Q_{fis}^j = average energy per fission for material j (MeV)

ϕ_n^j = value of flux of material j obtained from MCNP output file

Σ_f^j = macroscopic fission cross section of material j (cm^{-1})

V^j = total volume of all cells containing material j (cm^3)

m = number of materials being analyzed

TABLE 3
FRACTION OF RECOVERABLE ENERGY PER FISSION FOR CERTAIN
ACTINIDES DIVIDED BY THE RECOVERABLE ENERGY PER FISSION FOR U-235

Isotope	Fraction	Isotope	Fraction
Th-227	0.9043	Pu-240	1.0379
Th-229	0.9247	Pu-241	1.0536
Th-232	0.9573	Pu-242	1.0583
Pa-231	0.9471	Am-241	1.0513
Pa-233	0.9850	Am-242m	1.0609
U-232	0.9553	Am-243	1.0685
U-233	0.9881	Cm-242	1.0583
U-234	0.9774	Cm-243	1.0685
U-235	1.0000	Cm-244	1.0787
U-236	0.9973	Cm-245	1.0889
U-237	1.0074	Cm-246	1.0991
U-238	1.0175	Cm-248	1.1195
Np-237	1.0073	Cm-249	1.1296
Np-238	1.0175	Cf-251	1.1501
Pu-238	1.0175	Es-254	1.1807
Pu-239	1.0435		

3.4.2 Flux Tally Normalization/Reactor Physics Constants

For each material j , the value of the flux that is used for burnup calculations in ORIGEN2 is calculated from the flux tallied by MCNP (which is normalized per MCNP source neutron):

$$\phi = \phi_n * C \quad (5)$$

where: ϕ = true value of the flux (normalized to system power).

C = a constant (see Equation 7 or 9)

When an MCNP input file with a "kcode" (criticality) source definition is used and k_{eff} and its associated error are found from the MCNP output file, then the value of C is as follows:

$$C = \frac{\nu * P * 10^6 \text{ W/MW}}{(1.602 \times 10^{-13} \text{ J/MeV}) * k_{\text{eff}} * Q_{\text{ave}}} \quad (6)$$

where: ν = average number of neutrons produced per fission

(see next section for calculation of ν)

P = power defined by user for each material (in MW)

k_{eff} = effective multiplication factor obtained by MCNP

When the MCNP input is a "sdef" source definition, then the value of C is instead:

$$C = \frac{\text{src} * P * 10^6 \text{ W/MW}}{\text{floss} * (1.602 \times 10^{-13} \text{ J/MeV}) * Q_{\text{ave}}} \quad (7)$$

where: src = weight of source neutrons (approximately equal to one)

floss = weight of neutrons lost to fission

3.4.3 Reactor Physics Constants

For both types of source definitions, the value of ν can be calculated from results in the MCNP output file. For a "kcode" source definition, it is calculated as follows:

$$\nu = k_{\text{eff}} * \text{src}/\text{floss} \quad (8)$$

where: src = weight of source neutrons (approximately equal to one)

floss = weight of neutrons lost to fission

For a "sdef" source definition, the value of ν is:

$$\nu = \text{fsrc}/\text{floss} \quad (9)$$

where: fsrc = weight of source neutrons gained in fission

For either type of MCNP input file, the number of neutrons produced per neutron destroyed (η) is:

$$\eta = \frac{(\nu\sigma_f + 2.0 * \sigma_{n2n})}{(\sigma_\gamma + \sigma_f + \sigma_{n2n})} \quad (10)$$

where: σ_f = fission cross section from MCNP

σ_γ = (n, γ) cross section from MCNP

σ_{n2n} = (n,2n) cross section from MCNP

3.4.4 Effective Multiplication Factor

The value of the effective multiplication factor for a "sdef" source definition must be calculated from the value of the net multiplication obtained from the MCNP output file:

$$k_{eff} = \frac{(fmult - 1)}{(fmult - 1/\nu)} \quad (11)$$

where: $fmult$ = net multiplication in the system

The relative error (σ) associated with k_{eff} is then:

$$\sigma = \frac{\{ (fmult*(1+err) - 1) - k_{eff} \} / k_{eff}}{(fmult*(1+err) - 1/\nu)} \quad (12)$$

where: err = relative error associated with net multiplication in system

3.4.5 Power

Finally, the power produced by each material is:

$$P^j = \frac{(Q_{ave} * \phi^j * \sum_f^j * V^j * 1.60219 * 10^{-13} \text{ J/MeV})}{10^6 \text{ W/MW}} \quad (13)$$

where: P^j = power produced by material j (MW)

ϕ^j = flux of neutrons in material j (n/cm²/sec)

3.4.6 Fractional Importance

The fractional importance calculations help determine which isotopes are considered "important" and which are not. If any of the following values (atom fraction, weight fraction, fraction of absorption, and fraction of fission) are greater than the value of the "fractional importance" assigned by the user, then the isotope is considered "important" and is included in all transfers from ORIGEN2 to MCNP and back throughout the remainder of the run.

$$a_{fi} = \frac{gad_i}{\sum_{i=1}^n gad_i} \quad (14)$$

$$w_{fi} = \frac{gad_i * A_i}{\sum_{i=1}^n (gad_i * A_i)} \quad (15)$$

$$f(\sigma_a)_i = \frac{gad_i * \sigma_{ai}}{\sum_{i=1}^n (gad_i * \sigma_{ai})} \quad (16)$$

$$f(\sigma_f)_i = \frac{gad_i * \sigma_{fi}}{\sum_{i=1}^n (gad_i * \sigma_{fi})} \quad (17)$$

where: i = isotope being studied

n = total number of isotopes in system

a_{fi} = atom fraction of isotope i in system

w_{fi} = weight fraction of isotope i in system

$f(\sigma_a)_i$ = fraction of absorption isotope i contributes to system

$f(\sigma_f)_i$ = fraction of fission isotope i contributes to system

gad_i = amount of isotope in system in gram-atoms

A_i = atomic weight of isotope i in grams

σ_{ai} = microscopic absorption cross section of isotope i

σ_{fi} = microscopic fission cross section of isotope i

4.0 USER INTERACTIONS WITH THE SOFTWARE

The primary role of the user in this program is to create the required two to four input files. A description of input parameters will be presented below, and the format of the input files will be shown in Section 5.0.

4.1 Required Input Files

The user must generate two to four different input files before he/she executes *monteburns*. The two required input files he/she must generate are the MCNP input file (designated here by ******* but can be any name up to 7 characters), and a general *monteburns* input file (this must have the same prefix ******* with an extension of ".inp" for a name of *****.inp**). For most burnup scenarios the user must also generate a feed input file, which contains detailed instructions for *monteburns* at each step (i.e. material feed/removal, power, time interval). The only case in which a feed input file is not required is for a constant power burn with no material feed or removal. Finally, one other input file is also used by *monteburns*, *mbxs.inp*, which is a cross section "map" for *monteburns*. A sample of this file is included with the *monteburns* source code package; this sample file can be modified as requirements dictate (see Section 5.4 for more information).

4.2 Input Parameters

The user is required to know several input variables in order to run this code. Section 5.0 will describe how each of these parameters are entered into input files. The first and last items are separate input files, while all other input variables are contained in the *monteburns* input file, *****.inp**. The required input parameters are as follows:

MCNP input file - this file must represent the system that the user wants to analyze, including geometry and compositions of materials. Note: this file must be executable by MCNP before it can work in *monteburns*.

Number of MCNP Materials - the number of materials the user would like to have irradiated from the MCNP input file (i.e. transferred back and forth from MCNP to ORIGEN2).

MCNP Material Number(s) - the actual number of the material(s) in the MCNP input file for which a burnup analysis is desired (the average flux for all cells and parts of a repeated structure or lattice with this material will be obtained). Note: the number of entries here must equal the number of MCNP materials entered above. Additionally, the order in which these material numbers are listed define what *monteburns* material number is assigned to each MCNP material number (this will be used for determining what material is in each region - see Section 5.3 for more information). For example, if MCNP material 1 is listed first followed by 5 and 10, then *monteburns* material 1 is initially defined to be MCNP material 1, *monteburns*

material number 2 is MCNP material 5, and *monteburns* material number 3 is initially comprised of MCNP material 10.

Material Volume(s) - the sum of the volume of all cells in the MCNP input file that contain each of the material number(s) listed above (again, the number of entries must equal the number of MCNP materials specified above). If the user enters a value of 0.0 for this, then the MCNP calculated volume will be used. However, if for some reason, the geometry is too complex and MCNP cannot calculate the value, then an error message will appear, *monteburns* will terminate, and it must be rerun with non-zero values. Additionally, in most cases of repeated structures, MCNP will not calculate the volume of all cells containing a given material correctly. For each of these cases (and for any other instances the user desires), the user must enter the sum of the volumes of all cells containing each material being analyzed.

Total Power of System - the power generated by the entire system represented in the MCNP model (note that this is not necessarily the same as the power generated solely by the materials burned in *monteburns*). This value, along with the recoverable energy per fission, is used to normalize the flux from MCNP in each burned region for use in ORIGEN2. This flux is then converted to fission power, which is output. Additionally, the user can enter the fraction of this power to be used during each outer burn step (if power is not constant over the entire burn) in the feed input file. Note: the value of fission power output is subject to statistical errors and may not be exactly the same as the power input. Increased statistics in MCNP should minimize this problem, but nonetheless, the user should check the power output to ensure that it is close to the amount of power input.

Recoverable energy per fission - this value represents the average recoverable energy per fission (Q) in MeV in the aforementioned MCNP model. If the user does not know the exact amount of energy generated by a combination of several isotopes, then he/she can enter the recoverable energy per fission for U-235 for that system (commonly ~200 MeV for light water reactors), preceded by a negative sign. The negative sign means that the value of the recoverable energy per fission will be calculated by *monteburns* based on the fissile isotopics of the system. In this case, Q is calculated as the sum of all actinide Q fractions, which are based on the fraction of fissions caused by a specific isotope times the Q of that isotope divided by the Q of U-235 (see Equations 1-4 for more information). WARNING: the fissile isotopics used for the calculation of Q are based only on the materials burned by *monteburns*. If the fissile isotopics of the entire system is significantly different from the fissile isotopics of the materials burned, then the average value of Q may be in error, thus the flux normalization may be in error (although in most cases this should be a relatively small effect).

Total number of days burned - this number represents the length of time a material will be irradiated in ORIGEN2 (or the decay time if power equals zero). If the user provides a feed input file, then the irradiation lengths (in days) for each outer burn

step must be provided in the feed input file. Otherwise, the total irradiation time (in days) is entered in the *monteburns* input file.

Number of outer burn steps - this number indicates how many outer burn steps are to be performed. If a feed input file exists, then this should equal the number of steps described in the feed input file. If a feed input file does not exist, then the length of each irradiation equals the total days burned divided by the number of outer burn steps. Each of these steps represents a time period for which a burnup calculation will be performed (the burn will use 1-group cross sections that are calculated at a predictor step 1/2 way through the time interval). Each outer step can also indicate the addition and/or removal of a material.

Number of internal burn steps - this is the number of additional times into which the irradiation period will be divided for ORIGEN2. The smaller the irradiation period is, the more accurate answers ORIGEN2 produces. Fortunately, there is virtually no penalty to the execution time for increasing the number of internal burn steps because almost all of the execution time lies in MCNP. In general, the optimum number of internal burn steps is approximately 40 to 50 for continuous feed and 8 to 10 for discrete feed; for most applications, there is little gain in accuracy beyond this point. If continuous feed is used, then this number must be divisible by 10 (because of how the feed rate is interpolated over the time step), otherwise it must be divisible by 2. If this condition is not met in the user input, *monteburns* rounds the number up to meet the condition.

Number of predictor steps - this is another variable affecting the accuracy of the results. In a *monteburns* calculation, ORIGEN2 is run 1/2 way through the outer burn step, and then the resulting isotopics are used in MCNP to calculate 1-group cross sections. Then a complete ORIGEN2 run is performed with the new cross section values. However, the isotopic composition of the material changes during the irradiation step (both due to burnup and variance in continuous feed from beginning to end), and therefore, the 1-group cross sections may change during the burn step as well. To obtain the most accurate results, 1-group cross sections should represent an average cross section over the entire burn interval. If the initial cross section values for a step are not accurate, then the ORIGEN2 compositions halfway through the step may not be a good representation of the burn step. Thus, it is beneficial to perform a "predictor" step (derived from a basic form of the predictor-corrector method [Ref. 5]) to calculate cross sections more than once during a burn step and to compare the neutron energy spectrum and isotopic compositions halfway through the step (these values are printed in the output files) to make sure that the final cross sections are fairly representative of the system. The greater the number of predictor steps used, the more likely that the calculated 1-group cross sections will accurately represent the average cross sections for the burn step. In practice, one predictor step is usually sufficient unless the isotopic composition changes significantly during the burn step. An additional predictor step is automatically performed for the first outer burn step because the initial cross sections available to *monteburns* must be adjusted for the system being analyzed.

For example, if there are ten outer burn steps and the number of predictor steps is one, then MCNP will be run to calculate 1-group cross sections eleven times (one for each outer burn step plus one additional predictor step for the first outer burn).

Step to restart after - a user can use this parameter to restart a run that ended unexpectedly, or to branch off from a previous *monteburns* run with different input variables (for example, if k_{eff} drops too low during the n^{th} burn step, the user can change the feed rate for the n^{th} step and restart from the previous step). The "restart step" indicates the outer burn step after which *monteburns* should start, using all input files created previously and results from previous calculations for the outer burn steps that were already completed. To use this variable effectively, all input files that were created by *monteburns* during the previous run must remain in the directory in which *monteburns* is running (most of these will appear in the *tmpfile* subdirectory of the main directory). If a restart run is not being performed, then the "restart step" value should be zero. This value gets modified during each step to reflect the value of the current step.

Number of ORIGEN2 library - this number represents the number of the ORIGEN2 library from which initial cross section values are obtained (they are modified to be system-dependent after the first step). The ORIGEN2 manual [Ref. 6] contains a list of over thirty different cross section libraries for different types of systems from which the user can choose. Each of these libraries should have been provided with the source code from RSICC and is associated with an *orig##* file, where ## is a number used to identify the library. The value of this two-digit number must be entered by the user. If the user generates his/her own library (i.e. from a previous *monteburns* run) to be used as the initial library, he/she can must give it a name *orig##* that has not been previously run in ORIGEN2, and place it in the proper library location (see below).

ORIGEN2 library location - this line of input must contain the location of the ORIGEN2 libraries in the user's file space or the directory of another user on the system that has the library files. This way, only one user on a UNIX operating system must have a copy of the libraries. Note: the ORIGEN2 decay library should also be located in this subdirectory and named *orig21*.

Fractional importance limit - this value represents the lower limit (tolerance) for the relative importance of one isotope versus the remainder of the system, based on the results obtained by running ORIGEN2 and MCNP. This importance limit is used because a large number of transmutation and/or fission products are produced during irradiation, but only the effect of "important" isotopes on the flux spectrum and/or reactivity may be desired because execution time increases for every isotope for which 1-group cross sections are calculated. Isotopes are deemed "important" based on their fractional contribution in the following four areas: atom fraction, weight fraction, fraction of absorption, and fraction of fission (see Equations 14-17). Thus, if an isotope has a fractional contribution in any of these four areas which is greater than the importance limit, then that isotope becomes an "important" tally

isotope. The "important" isotopes are then sent back to MCNP for two primary reasons; (1) these isotopes may significantly affect the system flux spectrum and reactivity, and (2) an MCNP modified 1-group cross section will produce more accurate transmutation and fission rates in ORIGEN2. If the fractional tolerance is set to zero, then all activation products, fission products, and actinides that are generated in ORIGEN2 will be tallied (except for those for which no MCNP cross section exists, in which case only the atom and weight fractions are calculated). If the fractional importance limit is set to one, then no isotopes will be deemed "important" except those specified as tally isotopes in the input. The user must also decide how he/she wishes to deal with fission products. If the fractional importance is a positive value then only those fission products deemed "important" will be include in MCNP. However, if the fractional importance is negative, then those fission products not specified by the user as "automatic" are lumped and divided appropriately into two different MCNP cross section sets - one for U-235 and one for Pu-239. The fraction of the total fission product mass that is separated into each is determined by comparing the number of fissions that result from uranium isotopes to those that occur in transuranic actinides (with an atomic number greater than 92) respectively.

Intermediate flag - Flag that indicates whether intermediate k_{eff} calculations should be performed or not. Normally, MCNP is only run once per predictor step, and these runs occur 1/2 through each outer burn step (i.e. halfway through each irradiation period). Thus, when this value is set to zero, then k_{eff} calculations are only performed by MCNP halfway through the burn step. However, it is often desired to obtain a value of k_{eff} at the end of each burn step to see exactly how it changed before preceding to the next burn step. Also, it may be desirable to see what effect discrete feed has on the system at the beginning of a burn step. When the value of this parameter is set to one, then these additional MCNP calculations are performed. However, neither cross section nor flux values are recalculated by MCNP in such a run, so they do not influence the ORIGEN2 results. The only purpose this "intermediate" MCNP calculation has is to provide the value of the effective multiplication factor at more than one point during each outer burn step. Thus, when a discrete feed addition occurs, three MCNP runs will be performed; otherwise two MCNP runs will be performed. If the value of this parameter is zero, then only one MCNP run will be performed for each outer burn step regardless if there is discrete feed or not.

Number and list of automatic tally isotopes for each material - this integer represents the number of isotopes/elements for which the user wants tallies to be performed in MCNP and results written to *monteburns* output files (i.e. automatic "important" isotopes). The user must then enter the MCNP identification number for each of these isotopes/elements (this can indicate library preference and/or temperature dependence). It also allows the user to use a cross section that is not specified in the default cross section file *mbxs.inp* (i.e. the cross section identifier listed here has precedence over the one in *mbxs.inp*).

Number of total tally isotopes for each material - this represents the number of isotopes for which tallies are being kept. At the beginning of *monteburns* (i.e. for the first burn step), this value will equal the number of automatic tally isotopes, but as *monteburns* runs, it determines what other isotopes make a significant contribution to the system (the tolerance value for a "significant contribution" or "important" isotope was entered by the user in the "fractional importance limit" variable discussed above). It will add these isotopes to the "total number of tally isotopes" listed and increase the number of total tally isotopes during each step.

Feed Input File - the purpose of a feed input file in *monteburns* is to be able to add or remove different amounts of materials to the system during each outer burn step, vary the power of time interval of an irradiation, and/or shuffle materials from one region to another. For each burn step, the user first specifies the length of the irradiation (in days), the fraction of power produced during that step relative to the total power entered in the *monteburns* input file, and in what region each material will be located during that step. Next, if continuous feed is specified, then the user inputs the feed rate (in grams/day) of a material both at the beginning and the end of the step, which is then partitioned into the previously discussed ORIGEN2 internal burn steps appropriately (the exact rate of feed material is interpolated between the beginning and end feed rates). For discrete feed (addition of all material at the beginning of a step), the user enters a value of -2.0 for the first feed column and then the amount of material desired (in grams/day of irradiation) in the next one. In addition, the user must enter the number of the feed material group he/she is adding for each outer burn step, or 0 if he/she is not adding any material.

Another portion of the feed input file allows the user to enter information about the removal of certain isotopes (if desired) before transferring compositions to MCNP. Here, the user must enter the number of the removal group desired, the fraction of this removal group that should be removed (a fractional removal value of 0.9 would mean that 90% of the removal group will be removed and 10% will remain at the end of a burn step), and indicate whether it is continuous or discrete removal (the number of the removal group will be positive for continuous feed and negative for discrete). The removal group is then defined as a range of atomic numbers. For example, 28 to 68 would mean that all elements between nickel and erbium would be removed (which would represent the majority of fission products). The two ranges 28 to 42 and 44 to 68 would mean that all fission products in this same range except technetium ($Z=43$) will be removed. The range 43 to 43 would indicate that the only element being removed would be technetium. For continuous removal (a removal group number greater than 0), the appropriate elements will be removed both after the halfway predictor step and at the end of the burn (simulating continuous removal), whereas for discrete removal (a removal group number less than 0), then the elements are removed only at the end of the burn step (simulating discrete removal). The format of this input file is described in Section 5.3.

5.0 DESCRIPTION OF INPUT FILES

This section describes the four input files that *monteburns* uses, including: 1) the MCNP input file, 2) the *monteburns* input file, 3) the feed input file, and 4) a cross section map.

5.1 MCNP Input File

To execute *monteburns*, the user must have enough knowledge about MCNP to create an MCNP input file for the system that he/she wishes to analyze using either the "kcode" or "sdef" command. Whether this is a complex MCNP input file or a simple one, the user must create and name it anything he/she desires (within MCNP guidelines). Two of the other associated input files must be named the same with a ".inp" and a ".feed" extension accordingly. The user does not need to include tally commands in the MCNP input file; *monteburns* does that automatically. However, the user can include their own tallies if desired as long as they have a tally number less than 100 (*monteburns* uses tally numbers 100 and above). A sample MCNP input file is included as Appendix A.

5.2 Monteburns Input File

Another file that the user must create is an input file describing parameters required for the operation of *monteburns*. These parameters are described and presented in Table 4, and a sample *monteburns* input file is displayed in Appendix B. Section 5.2 contains more information about each of these parameters.

TABLE 4
DESCRIPTION OF MONTEBURNS INPUT FILE

Parameter	Format	Description	Example
72-character title	72-char.	Briefly identifies scenario.	ATW system w/Tc99
Number of MCNP materials	integer	Number of materials from MCNP the user wants to have burned. This number must be less than 50.	3
MCNP material number	integer	The "m" number of the material(s) in the MCNP input file for which a burnup analysis is desired (all cells with this material(s) will be burned).	1 5 10
Material volume (cc)	real	Volume of cells in MCNP containing the aforementioned material number(s) (Note: if the user wants to use the volume calculated by MCNP, then 0.0 should be entered here) .	0.0 0.0 0.0

TABLE 4 (cont)

Power (in MWt)	real	This is the total nominal power generated by the system represented in the MCNP input file.	1000.0
Recoverable energy per fission (in MeV)	real	If known, the recoverable energy per fission for the system (in MeV). (Note: if no value is known, then the value for U-235 preceded by a negative sign can be entered and the Q-value will be determined using this number and the fraction of other actinides present)	-200.0
Total number of days burned	real	Indicates the length of time over which the entire irradiation will occur (Note: this value should be zero if a feed file is used and non-zero if one is not used).	0.0
Number of outer burn steps	integer	This value represents the number of times cross section values for ORIGEN2 are updated by MCNP. When a feed file exists, it should be equal to the number of feed steps that exist in the feed input file. Additionally, each step may represent the addition or removal of more material, or it may just represent an additional time step in irradiation periods. The number of outer burn steps must be less than 100.	7
Number of internal burn steps	integer	This value gives the number of intervals into which the main irradiation period for each ORIGEN2 input file will be divided. The more internal burn steps, the more accurate the results from ORIGEN2. If continuous feed is being used, this value should be divisible by 10. Otherwise, it should be divisible by 2.	40
Number of predictor steps	integer	Number of times MCNP and ORIGEN2 should be run 1/2 way through each outer burn step (to correlate cross section values with the composition of the system during burnup). One extra predictor is added for the 1st outer step.	1

TABLE 4 (cont)

Step to restart after	integer	A value of 0 represents a new <i>monteburns</i> run. If it is greater than 0, then it indicates the number of a previously completed step after which new calculations will be performed. Note: Files containing information up to this outer burn step must already exist in the user's working directory (under the subdirectory tmpfile).	0
Number of ORIGEN2 library	2-char.	The two-digit identification number associated with the initial ORIGEN2 cross section library.	60
ORIGEN2 library location	72-char.	This is the path name of the ORIGEN2 libraries in the user's directory.	/export/io 1/dip/ori- gen/librarie s
Fractional importance limit	real	This value is the tolerance criteria used by <i>monteburns</i> to determine which isotopes from ORIGEN2 are "important." "Important" isotopes are those for which the atom fraction, weight fraction, fraction of absorption, and/or fraction of fission in the overall material is greater than the limit listed here. If this value is less than zero, then those fission products that are not "automatically important" are lumped together as a general fission product in MCNP.	0.005
Flag for intermediate k_{eff} calculations	integer	This value indicates whether or not intermediate MCNP run(s) are desired or not. If activated (=1) for discrete feed cases, this will allow MCNP to run three times per burn step to get k_{eff} calculations before, after, and 1/2 way through each burn step. If continuous feed exists, then MCNP is only run twice, once 1/2 way through and once between burn steps. A value of 0 indicates only one MCNP run 1/2 way through each outer burn step.	0

TABLE 4 (cont)

Number of automatic tally isotopes for each material	integer	The number of isotopes for which the user specifies he/she wants to obtain tallies (no matter what the fractional importance the isotopes are).	9 9 9
Number of total tally isotopes for each material	integer	The number of total tally isotopes, including both the automatic ones listed below and those found to be "important." This value is initially equal to the number of automatic tally isotopes, but <i>monteburns</i> may automatically add some after running ORIGEN2.	9 9 9
List of automatic tally isotopes for each material	First a Five digit integer; then a period and a three digit ident.; 9-char. total	<p>A list of all isotopes for which the user automatically wants to obtain 1-group cross sections and tally information.</p> <p>Material 1</p> <p>Material 5</p> <p>Material 10</p>	<p>93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c</p> <p>93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c</p> <p>93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c</p>

5.3 Feed Input File

The feed input file allows the user to add or remove different amounts of materials to the system during each outer burn step, vary the power of time interval of an irradiation, and/or shuffle materials from one region to another. The format of a feed input file is free, so the user can enter as large of numbers for each variable as necessary as long as there are spaces in between variables. The first block of data that must be included is information about each outer burn step (in the sample file shown in Table 5 there are seven outer burn steps), including: 1) the irradiation time for each step, 2) the fraction of total power at which the system will be operating during each burn step, 3) the region in which each material will be located for the step, 4) what feed group will be added to each material for the step (0 means no feed), 5) two feed rate columns, 6) the number of the removal group number containing the elements that should be removed from ORIGEN2 output, and 7) what fraction of each element in this removal group should be removed. These variables comprise nine columns of data (see Table 5), which are read in free format. For burn steps where there is continuous feed, the first feed column (item 5) represents the feed rate (g/day) at the beginning of the step, and the second column (item 6) represents the feed rate at the end of the step. If a value of -1.0 is entered in the first feed rate column, then it is assumed that the beginning feed rate for that step is equal to the value of the ending feed rate of the previous step (thus, -1.0 cannot be entered as the beginning feed rate for the first step because it requires a previous step to obtain complete information). If the value entered in the first feed rate column is -2.0, then it indicates that discrete, not continuous feed, is added to the system during this burn step for this material. The amount of discrete feed added is then equal to the value entered the second column (in grams/day) times the number of days of the irradiation.

Similarly, for the removal groups, the user must first enter the number of the removal group, followed by the fraction of each element in the removal group that should be removed (0.0 means that none of the element's inventory is removed whereas 1.0 means the entire inventory of the designated elements is removed). If the removal group number is positive, then continuous removal occurs, whereas if it is negative, then discrete removal occurs. For discrete removal, *monteburns* edits the ORIGEN2 output file so that the desired fraction of the designated range(s) of elements are removed at the end of each outer burn step, whereas for continuous feed, the fission products are removed by ORIGEN2 after the 1/2 way predictor step as well as at the end of the burn step for each ORIGEN2 run. If the value of zero is entered for a feed or removal group, then no feed addition or removal occurs in that material during that outer burn step.

The next block of information in the feed input file provides data about the feed material groups. First, the user must list the number of feed material groups that he/she uses. Then, for each feed material group, he/she must first list the number of isotopes in that feed group followed by identifiers for those isotopes and the mass fraction of feed each isotope contributes to the final feed material (these do not have

to add up to one). The identifier includes the atomic number directly followed by the atomic mass number for each isotope (such as 92235 for U-235). The final block of information describes the removal groups. Again, the user must first list the number of removal groups. Then, for each removal group, the number of ranges of consecutive elements that the removal group contains must be listed, followed by the atomic numbers of the first and last elements that comprise each range (all isotopes of the specified elements are in the removal group, i.e. individual isotopes may not be removed).

Also in the feed input file, the user can specify if and how to shuffle materials between regions. *Monteburns* regions are defined according to the initial listing of MCNP materials to be burned in the ****.inp* file. The volume (i.e. MCNP cells) associated with the first MCNP material listed in the ****.inp* file is designated as region 1, and so on. These region numbers remain unchanged throughout the entire calculation. The material contained in a *monteburns* region is given the same material number as the region number; for example, when the output refers to *monteburns* material 2, it refers to the material in region 2 for that burn-step. Column 4 in the feed file input specifies which *monteburns* material is to be placed in each region prior to each burn-step. In particular, the number in this column indicates which region each material was in during the previous burn-step. For example, if there are two regions to be burned, the first burn-step would normally contain a "1" in column 4 for the first region and a "2" in column 4 for the second region; thus, the materials would remain as specified in the ****.inp* file. If the user wants to exchange the materials between the two regions prior to the second burn-step, then he/she would enter a "2" in column 4 for the first region and a "1" in column 4 for the second region (again, regions are defined in the order in which volumes appear in the ****.inp* file, and this same order must be followed in the feed input file).

Tables 5a and 5b display the format of two different feed input files. In the first example file (Table 5a), material is irradiated in region 1, moved from region 1 to region 2, irradiated in region 2, and finally the material is processed (all fission products except technetium (Tc) are removed, and then transuranic actinides and Tc-99 are added) and reinserted into region 1. For all but the first step, feed material is added to the batch prior to entering region one (implied by a -2.0 in the first feed rate column), and in each step material is removed when the batch is pulled from region two (indicated by a negative removal group number). The second example file (Table 5b) models continuous feed/removal of materials. In this case plutonium (Pu) is continuously added (at a decreasing rate) over the first five steps, while Tc is continuously removed. The feed is added continuously in ORIGEN2 over the burn period, and removal is performed by ORIGEN2 halfway through and at the end of each burn step (which in most *monteburns* cases will effectively simulate continuous removal). The -1.0 in the first feed rate column means that the ending feed rate of the previous step will be the same as the beginning feed rate of the current step. If the feed rates at the beginning and end of the burn steps are different, then the feed rate used by ORIGEN2 is interpolated between these two

values. The final two steps in Table 5b are at zero power, which allows the material to decay with no irradiation involved.

If the user wants to perform a constant power burn with no material feed or removal, then he/she does not need to create a feed input file. Instead, a simple irradiation calculation will be performed in ORIGEN2 for the total length of irradiation (in days) listed in the *monteburns* input file (this value must be non-zero for such a case). The length of each outer burn step will then equal this value divided by the designated number of outer burn steps. In addition to Tables 5a and 5b, another sample feed input file is included in Appendix C.

5.4 Cross Section Map

The cross section map file, *mbxs.inp*, should contain a list of identifiers for MCNP libraries associated with any isotope the user thinks is or may become "important" (often this is simply a list of the preferred identifier for every isotope for which an MCNP cross section library is available to the user). Although the user already has to input the identifier for "automatic" isotopes in the *monteburns* input file, if another isotope (typically fission products and actinides) is found to be "important," *monteburns* needs to know what cross section to direct MCNP to use. Additionally, *monteburns* does not currently have the capability to determine what cross section identifier was listed in the initial MCNP input file, so for any isotope that is in the initial MCNP input file and is not "automatic," *monteburns* looks to this list to find the appropriate cross section. Thus, the file *mbxs.inp* should contain a list of cross section identifiers to use for every isotope that is in the MCNP input file or that may become "important" (as mentioned above, it is prudent to identify every isotope/element for which an MCNP cross section is available, followed by the preferred identifier). If fission products are to be lumped (as designated by a negative fractional importance), then *mbxs.inp* must also include two average fission product libraries, one for Uranium-235 and one for Plutonium-239 (typically 45117.90c and 46119.90c; if the user wishes to substitute different libraries he/she must use these same isotope numbers, i.e. 45117.??? and 46119.???). The total sum of fission products are divided into two groups according to the fraction of fissions that occur in uranium versus transuranic actinides respectively.

This file may just contain a list of all isotope identifiers in only one particular library if the user chooses to use only that library or it may be a list of a combination of isotope identifiers from various libraries (but only **one identifier per isotope**). An identifier consists of the atomic number of the isotope followed by the atomic mass number, a period, and a library identifier, such as 50c or 55c (for example, 92238.50c for Uranium-238). In general, the numbers listed in this file will not frequently change, so the user can usually create a *mbxs.inp* file initially (or use/modify the one provided with the source code) and continue using it for a variety of cases. This file must exist in the directory in which the user is operating or *monteburns* will not run correctly. A sample *mbxs.inp* file is displayed in Appendix D.

TABLE 5a
DESCRIPTION/EXAMPLE 1 OF FEED INPUT FILE

Step #	Time Step (days)	Fract- ion of Power	Mat. # in Each Region	Feed Group #	1stFeed Rate Column	2ndFeed Rate Column	Remov. Group #	Remov. Group Fraction
1	182.62	1.000	1	0	0.0	0.0	0	1.000
			2	0	0.0	0.0	-1	1.000
2	365.25	1.000	2	1	-2.0	1250.0	0	1.000
			1	0	0.0	0.0	-1	1.000
3	547.87	1.000	2	1	-2.0	1150.0	0	1.000
			1	0	0.0	0.0	-1	1.000
4	730.50	1.000	2	1	-2.0	1070.0	0	1.000
			1	0	0.0	0.0	-1	1.000
5	730.50	1.000	2	1	-2.0	1050.0	0	1.000
			1	0	0.0	0.0	-1	1.000
Variable					Format		Example	
Number of Feed Materials					i4		1	
For Each Feed Material:								
Number of isotopes in feed					i4		12	
Atomic Number/Atomic Mass Number of each isotope followed by weight fraction of that isotope in feed material (Note: this value does not have to add up to one. It can be fractionated however the user desires. For example, for the numbers listed in the right hand column, they add up to 1.31, but they are relative to each other and the total amount of grams/day of each isotope is equal to the value entered in the first block times this weight fraction regardless if it adds up to one or not.)					i5,f9.7		43099 0.310000 93237 0.044916 94238 0.014001 94239 0.514214 94240 0.237591 94241 0.078681 94242 0.048014 95241 0.051421 95242 0.000068 95243 0.009262 96243 0.000034 96244 0.001797	
Number of Removal Groups					i4		1	
For Each Removal Group:								
Number of Ranges for Group					i4		2	
Range(s) of Atomic Numbers for Removal Group					i4,i4		10 42 44 79	

TABLE 5b
EXAMPLE 2 OF FEED INPUT FILE

Step #	Time Step (days)	Fraction of Power	Mat. # in Each Region	Feed Group #	1stFeed Rate Column	2ndFeed Rate Column	Remov. Group #	Remov. Group Fraction
1	182.62	1.000	1	1	1400.0	1300.0	1	1.000
2	365.25	1.000	1	1	-1.0	1250.0	1	1.000
3	547.87	1.000	1	1	-1.0	1150.0	1	1.000
4	730.50	1.000	1	1	-1.0	1070.0	1	1.000
5	730.50	1.000	1	1	-1.0	1050.0	1	1.000
6	365.25	0.000	1	1	0.0	0.0	0	0.000
7	365.25	0.000	1	1	0.0	0.0	0	0.000
Variable					Format	Example		
Number of Feed Materials					i4	1		
<i>For Each Feed Material:</i>								
Number of isotopes in feed					i4	2		
Identifier/Weight Fraction					i5,f9.7	94239 0.94 94240 0.06		
Number of Removal Groups					i4	1		
<i>For Each Removal Group:</i>								
Number of Ranges					i4	1		
Range					i4,i4	43 43		

6.0 ERROR MESSAGES

There are a number of problems that can occur in *monteburns*, some of which may be caused by errors in the user's input files. Such errors are accompanied by warning or error messages that appear on the screen (with the exception of one, which appears in the file *f9err_#*) to notify the user of the potential problem. These messages are listed and described in Table 6.

TABLE 6
ERROR MESSAGES

Error Message	Cause
'***** MB ERROR: No tally volume'	If the user inputs a material volume of 0.0 in the <i>***.inp</i> file, then the volume of the MCNP material must be obtained by adding up the volume of each cell containing that material in the MCNP output file. If MCNP contains no value for any cells containing that material, then this error message will appear. Since this volume is used in energy spectrum and cross section tally calculations, <i>monteburns</i> will terminate after displaying this error message if the volume is zero.
'***** MB WARNING: Natural iso xs not found #####'	The MCNP cross section libraries used in this program only have a limited number of values for natural elements. If the natural element entered by the user is not found in the cross section library used in this program, then this error message appears and the element will not be included in the MCNP input files. The cause of this error could either be that the user forgot to put the natural element cross section in <i>mbxs.inp</i> or it does not exist in MCNP (in which case the MCNP input file would not work anyway).
'***** MB WARNING: Iso xs not found #####'	This warning message appears when the cross section for one of the isotopes originally found in the MCNP input file cannot be found in the file <i>mbxs.inp</i> (the user should add it to this file).
'***** MB ERROR: Invalid removal group entered for outer step number #'	In the feed input file, the user must enter the number of the removal group associated with each outer burn step. Additionally, he/she must also enter the number of removal groups again in the final block along with the atomic number of the elements which belong in the removal group. If the user enters a removal group number greater than the value of the number of removal groups, then this error message appears on the screen and <i>monteburns</i> stops running (# stands for the outer burn step number).

TABLE 6 (cont)

<p>'***** MB ERROR: Not all user-specified MCNP materials were found in MCNP output file'</p>	<p>In the <i>monteburns</i> input file (***.inp), the user must specify which material(s) from MCNP he/she wishes to have burned (i.e. transferred between ORIGEN2 and MCNP). If one or more of these materials are not found in the MCNP output file, then this error message will appear on the screen and <i>monteburns</i> will terminate</p>
<p>'***** MB ERROR: Tally read error'</p>	<p>This means that the flux tally value from an MCNP output file was read as zero. A flux value of zero is then transferred to an ORIGEN2 input file, which means that no burnup will occur. Nonetheless, <i>monteburns</i> does not stop running.</p>
<p>'***** MB ERROR: Cross Section Tallies Not Correct'</p>	<p>If there are not enough tally output results in the MCNP output file for the number of tallies needed, then this error message will occur. It typically indicates a problem with the MCNP run. This error could be caused by tallies that existed in the initial MCNP deck (if they were numbered >100), or if the user exceeds the maximum allowable material limits.</p>
<p>'***** MB WARNING: Isotope ##### not found in fort.9'</p>	<p>There are some fission and activation products produced during the irradiation of a material that do not have cross section values in the working ORIGEN2 cross section file. Thus, their fraction importance in the areas of absorption and fission contribution cannot be calculated (although atom and weight fraction are). These fission and activation products are listed with this warning message in the file "f9err_\$" (\$ is the <i>monteburns</i> material number).</p>
<p>'***** MB WARNING: mcnp xs not found #####'</p>	<p>The MCNP cross section libraries used in this program have a limited number of isotopes for which cross section values exist. If an isotope is determined by <i>monteburns</i> to be "important," but its cross section identifier for MCNP does not exist in the file <i>mbxs.inp</i>, then this warning message appears and the isotope is not transferred back to MCNP. This message may also appear if an isotope from a natural element in the initial MCNP input is found to be "important" but does not have a cross section because it is a natural element. It is then typically included in the MCNP input file as part of the natural element.</p>

TABLE 6 (cont)

<p>***** MB WARNING: No Uranium (or Plutonium) Fission Product library was provided in <i>mbxs.inp</i></p>	<p>If the fractional importance value is negative, then fission products resulting from ORIGEN2 irradiation calculations (except those deemed "important") are summed together and given two general MCNP cross sections for fission products (the total sum is divided according to the percent of fissions caused by U-235 and Pu-239 and given the appropriate cross section for each). If either of these two fission product cross section libraries is not included in <i>mbxs.inp</i>, then this message appears and they are neglected.</p>
--	---

7.0 OUTPUT FILES

Two large, primary output files are produced by *monteburns*. These output files consist of the name of the MCNP input file created by the user followed by an extension (similar to the input files for *monteburns*). The extensions of these output files are ".mbout" (see Appendix E for a sample file) and ".mbchk" (due to its large size, this output file is not included in this manual). For each of the output groups listed below (except the first two, which do not contain material-dependent parameters), results appear for each *monteburns* material region being analyzed. Note: this is not the same as the MCNP material number initially assigned to each region. Since shuffling between regions occurs, there is no way to keep track of results for each MCNP material, so the results for each region during each outer burn step appear instead. The user can then track each MCNP material individually through these regions.

In the first output file (***.mbout), the following results are reported:

- Monteburns MCNP k-eff versus time - displays a list of the cumulative time (in days) for which irradiation has occurred, the effective multiplication factor (k_{eff}), associated relative error, v (see Equations 8 and/or 9), average recoverable energy per fission (as calculated by *monteburns*) in MeV, and η for the system (see Equations 4 and 10 respectively).
- Monteburns MCNP k-eff at beginning of step - contains a list of the cumulative time (in days) of irradiation that has occurred before each step begins as well as the effective multiplication factor, relative error, and v at the beginning of each step (after discrete feed has been added). This data is only included in the output if discrete feed is used and intermediate k_{eff} calculations are requested.
- Monteburns Transport History - for each material at each outer burn-step, this history displays recoverable energy per fission (see Equation 1), neutron flux, macroscopic fission cross section (Σ_f), power generation (for the material), capture - (n,γ), fission - (n,f), and ($n,2n$) cross sections, the ratio of fission to capture, and η (see Equation 10); these last five parameters are relevant for the actinides only.
- Monteburns Flux Spectrum - contains the flux of neutrons for the following energy ranges: 0 to 0.1 eV, 0.1 to 1 eV, 1 to 100 eV, 100 eV to 100 keV, 100 keV to 1 MeV, and 1 MeV to 20 MeV for each outer burn step. To obtain a more detailed spectrum, the user must enter his/her own tallies into the MCNP input file (or modify *monteburns*).
- Monteburns 1-group n,gamma cross sections - the value of the microscopic capture cross section (σ_c) for the tally isotopes identified by the user as "automatic" for each outer burn step.
- Monteburns 1-group fission cross sections - the value of the microscopic fission cross section (σ_f) for the tally isotopes identified by the user as "automatic" for each outer burn step.

- Monteburns fission to capture ratio - the ratio of the microscopic fission cross section to the microscopic capture cross section (σ_f / σ_c) for the tally isotopes identified by the user as "automatic" for each outer burn step.
- Monteburns grams of material at beginning of steps - the amount of material (in grams) of each of the "automatic" isotopes that exist before each outer burn step is run.
- Monteburns grams of material at ends of steps - the amount of material (in grams) of each of the "automatic" isotopes after each outer burn step is completed.
- Monteburns grams of feed per step - the amount of material (in grams) of each of the "automatic" isotopes that is added to the system during each outer burn step.
- Monteburns grams produced (or destroyed) per step - the amount of material (in grams) of each of the "automatic" isotopes produced (or destroyed if the output is negative) during irradiation for each outer burn step. The interpretation of this data may depend on feed, removal, or material shuffling.
- Summary of inventory/feed/production - the amount of each "automatic" isotope (in grams) at the beginning and end of *monteburns*, the amount of each added through feed material, and the net change in each. The interpretation of this data may depend on feed, removal, or material shuffling.
- Feed rate (g/day) - the average continuous feed rate (in grams per day) of each isotope in the feed material for each outer burn step.
- Production/Destruction rate (g/day) - the rate of change (in grams per day) of each isotope in the feed material that is produced to that destroyed during irradiation for each outer burn step. The interpretation of this data may depend on feed, removal, or material shuffling.
- The feed input file - if it exists, this file is included at the end of this output file so that the user can determine what feed input file he/she used to produced the results presented in this output file.

In the second output file (***.mbchk), many intermediate results from the execution of *monteburns* are identified. In this output file, the following results are reported for each *monteburns* material analyzed:

- Monteburns spectrum for each predictor step - lists the values of the flux spectrum 1/2 way through each outer burn step. The flux spectrum is given for each outer burn step in the following energy ranges: 0 to 0.1 eV, 0.1 to 1 eV, 1 to 100 eV, 100 eV to 100 keV, 100 keV to 1 MeV, and 1 MeV to 20 MeV. This can be used to determine if smaller time intervals or more predictor steps need to be run.
- Monteburns grams at 1/2 step - lists the amount of each isotope (in grams) present 1/2 way through the irradiation both for the predictor step and the actual step. The grams of each automatic "important" isotope present 1/2 way through the last predictor step are listed first for each outer burn step followed by the composition of these isotopes 1/2 way through the actual step. This way the user

can determine if the predictor step provided accurate enough results or if more predictor steps (or smaller time intervals) need to be run. If the two values for any isotope are significantly different, then *monteburns* should be run using more predictor steps to obtain more representative cross section values.

- Fractional importance of isotopes sent from ORIGEN2 to MCNP - this lists the isotopes that were included in the "total number of tally isotopes" each time MCNP is run. This list contains the total mass of the isotope in the specified region, and the fractional importance of each isotope in the following four categories: atom fraction, mass fraction, capture, and fission. If a number in the fission column reads 0.1, then 10% of the fissions occurred in this material. This file also includes a warning message if an isotope that is deemed "important" by *monteburns* or "automatic" by the user is not found in the MCNP cross section library used by *monteburns*.

8.0 LIMITATIONS OF AND FUTURE WORK FOR MONTEBURNS

Monteburns was designed to run on a Solaris Release 2.6 system. *Monteburns* should work with no or limited modifications on other UNIX systems, provided that the user has working versions of MCNP and ORIGEN2.1. *Monteburns* is not yet capable of running on VMS or PC systems.

Monteburns is only as good as the MCNP cross sections that are available to the user. If cross section libraries do not exist for several fission products or actinides, or cross sections at the appropriate temperatures are not available, then *monteburns* results should be closely scrutinized.

Monteburns output only contains data relating to material isotopics and a few reactor physics parameters (k_{eff} , η , ν , etc.). It can be modified in the future, however, to extract more values, such as material activations and decay powers, depending on what uses the program might eventually have.

Monteburns currently uses the most simple form of the predictor-corrector method. In the future a more sophisticated numerical technique could be applied, although the simple method has proven adequate for problems studied thus far.

Monteburns currently uses ORIGEN2.1. There may be some advantages to using ORIGEN-S in the future, due to increased output options, improved default cross section sets, and possibly wider availability.

In addition to the possible modifications above, work is ongoing to make the input/output of *monteburns* more user-friendly. Also, work is continuing in the benchmarking of *monteburns* to experimental and analytical burnup results.

9.0 IMPLEMENTATION OF MONTEBURNS

The *monteburns* executable can be run on most any UNIX platforms as long as the following files are present in the working directory, and the directory has access to MCNP and ORIGEN2 (including the libraries). The symbol '***' represents the name the user assigns to the input files (Note: all three input files must have the same name with different extensions).

- *** - MCNP input file
- ***.inp - user's input file
- ***.feed (optional) - feed input file
- *mbxs.inp* - MCNP cross section file
- *monteb* (FORTRAN77 executable) and/or *monteb.f* (FORTRAN77 program)
- *monteburns* c-shell file

To execute the c-shell file executable *monteburns* on a UNIX system, the user must have a copy of *monteburns* and either the executable FORTRAN77 program *monteb* that is operable on his/her system or compile the executable from the FORTRAN77 program *monteb.f*. The FORTRAN77 program can be compiled using the following command:

```
% f77 -o monteb monteb.f
```

Monteburns can then be run by typing the following command at the UNIX prompt:

```
% csh monteburns ***
```

where *** is the name of the MCNP input files and base name for the other input files.

After entering the above information, *monteburns* should be running and a number of intermediate results will be displayed on the screen as it runs.

10.0 REFERENCES

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6. A. G. Croff, *A User's Manual for ORIGEN2 Computer Code*, Oak Ridge National Laboratory, ORNL/TM-7175, July 1980.

11.0 APPENDICES

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See the enclosed appendices.

APPENDIX A - MCNP Input File - adv1d

adv1d Advanced ATW, 2mDiamx2mHigh, 2 GW, 0.5mTarg, Equil,
c Fuel - PWR mix

```

c
100 2 -10.242 100 -120 -205 imp:n=1 $ Lead
120 2 -10.242 120 -130 -200 imp:n=1 $ Lead Below Target
140 2 -10.242 130 -131 421 -200 imp:n=1 $ Lead Target
141 2 -10.242 130 -131 -421 imp:n=1 $ B4C Insert
150 20 -7.9 131 -132 -200 imp:n=1 $ Target Window
260 0 132 -160 421 -200 imp:n=1 $ Void Above Lead Target
261 0 132 -160 -421 imp:n=1 $ B4C Insert
280 2 -10.242 120 -140 204 -205 imp:n=1 $ Lead
400 2 -10.242 140 -160 200 -205 imp:n=1 $ Lead
420 61 0.04284 120 -140 200 -201 imp:n=1 $ Fuel
440 63 0.04284 120 -140 201 -202 imp:n=1 $ Fuel
460 64 0.04284 120 -140 202 -203 imp:n=1 $ Fuel
480 6 0.07372 120 -140 203 -204 imp:n=1 $ Moderated Tc Targets
999 0 -100:160:205 imp:n=0 $ Void

```

```

100 pz -350.0
120 pz -100.0
130 pz -40.0
131 pz 15.0
132 pz 16.0
140 pz 100.0
160 pz 350.0

```

```

c
200 cz 25.0
201 cz 61.237
202 cz 82.916
203 cz 100.0
204 cz 113.5
205 cz 400.0

```

```

c
421 cz 24.99

```

```

m2 82000.50c 0.445 $ LBE, TD@400C=10.242 g/cc
83209.50c 0.555

```

```

c
c
m6 1001.50c 0.031633 $ ZrH1.8 Moderated Tc Assembly, TD 0.07483
6000.50c 4.753e-5
14000.50c 2.541e-4
15031.50c 1.037e-5
16000.60c 6.676e-6
24000.50c 2.333e-3
25055.50c 2.598e-4
26000.50c 8.350e-3
28000.50c 1.459e-3
40000.56c 0.017573
42000.50c 1.860e-4
43099.50c 0.002284
82000.50c 0.004168
83209.50c 0.005154

```

```

c
m20 40000.56c -0.0001 $ Croloy 1.25, from Maria and Ann-Louise
12000.50c -0.0035
6000.50c -0.001
25055.50c -0.004
14000.50c -0.003
24000.50c -0.0125
42000.50c -0.006
26000.55c -0.9699

```

```

c pwr1
m61 92238.50c 2.091E-04
93237.55c 3.797E-05
94238.50c 1.179E-05
94239.55c 4.310E-04

```



```
94240.50c 1.983E-04
94241.50c 6.540E-05
94242.50c 3.975E-05
95241.50c 4.274E-05
95242.50c 5.226E-08
95243.50c 7.641E-06
96243.35c 3.136E-08
96244.50c 1.474E-06
40000.56c 7.523E-03
82000.50c 7.166E-03
83209.50c 8.938E-03
22000.50c 2.504E-05
24000.50c 3.675E-03
26000.50c 1.409E-02
28000.50c 3.052E-03
42000.50c 3.734E-04
c pwr2
m63 92238.50c 2.382E-04
93237.55c 4.326E-05
94238.50c 1.343E-05
94239.55c 4.911E-04
94240.50c 2.260E-04
94241.50c 7.452E-05
94242.50c 4.529E-05
95241.50c 4.870E-05
95242.50c 5.955E-08
95243.50c 8.706E-06
96243.35c 3.573E-08
96244.50c 1.679E-06
40000.56c 7.377E-03
82000.50c 7.166E-03
83209.50c 8.938E-03
22000.50c 2.504E-05
24000.50c 3.675E-03
26000.50c 1.409E-02
28000.50c 3.052E-03
42000.50c 3.734E-04
c pwr3
m64 92238.50c 2.639E-04
93237.55c 4.792E-05
94238.50c 1.488E-05
94239.55c 5.441E-04
94240.50c 2.504E-04
94241.50c 8.256E-05
94242.50c 5.018E-05
95241.50c 5.395E-05
95242.50c 6.597E-08
95243.50c 9.645E-06
96243.35c 3.958E-08
96244.50c 1.860E-06
40000.56c 7.249E-03
82000.50c 7.166E-03
83209.50c 8.938E-03
22000.50c 2.504E-05
24000.50c 3.675E-03
26000.50c 1.409E-02
28000.50c 3.052E-03
42000.50c 3.734E-04
print
tmp 6.032e-8 13r
c Cell 141 is source
nps 50
c
c Source, d3=5 - evaporation spectrum, d1 gives parabolic
c distribution with radius of 24.9 cm, d2 gives cubic dist
c from -40 to 15 cm (top of target)
c
sdef par=1 erg=d3 pos=0 0 -40 axs=0 0 1 rad=d1 ext=d2
sp1 -21 0.
sil 24.9
c sp2 -31 0.0667
sp2 -21 3.
```

si2 0. 54.99
sp3 -5
dbcn 12j 7.01e7

End of Appendix A

APPENDIX B - Monteburns Input File - adv1d.inp

adv1d Advanced ATW, 2mDiamx2mHigh, 2 GW, 0.5mTarg, Equil, moderated by Tc99/ZrH

```

4      ! Number of MCNP materials
61     ! MCNP Material number (must be less than 100)
63     ! MCNP Material number of MB material 2
64     ! MCNP Material number of MB material 3
6      ! MCNP Material number of MB material 4
0.     ! Material volume #1 (cc), input 0 to use mcnp value (if exists)
0.     ! Material volume #2
0.     ! Material volume #3
0.     ! Material volume #4
2000.  ! Total Power of System (in MWt)
-200.  ! Recov. energy/fission (MeV); if negative use for U235 and scale
0.     ! Total number of days burned (used if no feed)
20     ! Number of outer burn steps
40     ! Number of internal burn steps (multiple of 10)
1      ! Number of predictor steps (+1 on first step)
0      ! Step number to restart after (0=beginning)
60     ! Number of origen2 library - next line is origen2 lib. location
/export/space11/dip/origen/libraries
.005   ! 0) no Fps -1) U235 Fps -2) Pu239 Fps >0) % contrib.
1      ! Intermediate keff calc. 0) No 1) Yes
17     ! Number of automatic tally isotopes, followed by list.
17
17
4
17     ! Number of total tally iso's (= above for 1st iteration)
17
17
4
92238.50c ! Region 1
93237.55c
94238.50c
94239.55c
94240.50c
94241.50c
94242.50c
95241.50c
95242.50c
95243.50c
96242.50c
96243.35c
96244.50c
96245.35c
96246.35c
96247.35c
96248.35c
92238.50c ! Region 2
93237.55c
94238.50c
94239.55c
94240.50c
94241.50c
94242.50c
95241.50c
95242.50c
95243.50c
96242.50c
96243.35c
96244.50c
96245.35c
96246.35c
96247.35c
96248.35c
92238.50c ! Region 3
93237.55c
94238.50c
94239.55c
94240.50c

```

94241.50c
94242.50c
95241.50c
95242.50c
95243.50c
96242.50c
96243.35c
96244.50c
96245.35c
96246.35c
96247.35c
96248.35c
1001.50c ! Region 4
43099.50c
83209.50c
94239.55c

End of Appendix B

APPENDIX C - Feed Input File - adv1d.feed

TimeStep Feed#PowFr mat#BeginAndEnd(-1=previous)RemovalGroup#FractionF.P.Removed
(i4) (f8.2), (f7.3) (i4)(i4) grams/day(2f8.1)(i4)(f7.3)

```

1 106.54 1.000 1 0 0.0 0.0 -1 0.990!
    2 0 0.0 0.0 0 0.000!
    3 0 0.0 0.0 0 0.000!
    4 0 0.0 0.0 -2 0.999!
2 106.54 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2700.0 0 0.000!
    4 2 -2.0 26716.9 -2 0.999!
3 106.54 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2550.0 0 0.000!
    4 2 -2.0 26716.9 -2 0.999!
4 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2450.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
5 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2380.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
6 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2320.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
7 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2270.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
8 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2225.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
9 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2185.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
10 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2150.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
11 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2120.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
12 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2095.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
13 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2075.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
14 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2055.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
15 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2035.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
16 121.76 1.000 2 0 0.0 0.0 -1 0.990!
    3 0 0.0 0.0 0 0.000!
    1 1 -2.0 2015.0 0 0.000!
    4 2 -2.0 23377.3 -2 0.999!
17 121.76 1.000 2 0 0.0 0.0 -1 0.990!

```

```

      3 0  0.0  0.0  0 0.000!
      1 1 -2.0 2000.0 0 0.000!
      4 2 -2.0 23377.3 -2 0.999!
18 121.76 1.000 2 0  0.0  0.0 -1 0.990!
      3 0  0.0  0.0  0 0.000!
      1 1 -2.0 1985.0 0 0.000!
      4 2 -2.0 23377.3 -2 0.999!
19 121.76 1.000 2 0  0.0  0.0 -1 0.990!
      3 0  0.0  0.0  0 0.000!
      1 1 -2.0 1970.0 0 0.000!
      4 2 -2.0 23377.3 -2 0.999!
20 121.76 1.000 2 0  0.0  0.0 -1 0.990!
      3 0  0.0  0.0  0 0.000!
      1 1 -2.0 1955.0 0 0.000!
      4 2 -2.0 23377.3 -2 0.999!

  2      !# of feed specs
 12      !# isos in Feed #1, TC-99, LWR Discharge
92238 .250000
93237 .044916
94238 .014001
94239 .514214
94240 .237591
94241 .078681
94242 .048014
95241 .051421
95242 .000068
95243 .009262
96243 .000034
96244 .001797
  4
1001 .007061
25055 .003161
43099 .050031
83209 .238545
  2      !# of removal groups
  2      !# of ranges for Feed #1 removal step
10 79      ! 1st range for Feed #1
92 92      ! 2nd range for Feed #1
  1      !# of ranges in rem group # 2
1 95      ! remove everything, natural iso's retained

```

End of Appendix C

APPENDIX D - Sample MCNP Cross Section Map - mbxs.inp

1001.50c
1002.55c
1003.50c
2003.50c
2004.50c
3006.50c
3007.55c
4007.35c
4009.50c
5010.50c
5011.56c
6012.50c
6013.35c
6000.50c
7014.50c
7015.55c
8016.50c
9019.50c
11023.50c
12000.50c
13027.50c
14000.50c
15031.50c
16000.60c
16032.50c
17000.50c
18000.50c
19000.50c
20000.50c
21045.55c
22000.50c
23051.31c
23000.50c
24000.50c
25055.50c
26000.55c
27059.50c
28058.35c
28000.50c
29000.50c
31000.50c
33074.35c
33075.35c
35079.55c
35081.55c
36078.50c
36080.50c
36082.59c
36083.59c
36084.59c
36086.59c
37085.55c
37087.55c
39088.35c
39089.35c
40093.50c
40000.56c
41093.50c
42095.50c
42000.50c
43099.50c
44101.50c
44103.50c
45103.50c
45105.50c
45117.90c
46105.50c

46108.50c
46119.90c
47107.50c
47109.50c
47000.55c
48000.50c
50000.35c
53127.55c
53135.50c
54131.50c
54134.35c
54135.50c
54000.35c
55133.50c
55135.50c
56138.50c
59141.50c
60143.50c
60145.50c
60147.50c
60149.50c
61147.50c
61148.50c
61149.50c
62147.50c
62149.50c
62150.50c
62151.50c
62152.50c
63151.55c
63152.50c
63153.55c
63154.50c
63155.50c
63000.35c
64152.52c
64154.50c
64155.50c
64156.50c
64157.50c
64158.50c
64160.50c
64000.35c
67165.55c
69169.55c
72000.50c
73181.50c
74182.55c
74183.55c
74184.55c
74186.55c
74000.55c
75185.35c
75187.35c
77000.55c
78000.35c
79197.56c
82000.50c
83209.50c
90231.35c
90232.50c
90233.35c
91231.50c
91233.50c
92233.50c
92234.50c
92235.50c
92236.50c
92237.50c
92238.50c
92239.35c
92240.35c

93235.35c
93236.35c
93237.55c
93238.35c
94237.35c
94238.50c
94239.55c
94240.50c
94241.50c
94242.50c
94243.35c
95241.50c
95242.50c
95243.50c
96242.50c
96243.35c
96244.50c
96245.35c
96246.35c
96247.35c
96248.35c
97249.35c
98249.35c
98250.35c
98251.35c
98252.35c

End of Appendix D

APPENDIX E - Sample Output File - adv1d.mbout

adv1d Advanced ATW, 2mDiamx2mHigh, 2 GW, 0.5mTarg, Equil, moderated by

Total Power (MW) = 2.00E+03 Days = 2.39E+03
outer steps = 20, # inner steps = 40, # predictor steps = 1
Fractional Importance Limit = 0.0050

Monteburns MCNP k-eff versus time

days	k-eff	rel err	nu	avQ6a	
0m	0.00	0.9650	0.0102	2.929	207.506
1m	53.27	0.8869	0.0241	2.883	207.641
1e	106.54	0.8788	0.0397	2.935	
2b	106.55	0.9747	0.0081	2.931	
2m	159.81	0.9056	0.0288	2.898	207.614
2e	213.08	0.9110	0.0313	2.932	
3b	213.09	0.8442	0.0405	2.878	
3m	266.35	0.9105	0.0259	2.906	207.615
3e	319.62	0.9053	0.0246	2.951	
4b	319.63	0.9319	0.0206	2.938	
4m	380.50	0.8943	0.0269	2.929	207.602
4e	441.38	0.9037	0.0244	2.937	
5b	441.39	0.9438	0.0134	2.947	
5m	502.26	0.9207	0.0225	2.942	207.552
5e	563.14	0.8408	0.0365	2.868	
6b	563.15	0.9053	0.0282	2.908	
6m	624.02	0.9270	0.0207	2.932	207.551
6e	684.90	0.8925	0.0289	2.938	
7b	684.91	0.9005	0.0284	2.925	
7m	745.78	0.8821	0.0311	2.932	207.472
7e	806.66	0.8687	0.0346	2.919	
8b	806.67	0.9127	0.0264	2.941	
8m	867.54	0.7754	0.0479	2.920	207.456
8e	928.42	0.7625	0.0571	2.922	
9b	928.43	0.8892	0.0328	2.929	
9m	989.30	0.8457	0.0334	2.915	207.513
9e	1050.18	0.8806	0.0356	2.932	
10b	1050.19	0.7916	0.0420	2.918	
10m	1111.06	0.8108	0.0454	2.915	207.448
10e	1171.94	0.7720	0.0633	2.906	
11b	1171.95	0.8518	0.0319	2.925	
11m	1232.82	0.8413	0.0518	2.939	207.459
11e	1293.70	0.7954	0.0553	2.886	
12b	1293.71	0.9489	0.0157	2.934	
12m	1354.58	0.8951	0.0331	2.938	207.508
12e	1415.46	0.7636	0.0577	2.968	
13b	1415.47	0.7853	0.0503	2.900	
13m	1476.34	0.8719	0.0393	2.968	207.460
13e	1537.22	0.8809	0.0284	2.928	
14b	1537.23	0.8641	0.0468	2.964	
14m	1598.10	0.7482	0.0542	2.895	207.417
14e	1658.98	0.7449	0.0749	2.941	
15b	1658.99	0.8845	0.0352	2.952	
15m	1719.86	0.6984	0.0992	2.989	207.465
15e	1780.74	0.6950	0.0647	2.938	
16b	1780.75	0.8497	0.0403	2.970	
16m	1841.62	0.7929	0.0696	2.932	207.513
16e	1902.50	0.7711	0.0685	2.953	
17b	1902.51	0.8575	0.0487	2.981	
17m	1963.38	0.7746	0.0622	2.932	207.446
17e	2024.26	0.6652	0.1013	2.948	
18b	2024.27	0.7925	0.0552	2.963	
18m	2085.14	0.8019	0.0518	2.944	207.578
18e	2146.02	0.7537	0.0565	3.002	
19b	2146.03	0.8463	0.0324	3.006	
19m	2206.90	0.8838	0.0278	3.021	207.516
19e	2267.78	0.6937	0.0724	2.921	
20b	2267.79	0.8064	0.0447	2.909	
20m	2328.66	0.7189	0.0644	2.942	207.490
20e	2389.54	0.7177	0.0687	2.912	

Monteburns MCNP k-eff at beginning of step

days	k-eff	rel err	nu	
2b	106.55	0.9747	0.0081	2.931
3b	213.09	0.8442	0.0405	2.878
4b	319.63	0.9319	0.0206	2.938
5b	441.39	0.9438	0.0134	2.947
6b	563.15	0.9053	0.0282	2.908
7b	684.91	0.9005	0.0284	2.925
8b	806.67	0.9127	0.0264	2.941
9b	928.43	0.8892	0.0328	2.929
10b	1050.19	0.7916	0.0420	2.918
11b	1171.95	0.8518	0.0319	2.925
12b	1293.71	0.9489	0.0157	2.934
13b	1415.47	0.7853	0.0503	2.900
14b	1537.23	0.8641	0.0468	2.964
15b	1658.99	0.8845	0.0352	2.952
16b	1780.75	0.8497	0.0403	2.970

17b 1902.51 0.8575 0.0487 2.981
18b 2024.27 0.7925 0.0552 2.963
19b 2146.03 0.8463 0.0324 3.006
20b 2267.79 0.8064 0.0447 2.909

Monteburns Transport History

Monteburns Transport History for material 1

	Qts	flux	SigmaF	power	n_gamma	n_fission	fs/cap	n2n	eta	
0	207.506	1.40E+16	1.00E-03	910.276	5.63E-01	1.02E+00	1.82E+00	3.20E-04	1.890	
1	207.603	1.62E+16	8.97E-04	948.443	5.61E-01	9.80E-01	1.75E+00	1.68E-04	1.833	
2	207.564	1.39E+16	8.73E-04	790.836	5.86E-01	9.22E-01	1.57E+00	1.94E-04	1.772	
3	207.570	1.31E+16	9.01E-04	772.114	5.59E-01	8.94E-01	1.60E+00	2.85E-04	1.788	
4	207.500	1.21E+16	9.11E-04	717.257	5.67E-01	8.55E-01	1.51E+00	7.37E-05	1.761	
5	207.435	1.25E+16	8.85E-04	719.293	5.29E-01	8.10E-01	1.53E+00	1.85E-04	1.780	
6	207.409	1.24E+16	8.85E-04	718.169	4.94E-01	7.63E-01	1.54E+00	2.31E-04	1.767	
7	207.413	1.66E+16	9.13E-04	988.327	4.96E-01	7.52E-01	1.52E+00	3.86E-04	1.761	
8	207.354	2.09E+16	8.34E-04	1136.100	4.57E-01	6.94E-01	1.52E+00	1.70E-04	1.762	
9	207.379	1.67E+16	9.10E-04	989.802	4.96E-01	7.26E-01	1.47E+00	2.03E-04	1.732	
10	207.357	1.86E+16	9.03E-04	1098.292	5.24E-01	7.02E-01	1.34E+00	7.16E-04	1.670	
11	207.322	1.91E+16	8.27E-04	1027.135	4.75E-01	6.60E-01	1.39E+00	3.57E-04	1.709	
12	207.422	1.47E+16	9.13E-04	878.329	4.94E-01	6.77E-01	1.37E+00	1.81E-04	1.699	
13	207.413	1.52E+16	9.14E-04	903.577	4.71E-01	6.68E-01	1.42E+00	7.12E-04	1.742	
14	207.348	2.43E+16	8.61E-04	1366.330	4.92E-01	6.41E-01	1.30E+00	3.43E-04	1.637	
15	207.413	2.63E+16	8.82E-04	1511.152	4.73E-01	6.39E-01	1.35E+00	3.55E-04	1.718	
16	207.426	1.95E+16	8.49E-04	1080.810	4.21E-01	6.20E-01	1.47E+00	5.93E-04	1.747	
17	207.365	2.27E+16	8.00E-04	1185.041	4.38E-01	5.99E-01	1.37E+00	3.00E-04	1.693	
18	207.445	1.81E+16	8.39E-04	992.425	4.59E-01	6.07E-01	1.32E+00	3.10E-04	1.676	
19	207.470	1.52E+16	9.01E-04	892.458	4.20E-01	6.25E-01	1.49E+00	3.05E-04	1.807	
20	207.371	2.19E+16	8.09E-04	1153.736	4.07E-01	5.84E-01	1.43E+00	2.09E-04	1.733	

Monteburns Transport History for material 2

	Qts	flux	SigmaF	power	n_gamma	n_fission	fs/cap	n2n	eta	
0	207.506	8.27E+15	1.12E-03	604.736	5.01E-01	1.01E+00	2.01E+00	3.19E-04	1.955	
1	207.606	9.75E+15	1.08E-03	684.916	5.74E-01	1.01E+00	1.75E+00	6.47E-04	1.835	
2	207.579	8.74E+15	1.04E-03	595.773	5.68E-01	9.45E-01	1.66E+00	1.47E-04	1.810	
3	207.534	8.40E+15	1.02E-03	560.959	5.55E-01	8.77E-01	1.59E+00	2.28E-04	1.780	
4	207.496	7.81E+15	1.00E-03	510.116	4.83E-01	8.42E-01	1.74E+00	1.99E-04	1.861	
5	207.418	8.10E+15	1.05E-03	553.639	5.17E-01	8.27E-01	1.60E+00	1.94E-04	1.811	
6	207.434	7.30E+15	1.02E-03	484.254	4.62E-01	7.77E-01	1.68E+00	2.14E-04	1.840	
7	207.345	8.16E+15	1.00E-03	533.144	5.19E-01	7.55E-01	1.45E+00	2.89E-04	1.738	
8	207.439	1.01E+16	1.06E-03	698.541	5.32E-01	7.45E-01	1.40E+00	1.01E-04	1.705	
9	207.489	8.92E+15	1.04E-03	606.754	5.06E-01	7.38E-01	1.46E+00	6.88E-05	1.729	
10	207.395	9.31E+15	9.96E-04	604.566	4.94E-01	7.16E-01	1.45E+00	2.49E-04	1.726	
11	207.427	7.59E+15	1.06E-03	523.124	4.81E-01	7.16E-01	1.49E+00	5.45E-04	1.757	
12	207.403	8.13E+15	1.03E-03	546.442	4.32E-01	6.93E-01	1.60E+00	4.21E-04	1.809	
13	207.313	8.05E+15	9.73E-04	510.680	4.78E-01	6.68E-01	1.40E+00	9.38E-04	1.730	
14	207.406	1.01E+16	1.10E-03	726.053	4.71E-01	7.00E-01	1.49E+00	3.48E-04	1.731	
15	207.411	1.09E+16	1.11E-03	789.654	5.72E-01	7.06E-01	1.23E+00	4.93E-05	1.651	
16	207.486	9.06E+15	9.21E-04	544.538	4.36E-01	6.33E-01	1.45E+00	2.11E-04	1.737	
17	207.421	8.51E+15	9.94E-04	552.122	5.60E-01	6.50E-01	1.16E+00	3.93E-05	1.575	
18	207.608	9.66E+15	1.05E-03	669.563	4.11E-01	6.57E-01	1.60E+00	2.31E-04	1.812	
19	207.368	7.90E+15	9.18E-04	473.094	4.73E-01	6.18E-01	1.31E+00	4.54E-04	1.711	
20	207.480	9.81E+15	9.77E-04	625.493	4.89E-01	6.21E-01	1.27E+00	3.02E-04	1.646	

Monteburns Transport History for material 3

	Qts	flux	SigmaF	power	n_gamma	n_fission	fs/cap	n2n	eta	
0	207.506	4.08E+15	1.85E-03	493.434	1.08E+00	1.51E+00	1.40E+00	4.40E-04	1.708	
1	207.750	4.37E+15	1.93E-03	550.412	1.31E+00	1.63E+00	1.24E+00	7.41E-04	1.595	
2	207.702	4.28E+15	2.46E-03	688.797	1.68E+00	1.95E+00	1.16E+00	4.45E-04	1.559	
3	207.724	4.66E+15	2.42E-03	738.538	1.56E+00	1.88E+00	1.21E+00	2.44E-04	1.590	
4	207.765	4.38E+15	2.74E-03	784.013	1.68E+00	2.00E+00	1.18E+00	2.34E-04	1.588	
5	207.761	4.22E+15	2.73E-03	754.150	1.84E+00	1.94E+00	1.05E+00	7.04E-04	1.510	
6	207.759	4.29E+15	2.74E-03	768.445	1.65E+00	1.92E+00	1.17E+00	5.59E-04	1.579	
7	207.732	3.73E+15	1.97E-03	480.454	1.23E+00	1.33E+00	1.08E+00	1.53E-04	1.522	
8	207.691	3.68E+15	2.26E-03	542.775	1.34E+00	1.49E+00	1.11E+00	8.99E-04	1.537	
9	207.778	4.17E+15	2.04E-03	556.735	1.26E+00	1.38E+00	1.09E+00	2.93E-05	1.523	
10	207.735	4.00E+15	1.84E-03	481.581	1.15E+00	1.18E+00	1.03E+00	1.31E-04	1.477	
11	207.668	3.45E+15	2.24E-03	504.251	1.17E+00	1.43E+00	1.22E+00	2.43E-04	1.617	
12	207.759	3.78E+15	2.14E-03	527.775	1.14E+00	1.38E+00	1.22E+00	7.46E-04	1.612	
13	207.682	3.73E+15	2.16E-03	527.468	1.15E+00	1.31E+00	1.14E+00	1.30E-03	1.582	
14	207.652	4.06E+15	1.63E-03	431.461	9.73E-01	9.85E-01	1.01E+00	2.66E-04	1.456	
15	207.678	4.30E+15	2.04E-03	574.151	1.20E+00	1.30E+00	1.09E+00	0.00E+00	1.558	
16	207.748	3.78E+15	1.89E-03	466.588	1.06E+00	1.18E+00	1.11E+00	2.46E-04	1.543	
17	207.713	3.52E+15	1.79E-03	410.602	1.30E+00	1.07E+00	8.24E-01	1.19E-05	1.325	
18	207.775	4.43E+15	1.98E-03	573.841	9.28E-01	1.25E+00	1.34E+00	2.13E-04	1.688	
19	207.713	3.99E+15	2.18E-03	567.057	1.22E+00	1.31E+00	1.07E+00	3.35E-04	1.564	
20	207.752	4.03E+15	2.08E-03	546.660	1.07E+00	1.21E+00	1.13E+00	7.27E-05	1.562	

Monteburns Transport History for material 4

	Qts	flux	SigmaF	power	n_gamma	n_fission	fs/cap	n2n	eta	
0	200.000	1.09E+15	0.00E+00	0.000	1.22E+02	2.11E+02	1.73E+00	2.14E-05	1.857	
1	200.000	1.18E+15	0.00E+00	0.000	1.21E+02	2.12E+02	1.75E+00	1.17E-04	1.833	
2	0.000	1.68E+15	0.00E+00	0.000	1.74E+02	3.11E+02	1.79E+00	4.25E-06	1.860	
3	0.000	1.70E+15	0.00E+00	0.000	2.03E+02	3.99E+02	1.77E+00	1.35E-04	1.857	
4	0.000	1.97E+15	0.00E+00	0.000	2.06E+02	3.68E+02	1.79E+00	2.92E-05	1.877	
5	0.000	1.85E+15	0.00E+00	0.000	2.12E+02	3.81E+02	1.80E+00	7.98E-05	1.892	
6	0.000	1.73E+15	2.24E-11	0.000	2.12E+02	3.80E+02	1.79E+00	1.26E-04	1.881	
7	200.000	1.14E+15	0.00E+00	0.000	1.73E+02	3.10E+02	1.79E+00	1.97E-04	1.883	
8	0.000	9.71E+14	0.00E+00	0.000	1.81E+02	3.25E+02	1.79E+00	0.00E+00	1.873	
9	0.000	1.16E+15	0.00E+00	0.000	1.78E+02	3.18E+02	1.78E+00	8.36E-05	1.868	
10	0.000	1.17E+15	0.00E+00	0.000	1.95E+02	3.48E+02	1.78E+00	8.94E-05	1.868	
11	0.000	1.00E+15	0.00E+00	0.000	1.74E+02	3.12E+02	1.79E+00	0.00E+00	1.886	

MonteBurns Flux Spectrum
 12 0.000 1.09E+15 1.78E-10 0.000 1.79E+02 3.15E+02 1.75E+00 3.80E-04 1.875
 13 200.000 1.05E+15 3.20E-10 0.000 1.72E+02 3.01E+02 1.80E+00 1.78E-04 1.860
 14 200.000 6.74E+14 6.00E-10 0.000 1.74E+02 3.08E+02 1.77E+00 0.00E+00 1.912
 15 0.000 1.13E+15 0.00E+00 0.000 1.74E+02 3.08E+02 1.77E+00 0.00E+00 1.881
 16 0.000 8.96E+14 0.00E+00 0.000 1.89E+02 3.36E+02 1.78E+00 2.06E-04 1.884
 17 0.000 8.96E+14 0.00E+00 0.000 1.89E+02 3.36E+02 1.78E+00 2.06E-04 1.881
 18 0.000 1.18E+15 0.00E+00 0.000 1.81E+02 3.23E+02 1.79E+00 2.04E-04 1.938
 19 0.000 1.09E+15 0.00E+00 0.000 1.34E+15 0.00E+00 0.000 1.52E-04 1.881
 20 0.000 1.34E+15 0.00E+00 0.000 0.000 0.00E+00 0.000 1.52E-04 1.881

MonteBurns Flux Spectrum for material 1
 <1eV <100eV <100eV <1MeV >20MeV

MonteBurns Flux Spectrum for material 2
 <1eV <100eV <100eV <1MeV >20MeV

MonteBurns Flux Spectrum for material 3
 <1eV <100eV <100eV <1MeV >20MeV

MonteBurns Flux Spectrum for material 4
 <1eV <100eV <100eV <1MeV >20MeV

MonteBurns Flux Spectrum for material 5
 <1eV <100eV <100eV <1MeV >20MeV

7	18.11	21.95	12.48	23.06	17.34	7.06
8	18.65	23.12	11.96	23.52	14.72	8.03
9	17.61	23.64	11.35	23.34	17.87	6.19
10	19.40	25.62	11.44	21.24	14.90	7.39
11	17.67	22.74	12.38	22.74	17.27	7.20
12	16.51	24.00	11.94	24.34	15.14	8.07
13	17.82	21.93	11.39	23.47	17.52	7.86
14	18.39	22.51	11.51	23.72	19.30	4.57
15	18.05	22.54	13.03	24.98	17.90	3.50
16	21.14	24.57	9.83	23.13	14.86	6.46
17	18.59	25.56	11.52	22.45	13.72	8.16
18	18.85	24.09	10.85	23.22	17.35	5.64
19	18.67	23.35	11.65	22.57	16.52	7.23
20	18.20	26.37	10.64	21.59	14.93	8.27

Monteburns 1-group n,gamma cross sections

Monteburns 1-group n,gamma cross sections for material 1

92238.50c	93237.55c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.35c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c
0	3.25E-01	1.52E+00	7.36E-01	5.07E-01	5.38E-01	4.50E-01	4.27E-01	1.72E+00	3.89E-01	1.04E+00	3.17E-01	4.01E-01	8.02E-01	4.01E-01	3.92E-01	4.42E-01
1	3.32E-01	1.54E+00	7.23E-01	5.16E-01	5.27E-01	4.55E-01	4.26E-01	1.73E+00	3.94E-01	1.05E+00	3.09E-01	4.13E-01	8.25E-01	4.13E-01	4.07E-01	4.37E-01
2	3.66E-01	1.63E+00	7.80E-01	5.39E-01	5.66E-01	4.80E-01	4.34E-01	1.82E+00	4.21E-01	1.14E+00	3.40E-01	4.23E-01	8.64E-01	4.23E-01	4.39E-01	4.79E-01
3	3.36E-01	1.56E+00	7.30E-01	5.23E-01	5.46E-01	4.59E-01	4.34E-01	1.74E+00	3.98E-01	1.06E+00	3.58E-01	4.08E-01	8.22E-01	4.08E-01	3.85E-01	4.45E-01
4	3.27E-01	1.58E+00	7.88E-01	5.43E-01	5.68E-01	4.85E-01	4.38E-01	1.78E+00	4.25E-01	1.11E+00	3.32E-01	4.22E-01	8.44E-01	4.22E-01	4.38E-01	5.14E-01
5	3.37E-01	1.51E+00	7.26E-01	5.06E-01	5.16E-01	4.48E-01	4.11E-01	1.69E+00	3.82E-01	1.02E+00	3.04E-01	3.95E-01	8.36E-01	3.95E-01	3.74E-01	3.68E-01
6	2.88E-01	1.46E+00	7.00E-01	4.69E-01	5.00E-01	4.28E-01	4.04E-01	1.63E+00	3.58E-01	9.75E-01	2.83E-01	3.82E-01	7.88E-01	3.82E-01	3.66E-01	4.12E-01
7	2.94E-01	1.43E+00	6.99E-01	4.74E-01	5.08E-01	4.28E-01	4.02E-01	1.63E+00	3.56E-01	9.80E-01	3.21E-01	3.73E-01	7.43E-01	3.73E-01	3.77E-01	4.09E-01
8	2.85E-01	1.37E+00	6.65E-01	4.31E-01	4.59E-01	4.08E-01	3.73E-01	1.55E+00	3.36E-01	9.12E-01	2.89E-01	3.58E-01	7.30E-01	3.58E-01	3.35E-01	3.72E-01
9	3.08E-01	1.45E+00	6.83E-01	4.91E-01	5.12E-01	4.33E-01	4.02E-01	1.65E+00	3.74E-01	9.76E-01	2.80E-01	3.86E-01	7.65E-01	3.86E-01	3.60E-01	4.08E-01
10	3.47E-01	1.52E+00	7.15E-01	5.05E-01	5.36E-01	4.51E-01	4.15E-01	1.70E+00	3.89E-01	1.06E+00	3.07E-01	4.04E-01	7.89E-01	4.04E-01	3.82E-01	4.37E-01
11	2.88E-01	1.46E+00	6.94E-01	4.86E-01	4.82E-01	4.34E-01	3.95E-01	1.65E+00	3.63E-01	9.84E-01	3.02E-01	3.80E-01	7.97E-01	3.80E-01	3.61E-01	4.21E-01
12	3.09E-01	1.50E+00	7.09E-01	4.84E-01	5.07E-01	4.63E-01	4.16E-01	1.69E+00	3.81E-01	1.01E+00	2.97E-01	4.02E-01	8.19E-01	4.02E-01	4.61E-01	4.22E-01
13	2.99E-01	1.43E+00	6.79E-01	4.64E-01	4.78E-01	4.27E-01	3.89E-01	1.62E+00	3.59E-01	9.60E-01	2.98E-01	3.85E-01	7.87E-01	3.85E-01	3.55E-01	4.02E-01
14	3.23E-01	1.51E+00	6.93E-01	4.82E-01	5.15E-01	4.37E-01	4.08E-01	1.67E+00	3.70E-01	9.88E-01	2.79E-01	3.96E-01	7.88E-01	3.96E-01	3.86E-01	4.11E-01
15	3.12E-01	1.44E+00	6.78E-01	4.74E-01	4.72E-01	4.26E-01	3.97E-01	1.62E+00	3.55E-01	9.60E-01	2.70E-01	3.86E-01	7.77E-01	3.86E-01	3.66E-01	3.96E-01
16	2.65E-01	1.32E+00	6.27E-01	4.10E-01	4.45E-01	3.90E-01	3.81E-01	1.50E+00	3.10E-01	8.46E-01	2.37E-01	3.49E-01	7.25E-01	3.49E-01	3.29E-01	3.53E-01
17	2.82E-01	1.37E+00	6.44E-01	4.21E-01	4.69E-01	4.32E-01	3.72E-01	1.55E+00	3.27E-01	8.83E-01	2.44E-01	3.62E-01	7.46E-01	3.62E-01	3.40E-01	3.64E-01
18	2.98E-01	1.42E+00	6.72E-01	4.52E-01	4.96E-01	4.19E-01	3.88E-01	1.60E+00	3.45E-01	9.45E-01	2.68E-01	3.77E-01	7.66E-01	3.77E-01	3.74E-01	3.99E-01
19	2.85E-01	1.31E+00	6.20E-01	4.06E-01	4.29E-01	3.89E-01	3.57E-01	1.50E+00	3.09E-01	8.45E-01	2.41E-01	3.47E-01	7.12E-01	3.47E-01	3.24E-01	3.49E-01
20	2.65E-01	1.29E+00	6.13E-01	3.96E-01	4.25E-01	3.81E-01	3.60E-01	1.47E+00	2.97E-01	8.18E-01	2.23E-01	3.43E-01	7.04E-01	3.43E-01	3.24E-01	3.37E-01

Monteburns 1-group n,gamma cross sections for material 2

92238.50c	93237.55c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.35c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c
0	3.00E-01	1.38E+00	6.62E-01	4.39E-01	4.76E-01	4.09E-01	3.89E-01	1.56E+00	3.39E-01	9.26E-01	2.68E-01	3.61E-01	7.51E-01	3.61E-01	3.43E-01	3.83E-01
1	3.21E-01	1.56E+00	7.63E-01	5.24E-01	5.55E-01	4.41E-01	4.17E-01	1.76E+00	4.12E-01	1.07E+00	3.35E-01	4.22E-01	8.02E-01	4.22E-01	4.51E-01	4.81E-01
2	3.38E-01	1.55E+00	7.72E-01	5.16E-01	5.63E-01	4.60E-01	4.26E-01	1.74E+00	4.10E-01	1.08E+00	2.98E-01	4.10E-01	8.09E-01	4.10E-01	3.95E-01	4.50E-01
3	3.84E-01	1.50E+00	7.13E-01	5.15E-01	5.37E-01	4.64E-01	4.14E-01	1.70E+00	3.89E-01	1.03E+00	3.50E-01	4.02E-01	8.01E-01	4.02E-01	4.04E-01	3.30E-01
4	2.84E-01	1.40E+00	6.69E-01	4.60E-01	4.57E-01	4.17E-01	3.87E-01	1.59E+00	3.49E-01	9.34E-01	2.75E-01	3.79E-01	7.39E-01	3.79E-01	3.45E-01	4.08E-01
5	3.25E-01	1.47E+00	7.15E-01	4.88E-01	4.96E-01	4.44E-01	3.96E-01	1.66E+00	3.98E-01	9.74E-01	2.90E-01	3.93E-01	7.99E-01	3.93E-01	3.61E-01	4.08E-01
6	2.85E-01	1.34E+00	6.37E-01	4.25E-01	4.58E-01	4.00E-01	3.76E-01	1.52E+00	3.24E-01	8.85E-01	2.65E-01	3.60E-01	7.31E-01	3.60E-01	3.38E-01	3.61E-01
7	3.28E-01	1.52E+00	7.08E-01	4.95E-01	5.03E-01	4.51E-01	4.00E-01	1.70E+00	3.89E-01	1.04E+00	3.37E-01	4.06E-01	8.01E-01	4.06E-01	3.97E-01	4.18E-01
8	3.21E-01	1.57E+00	7.30E-01	5.05E-01	5.30E-01	4.60E-01	4.37E-01	1.77E+00	3.93E-01	1.06E+00	3.01E-01	4.17E-01	8.45E-01	4.17E-01	3.88E-01	4.28E-01
9	3.03E-01	1.49E+00	7.77E-01	4.91E-01	5.08E-01	4.44E-01	4.09E-01	1.68E+00	3.83E-01	9.95E-01	2.80E-01	3.76E-01	8.60E-01	3.76E-01	3.55E-01	4.25E-01
10	3.00E-01	1.46E+00	6.99E-01	5.19E-01	4.76E-01	4.38E-01	3.95E-01	1.65E+00	3.63E-01	9.95E-01	2.80E-01	3.76E-01	7.93E-01	3.76E-01	3.71E-01	4.40E-01
11	3.14E-01	1.42E+00	6.77E-01	4.63E-01	4.86E-01	4.25E-01	3.79E-01	1.62E+00	3.51E-01	9.46E-01	2.65E-01	3.77E-01	7.78E-01	3.77E-01	3.70E-01	4.09E-01
12	2.77E-01	1.31E+00	6.26E-01	4.14E-01	4.25E-01	3.89E-01	3.71E-01	1.49E+00	3.11E-01	8.47E-01	2.41E-01	3.47E-01	7.01E-01	3.47E-01	3.34E-01	3.54E-01
13	3.19E-01	1.42E+00	6.65E-01	4.42E-01	4.97E-01	4.22E-01	3.95E-01	1.60E+00	3.50E-01	9.44E-01	2.57E-01	3.76E-01	7.67E-01	3.76E-01	3.58E-01	3.77E-01
14	2.97E-01	1.44E+00	6.79E-01	4.57E-01	4.77E-01	4.25E-01	3.92E-01	1.62E+00	3.59E-01	9.58E-01	2.76E-01	3.92E-01	7.63E-01	3.92E-01	3.66E-01	3.96E-01
15	3.66E-01	1.67E+00	7.82E-01	5.76E-01	5.86E-01	5.01E-01	4.57E-01	1.88E+00	4.41E-01	1.15E+00	3.77E-01	4.38E-01	9.77E-01	4.38E-01	4.28E-01	4.93E-01
16	2.73E-01	1.31E+00	6.16E-01	4.00E-01	4.91E-01	3.88E-01	3.77E-01	1.49E+00	2.98E-01	8.38E-01	2.35E-01	3.25E-01	7.03E-01	3.25E-01	3.26E-01	3.45E-01
17	3.44E-01	1.72E+00	7.96E-01	5.73E-01	5.85E-01	5.02E-01	4.80E-01	1.91E+00	4.56E-01	1.18E+00	3.40E-01	4.87E-01	9.13E-01	4.87E-01	4.48E-01	4.81E-01
18	2.68E-01	1.26E+00	5.97E-01	3.81E-01	4.29E-01	3.73E-01	3.70E-01	1.44E+00	2.83E-01	7.94E-01	2.17E-01	3.25E-01	6.88E-01	3.25E-01	3.11E-01	3.27E-01
19	3.05E-01	1.47E+00	6.85E-01	4.62E-01	4.96E-01	4.32E-01	3.98E-01	1.65E+00	3.63E-01	9.75E-01	2.75E-01	3.90E-01	7.86E-01	3.90E-01	3.61E-01	3.92E-01
20	3.07E-01	1.54E+00	7.10E-01	4.79E-01	5.10E-01	4.54E-01	4.17E-01	1.73E+00	3.83E-01	1.08E+00	2.77E-01	4.06E-01	8.10E-01	4.06E-01	3.75E-01	4.41E-01

Monteburns 1-group n,gamma cross sections for material 3

92238.50c	93237.55c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.35c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c
0	4.16E-01	2.43E+00	1.03E+00	1.03E+00	1.27E+00	8.90E-01	8.95E-01	2.91E+00	1.54E+00	2.26E+00	6.24E-01	6.82E-01	1.00E+00	6.82E-01	5.93E-01	7.57E-01
1	6.35E-01	2.66E+00	1.66E+00	1.25E+00	1.33E+00	1.08E+00	1.69E+00	3.59E+00	2.25E+00	3.06E+00	1.21E+00	7.84E-01	8.23E-01	7.84E-01	4.95E-01	8.94E-01
2	5.86E-01	3.44E+00	1.55E+00	1.71E+00	1.91E+00	1.57E+00	2.09E+00	4.25E+00	3.23E+00	3.08E+00	7.97E-01	9.64E-01	3.17E+00	9.64E-01	6.67E-01	1.02E+00
3	7.25E-01	3.64E+00	1.76E+00	1.65E+00	1.53E+00	1.79E+00	1.19E+00	4.18E+00	3.85E+00	2.64E+00	8.59E-01	1.05E+00	1.15E+00	1.05E+00	8.35E-01	8.12E-01
4	5.05E-01	3.45E+00	1.73E+00	1.96E+00	1.86E+00	1.77E+00	1.23E+00	4.50E+00	4.11E+00	3.77E+00	9.10E-01	1.17E+00	1.26E+00	1.11E+00	8.23E-01	1.00E+00
5	7.18E-01	3.10E+00	1.61E+00	1.45E+00	1.42E+00	1.72E+00	1.72E+00	4.70E+00	4.45E+00	3.15E+00	5.32E-01	1.31E+00	2.08E+00	1.31E+00	6.94E-01	9.97E-01
6	5.20E-01	2.94E+00	1.78E+00	2.04E+00	1.58E+00	1.75E+00	1.69E+00	4.26E+00	4.56E+00	3.53E+00	6.82E-01	1.22E+00	2.59E+00	1.22E+00	5.76E-01	9.90E-01
7	7.59E-01	2.79E+00	1.43E+00	1.31E+00	1.46E+00	1.13E+00	1.77E+00	3.69E+00	3.22E+00	2.62E+00	5.56E-01	9.39E-01	1.23E+00	9.39E-01	4.51E-01	9.23E-01
8	5.25E-01	2.82E+00	1.53E+00	1.74E+00	1.35E+00	1.53E+00	6.43E-01	4.61E+00	3.21E+00	2.42E+00	5.56E-01	9.39E-01	1.09E+00	1.15E+00	8.81E-01	6.31E-01
9	4.80E-01	2.57E+00	1.49E+00	1.67E+00	1.36E+00	1.28E+00	7.15E-01	4.02E+00	3.02E+00	2.83E+00	4.57E-01	1.02E+00	1.05E+00	1.02E+00	5.55E-01	8.40E-01
0	3.95E-01	2.45E+00	1.40E+00	1.31E+00	1.54E+00	9.54E-01	4.47E-01	3.70E+00	2.21E+00	3.02E+00	5.81E-01	8.13E-01	1.15E+00	8.13E-01	7.70E-01	1.18E+00
1	3.92E-01	2.32E+00	1.57E+00	1.56E+00	1.74E+00	1.60E+00	1.08E+00	3.35E+00	3.68E+00	2.15E+00	4.45E-01	1.09E+00	1.42E+00	1.09E+00	7.83E-01	8.19E-01
2	4.12E-01	2.49E+00	1.52E+00	1.77E+00	1.16E+00	1.25E+00	4.35E-01	3.37E+00	3.41E+00	2.03E+00	7.08E-01	8.64E-01	1.19E+00	8.64E-01	4.03E-01	7.03E-01
3	3.88E-01	2.12E+00	1.72E+00	1.72E+00	1.42E+00	1.49E+00	8.09E-01	4.21E+00	2.75E+00	2.44E+00	6.82E-01	9.06E-01	1.01E+00	9.06E-01	5.76E-01	9.07E-01
4	3.80E-01	2.12E+00	9.64E-01	1.17E+00	1.18E+00	9.91E-01	6.33E-01	3.60E+00	1.67E+00	2.37E+00	3.27E-01	6.05E-01	9.76E-01	6.05E-01	4.48E-01	6.13E-01
5	6.89E-01	3.53E+00	1.40E+00	1.60E+00	1.22E+00	1.38E+00	4.21E+00	3.12E+00	1.87E+00	7.96E-01	9.39E-01	1.03E+00	9.39E-01	6.44E-01	8.00E-01	5.78E-01
6	3.62E-01	2.75E+00	1.41E+00	1.24E+00	1.34E+00	1.21E+00	9.19E-01	3.68E+00	1.69E+00	1.11E+00	1.11E+00	1.26E+00	1.26E+00	5.56E-01	7.38E-01	4.23E-01
7	7.82E-01	3.08E+00	2.31E+00	1.37E+00	1.66E+00	1.11E+00	5.98E-01	3.42E+00	2.16E+00	1.82E+00	6.90E-01	8.65E-01	3.37E+00	8.65E-01	5.56E-01	5.56E-01
8	2.95E-01	1.96E+00	1.19E+00	1.52E+00	9.74E-01	1.17E+00	5.24E-01	2.78E+00	2.86E+00	1.67E+00	4.71E-01	7.99E-01	1.25E+00	7.99E-01	6.79E-01	5.70E-01
9	3.74E-01	3.13E+00	1.44E+00	1.74E+00	1.41E+00	1.30E+00	5.02E+00	4.02E+00	3.10E+00	1.86E+00	5.58E-01	9.21E+00	2.31E+00	9.62E-01	4.80E-01	9.35E-01
0	4.60E-01	2.34E+00	1.35E+00	1.45E+00	1.19E+00	1.20E+00	1.31E+00	3.42E+00	3.06E+00	2.45E+00	5.35E-01	9.55E-01	1.68E+00	9.55E-01	5.40E-01	7.18E-01

2 7.57E-02 1.19E+01 1.26E-02 1.74E+02
3 8.38E-02 1.34E+01 1.33E-02 2.03E+02
4 8.78E-02 1.18E+01 1.35E-02 2.06E+02
5 9.35E-02 1.45E+01 1.38E-02 2.12E+02
6 9.10E-02 1.21E+01 1.36E-02 2.12E+02
7 7.54E-02 7.73E+00 1.29E-02 1.73E+02
8 7.77E-02 8.51E+00 1.34E-02 1.81E+02
9 7.61E-02 7.16E+00 1.31E-02 1.78E+02
10 8.35E-02 8.00E+00 1.34E-02 1.95E+02
11 7.54E-02 6.92E+00 1.32E-02 1.74E+02
12 7.35E-02 7.29E+00 1.29E-02 1.79E+02
13 7.36E-02 7.66E+00 1.26E-02 1.67E+02
14 7.60E-02 7.52E+00 1.26E-02 1.72E+02
15 7.49E-02 8.16E+00 1.33E-02 1.74E+02
16 8.62E-02 8.65E+00 1.37E-02 2.00E+02
17 8.04E-02 8.09E+00 1.30E-02 1.89E+02
18 7.98E-02 7.98E+00 1.32E-02 1.89E+02
19 7.84E-02 8.29E+00 1.29E-02 1.81E+02
20 8.04E-02 7.91E+00 1.29E-02 1.93E+02

Monteburns 1-group fission cross sections

Monteburns 1-group fission cross sections for material 1

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 95244.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c
0 2.60E-02 3.19E-01 1.14E+00 1.82E+00 3.62E-01 2.47E+00 2.53E-01 2.54E-01 4.00E+00 1.97E-01 1.24E-01 2.58E+00 4.17E-01 2.68E+00 2.86E+01 2.19E+00 3.17E-01
1 2.33E-02 3.10E-01 1.13E+00 1.82E+00 3.56E-01 2.48E+00 2.45E-01 2.44E-01 4.01E+00 1.89E-01 1.16E-01 2.58E+00 4.08E-01 2.69E+00 2.77E-01 2.17E+00 3.09E-01
2 2.41E-02 2.84E-01 1.12E+00 1.85E+00 3.32E-01 2.55E+00 2.25E-01 2.27E-01 4.15E+00 1.75E-01 1.11E-01 2.65E+00 3.74E-01 2.77E+00 2.58E-01 2.22E+00 2.89E-01
3 2.42E-02 3.05E-01 1.12E+00 1.84E+00 3.51E-01 2.50E+00 2.42E-01 2.45E-01 4.03E+00 1.89E-01 1.17E-01 2.59E+00 3.99E-01 2.70E+00 2.75E-01 2.18E+00 3.07E-01
4 2.51E-02 3.29E-01 1.17E+00 1.86E+00 3.76E-01 2.58E+00 2.61E-01 2.60E-01 4.24E+00 2.01E-01 1.24E-01 2.72E+00 4.30E-01 2.80E+00 2.93E-01 2.31E+00 3.25E-01
5 2.60E-02 3.30E-01 1.15E+00 1.83E+00 3.75E-01 2.47E+00 2.64E-01 2.67E-01 3.96E+00 2.08E-01 1.28E-01 2.59E+00 4.30E-01 2.68E+00 2.97E-01 2.18E+00 3.30E-01
6 2.39E-02 3.23E-01 1.13E+00 1.79E+00 3.65E-01 2.39E+00 2.57E-01 2.57E-01 3.82E+00 2.00E-01 1.21E-01 2.52E+00 4.22E-01 2.60E+00 2.90E-01 2.15E+00 3.22E-01
7 2.67E-02 3.25E-01 1.14E+00 1.80E+00 3.66E-01 2.41E+00 2.58E-01 2.61E-01 3.84E+00 2.03E-01 1.27E-01 2.52E+00 4.21E-01 2.60E+00 2.92E-01 2.15E+00 3.22E-01
8 2.54E-02 3.12E-01 1.11E+00 1.75E+00 3.55E-01 2.35E+00 2.47E-01 2.50E-01 3.73E+00 1.95E-01 1.21E-01 2.48E+00 4.04E-01 2.53E+00 2.81E-01 2.10E+00 3.11E-01
9 2.62E-02 3.37E-01 1.15E+00 1.85E+00 3.81E-01 2.42E+00 2.69E-01 2.73E-01 3.91E+00 2.13E-01 1.30E-01 2.52E+00 4.37E-01 2.62E+00 3.04E-01 2.15E+00 3.35E-01
10 2.52E-02 3.22E-01 1.14E+00 1.82E+00 3.68E-01 2.48E+00 2.58E-01 2.60E-01 3.99E+00 2.03E-01 1.24E-01 2.58E+00 4.21E-01 2.68E+00 2.91E-01 2.18E+00 3.23E-01
11 2.27E-02 3.04E-01 1.12E+00 1.79E+00 3.47E-01 2.42E+00 2.40E-01 2.36E-01 3.85E+00 1.83E-01 1.12E-01 2.53E+00 4.00E-01 2.62E+00 2.71E-01 2.16E+00 3.02E-01
12 2.27E-02 2.93E-01 1.10E+00 1.78E+00 3.39E-01 2.47E+00 2.33E-01 2.33E-01 3.92E+00 1.80E-01 1.11E-01 2.58E+00 3.85E-01 2.67E+00 2.65E-01 2.14E+00 2.95E-01
13 2.93E-02 3.32E-01 1.13E+00 1.79E+00 3.73E-01 2.41E+00 2.65E-01 2.72E-01 3.81E+00 2.13E-01 1.36E-01 2.51E+00 4.33E-01 2.61E+00 3.03E-01 2.13E+00 3.35E-01
14 2.30E-02 3.10E-01 1.11E+00 1.78E+00 3.53E-01 2.42E+00 2.43E-01 2.42E-01 3.87E+00 1.87E-01 1.14E-01 2.54E+00 4.05E-01 2.64E+00 2.75E-01 2.13E+00 3.09E-01
15 2.17E-02 3.12E-01 1.11E+00 1.76E+00 3.54E-01 2.39E+00 2.47E-01 2.46E-01 3.78E+00 1.90E-01 1.14E-01 2.50E+00 4.10E-01 2.58E+00 2.79E-01 2.11E+00 3.12E-01
16 2.64E-02 3.24E-01 1.12E+00 1.73E+00 3.65E-01 2.38E+00 2.56E-01 2.56E-01 3.56E+00 2.00E-01 1.26E-01 2.41E+00 4.21E-01 2.47E+00 2.88E-01 2.07E+00 3.19E-01
17 2.27E-02 3.18E-01 1.10E+00 1.72E+00 3.35E-01 2.37E+00 2.31E-01 2.30E-01 3.63E+00 1.80E-01 1.11E-01 2.44E+00 3.82E-01 2.52E+00 2.63E-01 2.08E+00 2.94E-01
18 2.28E-02 2.96E-01 1.10E+00 1.75E+00 3.42E-01 2.37E+00 2.31E-01 2.27E-01 3.74E+00 1.75E-01 1.09E-01 2.47E+00 3.87E-01 2.56E+00 2.60E-01 2.11E+00 2.91E-01
19 2.66E-02 3.21E-01 1.11E+00 1.73E+00 3.62E-01 2.29E+00 2.53E-01 2.52E-01 3.58E+00 1.97E-01 1.25E-01 2.40E+00 4.15E-01 2.48E+00 2.94E-01 2.08E+00 3.14E-01
20 2.07E-02 3.13E-01 1.10E+00 1.71E+00 3.56E-01 2.26E+00 2.49E-01 2.42E-01 3.50E+00 1.89E-01 1.11E-01 2.37E+00 4.08E-01 2.44E+00 2.78E-01 2.05E+00 3.10E-01

Monteburns 1-group fission cross sections for material 2

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 95244.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c
0 2.97E-02 3.47E-01 1.15E+00 1.77E+00 3.90E-01 2.35E+00 2.77E-01 2.83E-01 3.73E+00 2.21E-01 1.40E-01 2.48E+00 4.50E-01 2.55E+00 3.12E-01 2.12E+00 3.44E-01
1 2.72E-02 3.17E-01 1.14E+00 1.83E+00 3.63E-01 2.52E+00 2.55E-01 2.60E-01 4.08E+00 2.03E-01 1.28E-01 2.62E+00 4.15E-01 2.74E+00 2.89E-01 2.18E+00 3.25E-01
2 2.59E-02 3.12E-01 1.14E+00 1.82E+00 3.59E-01 2.50E+00 2.48E-01 2.50E-01 4.07E+00 1.94E-01 1.23E-01 2.61E+00 4.09E-01 2.72E+00 2.81E-01 2.18E+00 3.14E-01
3 2.47E-02 2.99E-01 1.11E+00 1.81E+00 3.46E-01 2.51E+00 2.41E-01 2.47E-01 4.02E+00 1.93E-01 1.20E-01 2.57E+00 3.93E-01 2.67E+00 2.77E-01 2.15E+00 3.06E-01
4 2.71E-02 3.48E-01 1.16E+00 1.85E+00 3.81E-01 2.45E+00 2.73E-01 2.87E-01 4.03E+00 2.25E-01 1.42E-01 2.55E+00 4.34E-01 2.68E+00 3.13E-01 2.14E+00 3.43E-01
5 3.05E-02 3.35E-01 1.14E+00 1.82E+00 3.88E-01 2.39E+00 2.78E-01 2.79E-01 3.81E+00 2.18E-01 1.34E-01 2.49E+00 4.50E-01 2.58E+00 3.10E-01 2.15E+00 3.42E-01
6 3.03E-02 3.39E-01 1.13E+00 1.75E+00 3.84E-01 2.32E+00 2.71E-01 2.78E-01 3.64E+00 2.17E-01 1.39E-01 2.43E+00 4.38E-01 2.51E+00 3.07E-01 2.09E+00 3.37E-01
7 2.72E-02 3.14E-01 1.12E+00 1.79E+00 3.56E-01 2.47E+00 2.48E-01 2.54E-01 3.95E+00 1.97E-01 1.26E-01 2.58E+00 4.11E-01 2.68E+00 2.84E-01 2.13E+00 3.19E-01
8 2.28E-02 2.54E-01 1.05E+00 1.78E+00 3.01E-01 2.48E+00 2.05E-01 2.12E-01 3.96E+00 1.65E-01 1.05E-01 2.57E+00 3.39E-01 2.69E+00 2.42E-01 2.12E+00 2.71E-01
9 2.52E-02 3.26E-01 1.13E+00 1.80E+00 3.69E-01 2.45E+00 2.62E-01 2.63E-01 3.95E+00 2.05E-01 1.27E-01 2.57E+00 4.28E-01 2.65E+00 2.96E-01 2.19E+00 3.27E-01
10 2.90E-02 3.21E-01 1.13E+00 1.82E+00 3.63E-01 2.43E+00 2.57E-01 2.64E-01 3.85E+00 2.07E-01 1.32E-01 2.54E+00 4.19E-01 2.62E+00 2.93E-01 2.17E+00 3.24E-01
11 2.37E-02 3.06E-01 1.11E+00 1.77E+00 3.49E-01 2.40E+00 2.40E-01 2.36E-01 3.78E+00 1.83E-01 1.14E-01 2.50E+00 4.02E-01 2.57E+00 2.71E-01 2.13E+00 3.03E-01
12 3.06E-02 3.48E-01 1.14E+00 1.75E+00 3.89E-01 2.29E+00 2.76E-01 2.79E-01 3.58E+00 2.19E-01 1.40E-01 2.41E+00 4.48E-01 2.47E+00 3.10E-01 2.08E+00 3.41E-01
13 2.83E-02 3.16E-01 1.10E+00 1.75E+00 3.63E-01 2.40E+00 2.52E-01 2.59E-01 3.74E+00 2.03E-01 1.31E-01 2.49E+00 4.12E-01 2.57E+00 2.88E-01 2.08E+00 3.19E-01
14 2.27E-02 3.28E-01 1.13E+00 1.76E+00 3.71E-01 2.39E+00 2.64E-01 2.64E-01 3.80E+00 2.07E-01 1.23E-01 2.50E+00 4.32E-01 2.57E+00 2.88E-01 2.11E+00 3.30E-01
15 2.37E-02 2.87E-01 1.10E+00 1.87E+00 3.37E-01 2.61E+00 2.28E-01 2.31E-01 4.24E+00 1.78E-01 1.12E-01 2.69E+00 3.86E-01 2.81E+00 2.66E-01 2.23E+00 2.97E-01
16 2.35E-02 3.09E-01 1.08E+00 1.73E+00 3.55E-01 2.27E+00 2.45E-01 2.43E-01 3.50E+00 1.91E-01 1.18E-01 2.40E+00 4.03E-01 2.44E+00 2.77E-01 2.06E+00 3.08E-01
17 2.04E-02 2.37E-01 1.06E+00 1.80E+00 3.82E-01 2.61E+00 1.89E-01 1.94E-01 4.23E+00 1.49E-01 9.42E-02 2.67E+00 3.19E-01 2.85E+00 2.23E-01 2.16E+00 2.53E-01
18 2.78E-02 3.19E-01 1.10E+00 1.71E+00 3.62E-01 2.23E+00 2.57E-01 2.63E-01 4.34E+00 2.07E-01 1.31E-01 2.36E+00 4.13E-01 2.41E+00 2.94E-01 2.05E+00 3.21E-01
19 2.45E-02 2.88E-01 1.08E+00 1.76E+00 3.38E-01 2.41E+00 2.32E-01 2.39E-01 3.83E+00 1.87E-01 1.18E-01 2.50E+00 3.81E-01 2.61E+00 2.69E-01 2.10E+00 3.00E-01
20 2.04E-02 2.59E-01 1.05E+00 1.75E+00 3.06E-01 2.46E+00 2.05E-01 2.05E-01 3.91E+00 1.59E-01 9.89E-02 2.56E+00 3.44E-01 2.66E+00 2.37E-01 2.15E+00 2.68E-01

Monteburns 1-group fission cross sections for material 3

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 95244.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c
0 3.66E-02 3.87E-01 1.22E+00 2.72E+00 4.26E-01 3.81E+00 3.11E-01 3.30E-01 1.00E+00 1.66E-01 1.66E-01 3.96E+00 5.06E-01 4.43E+00 3.52E-01 2.83E+00 4.06E-01
1 3.63E-02 3.74E-01 1.23E+00 2.90E+00 4.16E-01 4.23E+00 2.98E-01 3.17E-01 1.37E+00 1.63E-01 1.63E-01 4.35E+00 4.81E-01 4.86E+00 3.35E-01 3.01E+00 4.24E-01
2 4.58E-02 4.32E-01 1.31E+00 4.02E+00 4.68E-01 5.32E+00 3.45E-01 3.80E-01 1.85E+00 2.87E-01 1.96E-01 4.74E+00 4.89E-01 5.60E+00 3.90E-01 3.30E+00 4.24E-01
3 3.95E-02 3.94E-01 1.27E+00 3.87E+00 4.39E-01 6.53E+00 3.17E-01 3.46E-01 2.04E+00 2.61E-01 1.77E-01 5.15E+00 5.19E-01 6.23E+00 3.67E-01 2.76E+00 4.06E-01
4 4.83E-02 4.09E-01 1.27E+00 4.49E+00 4.45E-01 6.28E+00 3.31E-01 3.65E-01 2.27E+00 2.76E-01 1.85E-01 5.43E+00 5.35E-01 6.69E+00 3.78E-01 3.04E+00 4.14E-01
5 4.35E-02 4.04E-01 1.30E+00 4.66E+00 4.45E-01 6.35E+00 3.27E-01 3.65E-01 2.64E+00 2.76E-01 1.91E-01 5.75E+00 5.38E-01 7.69E+00 3.75E-01 3.09E+00 4.27E-01
6 4.87E-02 4.41E-01 1.30E+00 4.69E+00 4.77E-01 6.40E+00 3.56E-01 3.99E-01 2.47E+00 3.01E-01 2.08E-01 5.73E+00 5.89E-01 7.28E+00 4.07E-01 3.04E+00 4.93E-01
7 3.61E-02 3.67E-01 1.24E+00 3.28E+00 4.14E-01 4.61E+00 2.98E-01 3.21E-01 1.58E+00 2.43E-01 1.62E-01 4.34E+00 4.88E-01 5.53E+00 3.38E-01 2.99E+00 3.95E-01
8 3.15E-02 3.20E-01 1.21E+00 3.65E+00 3.68E-01 5.89E+00 2.57E-01 2.82E-01 1.81E+00 2.11E-01 1.41E-01 6.20E+00 4.29E-01 6.87E+00 3.01E-01 4.40E+00 3.37E-01
9 3.24E-02 3.21E-01 1.20E+00 3.78E+00 3.70E-01 4.88E+00 2.63E-01 2.86E-01 1.73E+00 2.14E-01 1.45E-01 4.61E+00 4.23E-01 5.72E+00 3.03E-01 2.69E+00 3.39E-01
10 3.46E-02 3.55E-01 1.21E+00 3.09E+00 3.96E-01 4.04E+00 2.83E-01 3.07E-01 1.31E-01 2.12E-01 1.54E-01 4.35E+00 4.64E-01 5.16E+00 3.32E-01 3.24E+00 3.57E-01
11 3.61E-02 3.52E-01 1.19E+00 3.77E+00 3.91E-01 3.58E+00 2.83E-01 3.07E-01 1.02E-01 2.02E-01 1.61E-01 4.69E+00 4.62E+00 5.32E+00 3.28E-01 2.71E+00 3.59E-01
12 4.20E-02 4.11E-01 1.29E+00 3.97E+00 4.46E-01 4.93E+00 3.31E-01 3.60E-01 1.90E-01 2.76E-01 1.85E-01 4.09E+00 5.28E-01 5.31E+00 3.73E-01 2.58E+00 4.10E-01
13 4.29E-02 4.12E-01 1.25E+00 3.55E+00 4.53E-01 4.61E+00 3.33E-01 3.65E-01 1.59E-01 2.79E-01 1.90E-01 4.28E+00 5.36E-01 5.38E+00 3.81E-01 2.89E+00 4.32E-01
14 2.20E-02 3.14E-01 1.12E+00 2.68E+00 3.62E-01 3.72E+00 2.41E-01 2.36E-01 1.04E-01 1.77E-01 1.09E-01 3.47E+00 4.19E-01 4.76E+00 3.17E-01 2.56E+00 3.55E-01
15 2.66E-02 3.61E-01 1.24E+00 3.74E+00 4.03E-01 5.11E+00 2.89E-01 2.93E-01 1.75E+00 2.23E-01 1.81E-01 3.97E+00 4.76E-01 5.44E-01 3.24E-01 2.61E+00 3.62E-01
16 3.52E-02 3.80E-01 1.23E+00 3.29E+00 4.28E-01 4.71E+00 3.07E-01 3.34E-01 1.79E+00 2.48E-01 1.28E-01 2.01E-01 1.35E-01 3.89E+00 3.90E-01 4.85E+00 2.78E-01 2.54E+00 3.07E-01
17 2.81E-02 2.82E-01 1.20E+00 3.04E+00 3.29E-01 4.37E+00 2.38E-01 2.68E-01 1.28E-01 2.01E-01 1.48E-01 3.69E+00 5.23E-01 4.84E+00 3.41E-01 2.42E+00 3.94E-01
18 3.01E-02 3.93E-01 1.22E+00 3.62E+00 4.27E-01 4.75E+00 3.08E-01 3.07E-01 1.62E+00 2.34E-01 1.48E-01 3.69E+00 5.23E-01 4.84E+00 3.41E-01 2.42E+00 3.94E-01
19 4.18E-02 3.90E-01 1.25E+00 3.94E+00 4.32E-01 5.17E+00 3.14E-01 3.49E-01 1.76E+00 2.65E-01 1.83E-01 4.74E+00 5.27E-01 5.79E+00 3.60E-01 2.74E+00 4.37E-01
20 4.19E-02 3.53E-01 1.19E+00 3.50E+00 3.94E-01 4.75E+00 2.90E-01 3.30E-01 1.70E+00 2.52E-01 1.77E-01 4.14E+00 5.46E-01 5.66E-01 3.36E-01 2.46E+00 3.66E-01

Monteburns 1-group fission cross sections for material 4

1001.50c 45099.50c 83209.50c 94239.55c
0 0.00E+00 0.00E+00 0.00E+00 2.11E+02
1 0.00E+00 0.00E+00 0.00E+00 2.11E+02
2 0.00E+00 0.00E+00 0.00E+00 3.11E+02
3 0.00E+00 0.00E+00 0.00E+00 3.59E+02
4 0.00E+00 0.00E+00 0.00E+00 3.68E+02
5 0.00E+00 0.00E+00 0.00E+00 3.81E+02
6 0.00E+00 0.00E+00 4.35E-09 3.80E+02
7 0.00E+00 0.00E+00 0.00E+00 3.10E+02
8 0.00E+00 0.00E+00 0.00E+00 3.25E+02
9 0.00E+00 0.00E+00 0.00E+00 3.18E+02
10 0.00E+00 0.00E+00 0.00E+00 3.48E+02
11 0.00E+00 0.00E+00 0.00E+00 3.12E+02
12 0.00E+00 0.00E+00 3.47E-08 3.15E+02
13 0.00E+00 0.00E+00 6.22E-08 3.01E+02
14 0.00E+00 0.00E+00 0.00E+00 3.09E+02
15 0.00E+00 0.00E+00 0.00E+00 3.08E+02
16 0.00E+00 0.00E+00 0.00E+00 3.58E+02
17 0.00E+00 0.00E+00 0.00E+00 3.38E+02
18 0.00E+00 0.00E+00 0.00E+00 3.36E+02
19 0.00E+00 0.00E+00 0.00E+00 3.23E+02
20 0.00E+00 0.00E+00 0.00E+00 3.41E+02

Monteburns fission to capture ratio

Monteburns fission to capture ratio for material 1

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c
0 0.0800 0.2101 1.5551 3.5793 0.6714 5.4918 0.5922 0.1477 10.2770 0.1890 0.3907 6.4235 0.5199 6.6843 0.7290 4.9526 0.8995
1 0.0702 0.2022 1.5676 3.5793 0.6714 5.4918 0.5922 0.1477 10.2770 0.1890 0.3907 6.4235 0.5199 6.6843 0.7290 4.9526 0.8995
2 0.0658 0.1745 1.4384 3.4237 0.5865 5.3107 0.5179 0.1251 9.8434 0.1795 0.3760 6.2467 0.4944 6.5272 0.6790 4.9601 0.8582
3 0.0722 0.1951 1.5404 3.5119 0.6436 5.4416 0.5659 0.1403 10.1206 0.1939 0.3721 6.2617 0.4329 6.5525 0.5878 4.6294 0.7512
4 0.0769 0.2087 1.4789 3.4335 0.6623 5.2024 0.5733 0.1460 9.9758 0.1819 0.3743 6.4411 0.5097 6.6238 0.7945 4.9903 0.8961
5 0.0771 0.2184 1.5814 3.6247 0.7274 5.5094 0.6418 0.1584 10.3458 0.2037 0.4208 6.5949 0.5142 6.6238 0.7945 4.9903 0.8961
6 0.0830 0.2217 1.6158 3.8108 0.7308 5.5995 0.6365 0.1577 10.6762 0.2052 0.4289 6.5909 0.5355 6.8136 0.7934 5.2145 0.9797
7 0.0910 0.2265 1.6310 3.7999 0.7210 5.6259 0.6417 0.1603 10.7707 0.2070 0.3949 6.7572 0.5669 6.9774 0.7735 5.2654 0.9970
8 0.0891 0.2276 1.6759 0.6707 0.7742 5.7510 0.6626 0.1609 11.1023 0.2137 0.4185 6.9141 0.5539 7.0634 0.8367 5.6386 1.0087
9 0.0850 0.2326 1.6808 0.7308 0.7442 5.5818 0.6705 0.1655 10.4757 0.2180 0.4649 6.5367 0.5718 6.7848 0.8444 5.2651 1.0424
10 0.0725 0.2110 1.5905 3.6042 0.6876 5.4949 0.5720 0.1527 10.2369 0.1905 0.4035 6.3872 0.5336 6.6492 0.7623 4.9764 0.9299
11 0.0788 0.2082 1.6090 3.6922 0.7195 5.5776 0.6082 0.1430 10.6136 0.1861 0.3720 6.6641 0.5026 6.9009 0.7508 5.1343 0.8789
12 0.0734 0.1952 1.5551 3.6844 0.6684 5.3380 0.5605 0.1381 10.2892 0.1786 0.3731 6.4077 0.4700 6.6399 0.5751 5.0732 0.8071
13 0.0978 0.2316 1.6680 3.8625 0.7811 5.6306 0.6829 0.1679 10.6104 0.2221 0.4548 6.5299 0.5502 6.7799 0.8495 5.2970 0.9034
14 0.0712 0.2051 1.6083 3.6867 0.6851 5.5457 0.5969 0.1452 10.4398 0.1897 0.4085 6.4100 0.5145 6.6636 0.7127 5.1769 0.8478
15 0.0697 0.2170 1.6361 3.7149 0.7186 5.6039 0.6225 0.1504 10.6275 0.1981 0.4198 6.4695 0.5274 6.6927 0.7629 5.3191 0.9294
16 0.0995 0.2458 1.7799 4.2140 0.8209 5.8578 0.6706 0.1713 11.4545 0.2370 0.5330 6.9097 0.5812 7.0839 0.8760 5.8669 1.0977
17 0.0808 0.2121 1.6747 4.0923 0.7156 5.4881 0.6221 0.1486 11.1216 0.2034 0.4539 6.7277 0.5120 6.9661 0.7758 5.6979 0.9960
18 0.0765 0.2091 1.6355 3.8741 0.6899 5.6522 0.5953 0.1416 10.8264 0.1856 0.4084 6.5695 0.5053 6.8049 0.6963 5.4227 0.9626
19 0.0932 0.2441 1.7953 4.2655 0.8426 5.8912 0.7096 0.1686 11.5873 0.2330 0.5194 6.9313 0.5831 7.1390 0.8751 5.9478 1.1053
20 0.0783 0.2425 1.7887 4.3230 0.8363 5.9173 0.6912 0.1647 11.7721 0.2306 0.4971 6.9158 0.5800 7.1028 0.8586 6.0840 1.0921

Monteburns fission to capture ratio for material 2

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c
0 0.0987 0.2518 1.7303 4.0270 0.8178 5.7463 0.7132 0.1807 11.0062 0.2392 0.5277 6.8587 0.5989 7.0631 0.9105 5.5463 1.1108
1 0.0847 0.2032 1.4900 3.4867 0.6535 5.4068 0.5779 0.1475 9.9081 0.1898 0.3814 6.2009 0.5178 6.4856 0.6861 4.8352 0.6744
2 0.0767 0.2018 1.4701 3.5175 0.6379 5.4313 0.5814 0.1436 9.9282 0.1801 0.4117 6.3633 0.5063 6.6169 0.7118 4.8551 0.8532
3 0.0732 0.1995 1.5551 3.5212 0.6442 5.4021 0.4691 0.1452 10.3303 0.1873 0.3421 6.3793 0.4907 6.6238 0.6858 5.1181 0.9265
4 0.0953 0.2492 1.7393 3.8788 0.8492 5.7170 0.7181 0.1754 10.9236 0.2331 0.4859 6.6697 0.6094 6.9037 0.9003 5.3312 1.1358
5 0.0938 0.2275 1.5942 3.7262 0.7678 5.5251 0.6880 0.1726 10.1405 0.2310 0.4892 6.4911 0.5727 6.8187 0.8685 5.2554 1.0707
6 0.1063 0.2526 1.7798 4.1137 0.8377 5.7993 0.7213 0.1823 11.2434 0.2457 0.5239 6.7639 0.5092 6.9742 0.9076 5.7923 1.1463
7 0.0827 0.2063 1.5826 3.6196 0.7085 5.4919 0.6207 0.1493 10.1704 0.1888 0.3741 6.3496 0.5133 6.6085 0.7148 5.0992 0.8730
8 0.0711 0.1612 1.4348 3.5260 0.5681 5.3966 0.4685 0.1201 10.0795 0.1557 0.3477 6.1490 0.4012 6.4486 0.6227 4.9612 0.7777
9 0.0832 0.2185 1.6568 3.6696 0.7263 5.5208 0.6394 0.1563 10.3183 0.2041 0.4359 6.6329 0.5395 6.8580 0.7973 4.9758 0.9519
10 0.0967 0.2192 1.6128 3.5015 0.7634 5.5583 0.6507 0.1605 10.6116 0.2078 0.4717 6.7535 0.4869 6.9587 0.8246 5.1084 0.8942
11 0.0754 0.2152 1.6346 3.8220 0.7187 5.5382 0.6327 0.1453 10.7719 0.1933 0.4318 6.6271 0.5165 6.8331 0.7311 5.2105 0.9541
12 0.1103 0.2658 1.8254 4.2206 0.9146 5.8747 0.7439 0.1871 11.5049 0.2582 0.5811 6.9550 0.6308 7.1269 0.9289 5.8912 1.1612
13 0.0882 0.2220 1.6563 3.9523 0.7294 5.7028 0.6398 0.1625 10.6869 0.2151 0.5108 6.6113 0.5378 6.8216 0.8030 5.5303 0.9980
14 0.0766 0.2279 1.6671 3.8548 0.7774 5.6164 0.6734 0.1628 10.6018 0.2163 0.4467 6.3840 0.5661 6.6275 0.8159 5.3307 0.9974
15 0.0648 0.1717 1.4034 3.2551 0.5752 5.2150 0.4883 0.1230 9.6279 0.1547 0.2971 6.1457 0.3947 6.4201 0.6210 4.5242 0.7609
16 0.0860 0.2257 1.7497 4.3191 0.7226 5.8554 0.6516 0.1633 11.7410 0.2280 0.5012 7.4016 0.5729 7.5070 0.8516 5.9833 1.0666
17 0.0594 0.1380 1.3308 3.1951 0.4818 5.1951 0.3934 0.1019 9.2733 0.1257 0.2768 5.4813 0.3497 5.8580 0.4982 4.4809 0.6699
18 0.1036 0.2523 1.8382 4.4984 0.8428 5.9843 0.6958 0.1830 12.1350 0.2606 0.6039 7.2495 0.6004 7.4110 0.9452 6.2706 1.1901
19 0.0803 0.1963 1.5721 3.8032 0.6809 5.5751 0.5837 0.1445 10.5384 0.1921 0.4313 6.4123 0.4853 6.6909 0.7434 5.3579 0.7353
20 0.0663 0.1675 1.4797 3.6540 0.5996 5.4218 0.4905 0.1183 10.2194 0.1473 0.3565 6.3051 0.4251 6.5647 0.6320 4.8707 0.7724

Monteburns fission to capture ratio for material 3

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c
0 0.0878 0.1591 1.1885 2.6366 0.3355 4.2860 0.3473 0.1134 6.4948 0.1122 0.2663 5.8023 0.5049 6.4885 0.5930 3.7446 0.3486
1 0.0572 0.1307 0.7429 2.4826 0.3127 3.9050 0.1761 0.0883 6.0602 0.0790 0.1344 5.5548 0.5849 6.2003 0.6774 3.3635 0.2098
2 0.0782 0.1256 0.8499 2.3510 0.2446 3.3859 0.1645 0.0895 5.7286 0.0932 0.2456 4.9154 0.1857 5.8111 0.5842 3.2348 0.10205
3 0.0537 0.1082 0.7198 2.3426 0.2863 3.6495 0.2671 0.0828 5.6652 0.0987 0.2067 4.9175 0.4625 5.9529 0.3348 3.2047 0.5007
4 0.0760 0.1184 0.7333 2.2881 0.2395 3.5459 0.2700 0.0815 5.5253 0.0731 0.2016 4.8744 0.4254 6.0102 0.4592 3.0262 0.7212
5 0.0606 0.1303 0.6894 2.3653 0.1938 3.6099 0.1898 0.0777 5.4291 0.0876 0.3586 4.3931 0.2594 5.8773 0.5408 3.1021 0.4367
6 0.0936 0.1502 0.7305 2.2982 0.3012 3.6578 0.1696 0.0817 5.5376 0.0851 0.3056 4.6776 0.2277 5.9498 0.7063 3.1012 0.2148
7 0.0646 0.1319 0.8695 2.5065 0.2844 4.0687 0.3880 0.0871 5.7559 0.0927 0.2920 4.6232 0.3970 5.8933 0.7504 3.2435 0.3418
8 0.0599 0.1135 0.7878 2.1020 0.2732 3.8531 0.3990 0.0610 5.6619 0.0871 0.0779 4.5108 0.3930 5.9941 0.2622 2.4464 0.5342
9 0.0675 0.1249 0.8083 2.2591 0.2723 3.8025 0.3683 0.0711 5.7272 0.0755 0.3179 5.5252 0.4025 5.6082 0.5457 3.5604 0.4474
10 0.0876 0.1449 0.8651 2.3542 0.2564 4.2353 0.6333 0.0829 5.9614 0.0768 0.2606 6.3433 0.4040 6.3506 0.4307 2.7450 0.7520
11 0.0922 0.1514 0.7569 2.4178 0.3346 3.4902 0.2620 0.0919 5.4979 0.1090 0.3331 4.7587 0.3292 5.8670 0.4182 3.3024 0.3556
12 0.0974 0.1648 0.8522 2.2408 0.3842 3.9608 0.7611 0.1067 5.5616 0.1363 0.2617 4.7298 0.4439 6.1441 0.9249 3.6679 0.8748
13 0.1106 0.1321 0.9819 2.4991 0.3430 3.9476 0.4108 0.0866 5.7752 0.1145 0.2791 4.7243 0.5329 5.9366 0.6616 3.1838 0.4149
14 0.0579 0.1483 1.1667 2.2947 0.3059 3.8565 0.3801 0.0654 6.2124 0.0743 0.3333 5.7427 0.4290 6.5743 0.5971 4.1682 0.2091
15 0.0386 0.1024 0.8840 2.3451 0.3294 3.6940 0.5983 0.0828 5.6209 0.1193 0.1776 4.2305 0.4613 5.6566 0.5034 3.2613 0.6268

16	0.0973	0.1379	0.8756	2.6421	0.3183	3.8993	0.3344	0.0908	5.6276	0.1516	0.3146	4.5597	0.4551	5.9289	0.6616	3.7086	0.9141
17	0.0359	0.0916	0.5200	2.2140	0.1980	3.9493	0.3989	0.0783	5.9394	0.1104	0.1963	4.4948	0.2859	5.6081	0.5051	3.0913	0.6863
18	0.1022	0.2002	1.0314	2.3878	0.4387	4.0597	0.5887	0.1104	5.6523	0.1403	0.3137	4.6165	0.4177	6.0598	0.5015	4.2518	0.3721
19	0.1117	0.1247	0.8704	2.2680	0.3059	3.9494	0.3063	0.0870	5.6942	0.1427	0.3301	4.9337	0.2277	6.0178	0.7496	2.9344	0.2467
20	0.0912	0.1508	0.8856	2.4197	0.3300	3.9627	0.5451	0.0965	5.5709	0.1029	0.3295	4.3321	0.2820	5.7142	0.6413	3.4300	0.9354

Monteburns fission to capture ratio for material 4

1001.50c 43099.50c 83209.50c 94239.55c

0	0.0000	0.0000	0.0000	1.7315
1	0.0000	0.0000	0.0000	1.7453
2	0.0000	0.0000	0.0000	1.7922
3	0.0000	0.0000	0.0000	1.7721
4	0.0000	0.0000	0.0000	1.7861
5	0.0000	0.0000	0.0000	1.8003
6	0.0000	0.0000	0.0000	1.7886
7	0.0000	0.0000	0.0000	1.7935
8	0.0000	0.0000	0.0000	1.7894
9	0.0000	0.0000	0.0000	1.7848
10	0.0000	0.0000	0.0000	1.7840
11	0.0000	0.0000	0.0000	1.7912
12	0.0000	0.0000	0.0000	1.7632
13	0.0000	0.0000	0.0000	1.7989
14	0.0000	0.0000	0.0000	1.7965
15	0.0000	0.0000	0.0000	1.7740
16	0.0000	0.0000	0.0000	1.7881
17	0.0000	0.0000	0.0000	1.7907
18	0.0000	0.0000	0.0000	1.7772
19	0.0000	0.0000	0.0000	1.7890
20	0.0000	0.0000	0.0000	1.7730

Monteburns grams of material at beginning of steps

Monteburns grams of material at beginning of steps for material 1

0	1.52E+05	2.74E+04	8.54E+03	3.14E+05	1.45E+05	4.80E+04	2.93E+04	3.14E+04	3.85E+01	5.65E+03	0.00E+00	2.32E+01	1.10E+03	0.00E+00	0.00E+00	0.00E+00	7.61E+05
1	1.52E+05	2.74E+04	8.54E+03	3.14E+05	1.45E+05	4.80E+04	2.93E+04	3.14E+04	3.85E+01	5.65E+03	0.00E+00	2.32E+01	1.10E+03	0.00E+00	0.00E+00	0.00E+00	7.61E+05
2	1.67E+05	2.64E+04	1.26E+04	2.94E+05	1.67E+05	4.85E+04	3.43E+04	2.97E+04	7.09E+02	6.59E+03	3.33E+03	7.07E+01	2.12E+03	1.08E+02	1.90E+00	2.22E+02	7.93E+05
3	1.81E+05	2.62E+04	1.69E+04	2.85E+05	1.87E+05	5.20E+04	3.82E+04	2.92E+04	8.36E+02	8.33E+03	5.00E+03	1.78E+02	3.40E+03	2.15E+02	5.16E+00	8.06E+02	1.21E+03
4	2.04E+05	2.52E+04	2.37E+04	2.61E+05	2.14E+05	5.59E+04	4.50E+04	2.75E+04	9.92E+02	1.08E+04	6.53E+03	3.61E+02	4.85E+03	6.36E+02	3.36E+01	9.87E+01	2.81E+02
5	2.14E+05	2.40E+04	2.73E+04	2.52E+05	2.28E+05	5.21E+04	5.05E+04	2.63E+04	1.02E+03	1.02E+04	6.67E+03	4.56E+02	5.76E+03	6.20E+02	4.24E+01	1.86E+00	8.01E+02
6	2.34E+05	2.47E+04	3.15E+04	2.42E+05	2.49E+05	5.98E+04	5.58E+04	2.65E+04	9.85E+02	1.16E+04	7.27E+03	5.77E+02	7.89E+03	9.17E+02	7.10E+01	3.00E+00	1.38E+01
7	2.53E+05	2.48E+04	3.52E+04	2.36E+05	2.59E+05	6.66E+04	6.02E+04	2.62E+04	9.06E+02	1.48E+04	6.94E+03	5.54E+02	9.50E+03	1.43E+03	1.58E+02	7.89E+01	4.86E+01
8	2.60E+05	2.32E+04	3.67E+04	2.22E+05	2.75E+05	6.00E+04	6.25E+04	2.40E+04	9.05E+02	1.53E+04	7.18E+03	6.59E+02	1.04E+04	1.74E+03	1.90E+02	9.83E+00	6.42E+01
9	2.77E+05	2.33E+04	3.92E+04	2.35E+05	2.83E+05	6.76E+04	6.93E+04	2.51E+04	1.21E+03	1.44E+04	7.41E+03	6.71E+02	1.20E+04	1.94E+03	2.32E+02	1.30E+01	9.90E+01
10	2.91E+05	2.28E+04	3.98E+04	2.21E+05	2.89E+05	6.60E+04	7.38E+04	2.35E+04	1.06E+03	1.61E+04	6.91E+03	9.28E+02	1.43E+04	2.32E+03	3.69E+02	2.91E+01	3.45E+00
11	2.93E+05	2.08E+04	3.89E+04	1.99E+05	2.92E+05	6.46E+04	7.36E+04	2.13E+04	9.91E+02	1.61E+04	6.78E+03	6.99E+02	1.57E+04	2.85E+03	4.76E+02	3.36E+01	3.46E+00
12	3.12E+05	2.24E+04	4.21E+04	2.29E+05	3.00E+05	7.52E+04	8.06E+04	2.42E+04	1.17E+03	1.56E+04	6.44E+03	7.15E+02	1.60E+04	2.91E+03	4.78E+02	3.72E+01	4.29E+00
13	3.21E+05	2.17E+04	4.05E+04	2.15E+05	3.05E+05	6.60E+04	8.19E+04	2.32E+04	9.98E+02	1.91E+04	5.86E+03	7.40E+02	1.82E+04	3.40E+03	6.87E+02	6.09E+01	8.53E+00
14	3.23E+05	2.01E+04	3.92E+04	1.97E+05	3.06E+05	6.73E+04	8.31E+04	2.16E+04	9.25E+02	1.73E+04	5.70E+03	7.15E+02	1.87E+04	3.82E+03	8.26E+02	6.75E+01	9.24E+00
15	3.42E+05	2.05E+04	4.31E+04	1.7E+05	3.13E+05	7.39E+04	8.92E+04	2.25E+04	1.14E+03	1.86E+04	6.72E+03	7.19E+02	1.94E+04	3.77E+03	8.10E+02	7.50E+01	1.08E+01
16	3.45E+05	2.00E+04	4.09E+04	2.10E+05	3.12E+05	7.23E+04	8.93E+04	2.11E+04	1.16E+03	2.02E+04	6.89E+03	7.18E+02	2.21E+04	4.86E+03	1.06E+03	1.02E+02	1.70E+01
17	3.36E+05	1.72E+04	3.77E+04	1.88E+05	3.00E+05	6.78E+04	8.98E+04	1.95E+04	8.98E+02	1.89E+04	5.77E+03	7.20E+02	2.18E+04	4.56E+03	1.29E+03	1.32E+02	2.26E+01
18	3.55E+05	1.76E+04	3.97E+04	2.00E+05	3.04E+05	7.18E+04	9.30E+04	1.96E+04	8.86E+02	2.17E+04	6.35E+03	7.35E+02	2.33E+04	4.95E+03	1.35E+03	1.39E+02	2.52E+01
19	3.63E+05	1.91E+04	3.86E+04	2.14E+05	3.10E+05	7.51E+04	9.44E+04	2.14E+04	1.18E+03	2.14E+04	5.72E+03	6.61E+02	2.44E+04	5.55E+03	1.50E+03	1.48E+02	2.91E+01
20	3.57E+05	1.74E+04	3.57E+04	1.84E+05	3.02E+05	6.51E+04	9.49E+04	1.98E+04	8.66E+02	2.04E+04	5.24E+03	6.19E+02	2.40E+04	5.44E+03	1.72E+03	1.97E+02	3.82E+01

Monteburns grams of material at beginning of steps for material 2

0	1.73E+05	3.12E+04	9.73E+03	3.57E+05	1.65E+05	5.47E+04	3.34E+04	3.57E+04	4.39E+01	6.44E+03	0.00E+00	2.64E+01	1.25E+03	0.00E+00	0.00E+00	0.00E+00	8.68E+05
1	1.73E+05	3.12E+04	9.73E+03	3.57E+05	1.65E+05	5.47E+04	3.34E+04	3.57E+04	4.39E+01	6.44E+03	0.00E+00	2.64E+01	1.25E+03	0.00E+00	0.00E+00	0.00E+00	8.68E+05
2	1.86E+05	3.04E+04	1.38E+04	3.38E+05	1.88E+05	5.72E+04	3.75E+04	3.34E+04	8.40E+02	8.40E+03	3.41E+03	1.09E+02	2.46E+03	5.73E+01	1.86E+01	5.18E+03	9.00E+05
3	2.10E+05	2.90E+04	2.08E+04	3.06E+05	2.17E+05	6.12E+04	4.48E+04	6.23E+02	1.06E+04	6.48E+03	2.57E+02	3.76E+03	5.02E+02	1.72E+01	3.22E+01	8.57E+03	9.44E+05
4	2.20E+05	2.77E+04	2.47E+04	2.95E+05	2.34E+05	5.68E+04	5.07E+04	3.05E+04	6.49E+02	1.02E+04	7.47E+03	3.99E+02	4.88E+03	4.22E+02	2.83E+01	1.18E+00	3.31E+02
5	2.41E+05	2.87E+04	2.90E+04	2.86E+05	2.57E+05	6.55E+04	5.59E+04	3.10E+04	5.98E+02	1.16E+04	8.16E+03	5.29E+02	6.98E+03	6.38E+02	4.82E+01	1.68E+00	6.28E+02
6	2.59E+05	2.82E+04	3.33E+04	2.71E+05	2.68E+05	7.29E+04	6.06E+04	2.95E+04	5.23E+02	1.52E+04	8.41E+03	5.18E+02	8.48E+03	1.21E+03	1.28E+02	5.42E+00	3.20E+01
7	2.68E+05	2.71E+04	3.52E+04	2.59E+05	2.85E+05	6.45E+04	6.29E+04	2.80E+04	5.51E+02	1.59E+04	8.33E+03	6.01E+02	9.11E+03	1.49E+03	1.43E+02	5.83E+00	3.97E+01
8	2.87E+05	2.83E+04	3.86E+04	2.86E+05	2.95E+05	7.46E+04	6.96E+04	3.06E+04	8.63E+02	1.42E+04	7.21E+03	6.49E+02	1.07E+04	1.49E+03	1.68E+02	7.56E+00	5.74E+01
9	3.00E+05	2.70E+04	3.99E+04	2.61E+05	3.02E+05	7.17E+04	7.49E+04	2.78E+04	7.55E+02	1.62E+04	7.58E+03	1.00E+03	1.33E+04	1.89E+03	3.14E+02	2.36E+01	2.54E+00
10	3.02E+05	2.47E+04	3.90E+04	2.37E+05	3.06E+05	7.06E+04	7.48E+04	2.52E+04	7.04E+02	1.63E+04	7.71E+03	7.06E+02	1.50E+04	2.31E+03	4.08E+02	2.57E+01	2.42E+00
11	3.12E+05	2.56E+04	4.19E+04	2.62E+05	3.11E+05	8.22E+04	8.13E+04	2.74E+04	9.44E+02	1.55E+04	7.47E+03	7.40E+02	1.55E+04	2.58E+03	4.18E+02	3.07E+01	3.36E+00
12	3.30E+05	2.50E+04	4.10E+04	2.47E+05	3.18E+05	7.15E+04	8.36E+04	2.64E+04	6.82E+02	1.95E+04	6.68E+03	7.98E+02	1.75E+04	3.12E+03	6.26E+02	5.41E+01	7.21E+00
13	3.32E+05	2.33E+04	3.94E+04	2.26E+05	3.21E+05	7.18E+04	8.47E+04	2.47E+04	6.47E+02	1.73E+04	6.44E+03	7.68E+02	1.82E+04	3.53E+03	7.51E+02	5.64E+01	7.71E+00
14	3.54E+05	2.47E+04	4.47E+04	2.60E+05	3.30E+05	8.21E+04	9.13E+04	2.69E+04	8.42E+02	1.86E+04	7.08E+03	7.46E+02	1.86E+04	3.36E+03	7.15E+02	6.38E+01	8.58E+00
15	3.61E+05	2.50E+04	4.23E+04	2.57E+05	3.31E+05	7.88E+04	9.13E+04	2.64E+04	6.99E+02	2.02E+04	6.55E+03	6.78E+02	2.13E+04	4.08E+03	9.14E+02	8.25E+01	1.29E+01
16	3.46E+05	2.00E+04	3.84E+04	2.18E+05	3.15E+05	7.22E+04	9.21E+04	2.25E+04	6.11E+02	1.89E+04	6.73E+03	7.81E+02	2.14E+04	4.27E+03	1.23E+03	1.22E+02	1.96E+01
17	3.67E+05	2.10E+04	4.00E+04	2.32E+05	3.17E+05	7.74E+04	9.29E+04	2.33E+04	7.46E+02	2.17E+04	7.08E+03	7.45E+02	2.22E+04	4.50E+03	1.22E+03	1.18E+02	2.09E+01
18	3.75E+05	2.24E+04	3.98E+04	2.51E+05	3.26E+05	8.34E+04	9.69E+04	2.47E+04	9.16E+02	2.17E+04	6.24E+03	7.22E+02	2.39E+04	5.38E+03	1.41E+03	1.36E+02	2.60E+01
19	3.67E+05	2.01E+04	3.59E+04	2.10E+05	3.16E+05	6.92E+04	9.70E+04	2.25E+04	6.33E+02	2.05E+04	5.88E+03	6.49E+02	2.35E+04	5.20E+03	1.63E+03	1.87E+02	3.40E+01
20	3.87E+05	2.03E+04	3.97E+04	2.24E+05	3.24E+05	7.79E+04	9.96E+04	2.28E+04	6.26E+02	2.44E+04	6.47E+03	6.78E+02	2.45E+04	6.28E+03	1.74E+03	1.77E+02	3.70E+01

Monteburns grams of material at beginning of steps for material 3

11 3.35E+05 2.75E+04 3.92E+04 2.92E+05 3.21E+05 7.86E+04 8.28E+04 2.92E+04 1.17E+03 1.84E+04 7.76E+03 8.68E+02 1.68E+04 3.07E+03 5.26E+02 4.39E+01 5.95E+00 1.25E+06
12 3.39E+05 2.61E+04 3.79E+04 2.74E+05 3.24E+05 7.62E+04 8.29E+04 2.77E+04 1.10E+03 1.80E+04 7.31E+03 7.28E+02 1.76E+04 3.55E+03 6.51E+02 5.22E+01 6.44E+00 1.24E+06
13 3.60E+05 2.83E+04 4.22E+04 3.07E+05 3.37E+05 8.49E+04 9.07E+04 3.11E+04 1.28E+03 1.83E+04 7.01E+03 7.09E+02 1.75E+04 3.49E+03 6.18E+02 5.76E+01 6.86E+00 1.33E+06
14 3.67E+05 2.77E+04 4.03E+04 2.94E+05 3.39E+05 7.88E+04 9.07E+04 3.01E+04 1.18E+03 1.80E+04 6.46E+03 7.12E+02 2.00E+04 4.01E+03 8.83E+02 7.65E+01 1.18E+01 1.32E+06
15 3.57E+05 2.38E+04 3.58E+04 2.62E+05 3.22E+05 7.76E+04 8.98E+04 2.58E+04 1.05E+03 1.94E+04 7.43E+03 6.95E+02 2.08E+04 4.52E+03 1.09E+03 1.06E+02 1.62E+01 1.25E+06
16 3.73E+05 2.37E+04 3.78E+04 2.69E+05 3.27E+05 7.99E+04 9.49E+04 2.58E+04 1.15E+03 2.05E+04 8.29E+03 7.40E+02 2.18E+04 4.69E+03 1.10E+03 1.08E+02 1.83E+01 1.29E+06
17 3.86E+05 2.53E+04 3.89E+04 2.79E+05 3.37E+05 8.09E+04 9.60E+04 2.73E+04 1.23E+03 2.18E+04 7.16E+03 6.80E+02 2.36E+04 5.30E+03 1.28E+03 1.25E+02 2.27E+01 1.33E+06
18 3.73E+05 2.24E+04 3.47E+04 2.58E+05 3.20E+05 7.58E+04 9.62E+04 2.51E+04 1.04E+03 2.07E+04 6.75E+03 6.52E+02 2.34E+04 5.20E+03 1.51E+03 1.61E+02 3.16E+01 1.27E+06
19 3.94E+05 2.35E+04 3.79E+04 2.75E+05 3.30E+05 8.14E+04 1.00E+05 2.63E+04 1.03E+03 2.30E+04 6.65E+03 6.94E+02 2.51E+04 5.53E+03 1.56E+03 1.70E+02 3.34E+01 1.33E+06
20 4.05E+05 2.54E+04 3.83E+04 2.91E+05 3.41E+05 8.34E+04 1.02E+05 2.86E+04 1.27E+03 2.28E+04 6.01E+03 6.16E+02 2.55E+04 5.82E+03 1.66E+03 1.69E+02 3.49E+01 1.38E+06

Monteburns grams of material at beginning of steps for material 4

1001.50c 3009.50c 83209.50c 94239.55c actinide
0 5.99E+04 6.79E+05 3.24E+06 0.00E+00 0.00E+00
1 9.59E+04 6.79E+05 3.24E+06 0.00E+00 0.00E+00
2 1.16E+05 7.82E+05 3.92E+06 0.00E+00 0.00E+00
3 1.36E+05 7.92E+05 4.60E+06 0.00E+00 0.00E+00
4 1.56E+05 7.85E+05 5.27E+06 0.00E+00 0.00E+00
5 1.76E+05 7.57E+05 5.95E+06 0.00E+00 0.00E+00
6 1.95E+05 7.14E+05 6.63E+06 0.00E+00 0.00E+00
7 2.15E+05 7.15E+05 7.31E+06 0.00E+00 0.00E+00
8 2.35E+05 7.94E+05 7.98E+06 0.00E+00 0.00E+00
9 2.55E+05 8.70E+05 8.66E+06 0.00E+00 0.00E+00
10 2.75E+05 9.40E+05 9.34E+06 0.00E+00 0.00E+00
11 2.95E+05 9.94E+05 1.00E+07 0.00E+00 0.00E+00
12 3.15E+05 1.07E+06 1.07E+07 0.00E+00 0.00E+00
13 3.34E+05 1.12E+06 1.14E+07 0.00E+00 0.00E+00
14 3.54E+05 1.17E+06 1.20E+07 0.00E+00 0.00E+00
15 3.74E+05 1.24E+06 1.27E+07 0.00E+00 0.00E+00
16 3.94E+05 1.28E+06 1.34E+07 0.00E+00 0.00E+00
17 4.14E+05 1.29E+06 1.41E+07 0.00E+00 0.00E+00
18 4.33E+05 1.34E+06 1.48E+07 0.00E+00 0.00E+00
19 4.53E+05 1.36E+06 1.54E+07 0.00E+00 0.00E+00
20 4.73E+05 1.38E+06 1.61E+07 0.00E+00 0.00E+00

Monteburns grams of material at ends of steps

Monteburns grams of material at ends of steps for material 1

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
0 1.52E+05 2.74E+04 8.54E+03 3.14E+05 1.45E+05 4.80E+04 2.93E+04 3.14E+04 3.85E+01 5.65E+03 0.00E+00 2.32E+01 1.10E+03 0.00E+00 0.00E+00 0.00E+00 7.61E+05
1 1.44E+05 2.08E+04 1.21E+04 2.28E+05 1.46E+05 3.98E+04 3.05E+04 2.29E+04 8.42E+02 5.83E+03 4.41E+03 1.14E+02 2.33E+03 1.75E+02 4.88E+02 8.76E+02 1.40E+03 7.05E+05
2 1.59E+05 2.07E+04 1.61E+04 2.25E+05 1.66E+05 4.24E+04 3.52E+04 2.26E+04 1.10E+03 6.74E+03 5.88E+03 2.24E+02 3.30E+03 3.23E+02 1.28E+01 3.39E+01 8.47E+03 6.59E+05
3 1.73E+05 2.09E+04 1.98E+04 2.22E+05 1.83E+05 4.61E+04 3.88E+04 2.27E+04 1.17E+03 8.80E+03 6.50E+03 3.39E+02 4.62E+03 4.85E+02 2.14E+01 5.68E+01 1.55E+02 7.91E+05
4 1.96E+05 1.98E+04 2.55E+04 2.02E+05 2.05E+05 4.97E+04 4.52E+04 2.12E+04 1.20E+03 1.06E+04 7.09E+03 4.82E+02 6.43E+03 9.28E+02 7.07E+01 3.14E+01 1.49E+01 7.91E+05
5 2.04E+05 1.89E+04 2.81E+04 1.95E+05 2.17E+05 4.75E+04 4.99E+04 2.03E+04 1.23E+03 1.03E+04 6.96E+03 5.34E+02 7.06E+03 1.00E+03 7.91E+01 3.84E+01 2.26E+01 8.09E+05
6 2.25E+05 1.96E+04 3.17E+04 1.90E+05 2.35E+05 5.39E+04 5.51E+04 2.08E+04 1.23E+03 1.16E+04 7.24E+03 6.17E+02 9.12E+03 1.35E+03 1.20E+02 6.04E+01 3.56E+01 8.63E+05
7 2.39E+05 1.83E+04 3.32E+04 1.73E+05 2.38E+05 5.73E+04 5.91E+04 1.87E+04 1.20E+03 1.41E+04 7.71E+03 6.63E+02 1.17E+04 1.94E+03 2.45E+02 1.58E+01 1.23E+01 8.75E+05
8 2.43E+05 1.61E+04 3.28E+04 1.54E+05 2.46E+05 5.18E+04 6.03E+04 1.59E+04 1.16E+03 1.43E+04 8.00E+03 7.22E+02 1.29E+04 2.34E+03 3.17E+02 2.04E+01 1.71E+01 8.60E+05
9 2.61E+05 1.71E+04 3.61E+04 1.72E+05 2.59E+05 5.94E+04 6.71E+04 1.79E+04 1.30E+03 1.43E+04 7.91E+03 7.02E+02 1.36E+04 2.50E+03 3.49E+02 2.33E+01 2.10E+01 9.31E+05
10 2.71E+05 1.59E+04 3.56E+04 1.59E+05 2.59E+05 5.83E+04 7.04E+04 1.59E+04 1.16E+03 1.60E+04 7.76E+03 8.59E+02 1.64E+04 3.07E+03 5.26E+02 4.39E+01 5.95E+00 9.32E+05
11 2.75E+05 1.46E+04 3.43E+04 1.45E+05 2.63E+05 5.61E+04 7.07E+04 1.46E+04 1.09E+03 1.56E+04 7.31E+03 7.19E+02 1.72E+04 3.55E+03 6.51E+02 5.22E+01 6.44E+00 9.18E+05
12 2.96E+05 1.70E+04 3.87E+04 1.77E+05 2.77E+05 6.51E+04 7.85E+04 1.81E+04 1.27E+03 1.59E+04 7.01E+03 7.00E+02 1.71E+04 3.49E+03 6.18E+02 5.76E+01 6.86E+00 9.12E+05
13 3.05E+05 1.65E+04 3.68E+04 1.66E+05 2.79E+05 5.91E+04 7.87E+04 1.72E+04 1.16E+03 1.83E+04 6.46E+03 7.04E+02 1.95E+04 4.01E+03 8.36E+02 7.65E+01 1.18E+01 1.01E+06
14 2.95E+05 1.27E+04 3.23E+04 1.35E+05 2.63E+05 5.81E+04 7.79E+04 1.31E+04 1.03E+03 1.71E+04 7.43E+03 6.87E+02 2.03E+04 4.52E+03 1.09E+03 1.06E+02 1.62E+01 9.42E+05
15 3.12E+05 1.27E+04 3.44E+04 1.43E+05 2.69E+05 6.06E+04 8.31E+04 1.32E+04 1.14E+03 1.82E+04 6.29E+03 7.32E+02 2.14E+04 4.69E+03 1.10E+03 1.08E+02 1.83E+01 9.85E+05
16 3.25E+05 1.44E+04 3.54E+04 1.54E+05 2.79E+05 6.17E+04 8.43E+04 1.47E+04 1.22E+03 1.96E+04 7.16E+03 6.72E+02 2.32E+04 5.30E+03 1.28E+03 1.25E+02 2.27E+01 1.03E+06
17 3.13E+05 1.16E+04 3.13E+04 1.34E+05 2.62E+05 5.68E+04 8.46E+04 1.27E+04 1.02E+03 1.85E+04 6.75E+03 6.44E+02 2.30E+04 5.20E+03 1.51E+03 1.61E+02 3.16E+01 9.64E+05
18 3.34E+05 1.28E+04 3.45E+04 1.51E+05 2.73E+05 6.25E+04 8.86E+04 1.40E+04 1.02E+03 2.07E+04 6.65E+03 6.86E+02 2.47E+04 5.53E+03 1.56E+03 1.70E+02 3.34E+01 1.03E+06
19 3.46E+05 1.47E+04 3.49E+04 1.69E+05 2.85E+05 6.47E+04 9.05E+04 1.26E+04 1.26E+03 2.06E+04 6.01E+03 6.08E+02 2.51E+04 5.82E+03 1.66E+03 1.69E+02 3.49E+01 1.08E+06
20 3.35E+05 1.21E+04 3.00E+04 1.34E+05 2.66E+05 5.55E+04 8.83E+04 1.33E+04 1.05E+03 1.98E+04 6.27E+03 5.58E+02 2.48E+04 5.81E+03 1.91E+03 2.19E+02 4.85E+01 9.96E+05

Monteburns grams of material at ends of steps for material 2

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
0 1.73E+05 3.12E+04 9.73E+03 3.57E+05 1.65E+05 5.47E+04 3.34E+04 3.57E+04 4.39E+01 6.44E+03 0.00E+00 2.64E+01 1.25E+03 0.00E+00 0.00E+00 0.00E+00 8.68E+05
1 1.67E+05 2.64E+04 8.26E+04 2.94E+05 1.67E+05 4.85E+04 3.43E+04 2.97E+04 7.09E+02 6.59E+03 3.33E+03 7.07E+01 2.12E+03 1.08E+02 1.90E+00 2.22E+02 2.22E+04 7.93E+05
2 1.81E+05 2.62E+04 1.69E+04 2.85E+05 1.87E+05 5.20E+04 3.82E+04 2.92E+04 8.36E+02 8.33E+03 5.00E+03 1.78E+02 3.40E+03 2.15E+02 5.16E+00 8.06E+02 1.21E+03 8.34E+05
3 2.04E+05 2.52E+04 2.37E+04 2.61E+05 2.14E+05 5.59E+04 4.50E+04 2.75E+04 9.92E+02 1.08E+04 6.53E+03 3.61E+02 4.85E+03 6.36E+02 3.36E+01 9.87E+01 2.81E+02 8.82E+05
4 2.14E+05 2.40E+04 2.73E+04 2.52E+05 2.28E+05 5.21E+04 5.05E+04 2.63E+04 1.02E+03 1.04E+04 6.67E+03 4.56E+02 5.76E+03 6.20E+02 4.24E+01 1.86E+00 8.01E+02 9.00E+05
5 2.34E+05 2.47E+04 3.15E+04 2.42E+05 2.49E+05 5.98E+04 5.58E+04 2.65E+04 9.85E+02 1.16E+04 7.27E+03 5.77E+02 7.89E+03 9.17E+02 7.10E+01 3.00E+00 1.38E+01 9.54E+05
6 2.53E+05 2.48E+04 3.52E+04 2.36E+05 2.59E+05 6.66E+04 6.02E+04 9.08E+02 1.48E+04 6.94E+03 5.54E+02 9.50E+01 1.43E+03 1.58E+02 7.89E+00 4.86E+01 9.96E+05
7 2.60E+05 2.32E+04 3.67E+04 2.22E+05 2.75E+05 6.90E+04 6.25E+04 2.40E+04 1.02E+03 1.85E+04 6.75E+03 6.44E+02 2.30E+04 5.20E+03 1.51E+03 1.61E+02 3.16E+01 9.64E+05
8 2.77E+05 2.33E+04 3.92E+04 2.35E+05 2.83E+05 7.65E+04 6.93E+04 2.51E+04 1.21E+03 1.44E+04 7.41E+03 6.71E+02 1.20E+04 1.94E+03 2.32E+02 1.30E+01 9.90E+01 1.06E+06
9 2.91E+05 2.28E+04 3.98E+04 2.21E+05 2.89E+05 6.60E+04 7.38E+04 2.35E+04 1.06E+03 1.61E+04 6.91E+03 9.28E+02 1.43E+04 2.32E+03 3.69E+02 2.91E+01 3.45E+00 1.07E+06
10 2.93E+05 2.08E+04 3.89E+04 1.99E+05 2.92E+05 6.46E+04 7.36E+04 2.13E+04 9.91E+02 1.61E+04 6.78E+03 6.99E+02 1.57E+04 2.85E+03 4.76E+02 3.36E+01 3.46E+00 1.05E+06
11 3.12E+05 2.24E+04 4.21E+04 2.29E+05 3.00E+05 7.52E+04 8.06E+04 2.42E+04 1.17E+03 1.56E+04 6.44E+03 7.15E+02 1.60E+04 2.91E+03 4.78E+02 3.72E+01 4.29E+00 1.13E+06
12 3.21E+05 2.17E+04 4.05E+04 2.15E+05 3.05E+05 6.60E+04 8.19E+04 2.32E+04 9.98E+02 1.91E+04 5.86E+03 7.40E+02 1.82E+04 3.40E+03 6.87E+02 6.09E+01 8.53E+00 1.12E+06
13 3.23E+05 2.01E+04 3.92E+04 1.97E+05 3.06E+05 6.73E+04 8.31E+04 2.16E+04 9.25E+02 1.73E+04 5.70E+03 7.15E+02 1.87E+04 3.82E+03 8.26E+02 6.75E+01 9.24E+00 1.11E+06
14 3.42E+05 2.03E+04 4.31E+04 2.17E+05 3.13E+05 7.39E+04 8.92E+04 2.25E+04 1.14E+03 1.86E+04 6.72E+03 7.19E+02 1.94E+04 4.77E+03 8.10E+02 7.50E+01 1.08E+01 1.17E+06
15 3.45E+05 2.00E+04 4.09E+04 2.10E+05 3.12E+05 7.23E+04 8.93E+04 2.11E+04 1.16E+03 2.02E+04 6.89E+03 7.18E+02 2.21E+04 4.86E+03 1.06E+03 1.02E+02 1.70E+01 1.17E+06
16 3.36E+05 1.72E+04 3.77E+04 1.88E+05 3.00E+05 6.78E+04 8.98E+04 1.95E+04 9.77E+02 2.02E+04 6.55E+03 7.20E+02 2.18E+04 4.56E+03 1.29E+03 1.32E+02 2.26E+01 1.11E+06
17 3.55E+05 1.76E+04 3.97E+04 2.00E+05 3.04E+05 7.18E+04 9.30E+04 1.96E+04 8.86E+02 2.17E+04 6.35E+03 7.35E+02 2.33E+04 4.95E+03 1.35E+03 1.39E+02 2.52E+01 1.16E+06
18 3.63E+05 1.91E+04 3.86E+04 2.14E+05 3.10E+05 7.51E+04 9.44E+04 2.14E+04 1.18E+03 2.14E+04 6.61E+03 7.52E+02 2.44E+04 5.55E+03 1.50E+03 1.48E+02 2.91E+01 1.20E+06
19 3.57E+05 1.74E+04 3.57E+04 1.84E+05 3.02E+05 6.51E+04 9.49E+04 1.98E+04 8.66E+02 2.04E+04 5.24E+03 6.19E+02 2.40E+04 5.44E+03 1.72E+03 1.97E+02 3.82E+01 1.14E+06
20 3.74E+05 1.69E+04 3.86E+04 1.91E+05 3.08E+05 7.10E+04 9.74E+04 1.92E+04 8.93E+02 2.37E+04 6.07E+03 6.50E+02 2.59E+04 6.39E+03 1.89E+03 1.97E+02 4.29E+01 1.18E+06

Monteburns grams of material at ends of steps for material 3

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
0 1.91E+05 3.46E+04 1.08E+04 3.96E+05 1.83E+05 6.06E+04 3.70E+04 3.96E+04 4.86E+01 7.14E+03 0.00E+00 2.93E+01 1.38E+03 0.00E+00 0.00E+00 0.00E+00 9.61E+05
1 1.86E+05 3.04E+04 1.38E+04 3.38E+05 1.88E+05 5.72E+04 3.75E+04 3.42E+04 3.34E+02 8.40E+03 3.41E+03 1.09E+02 2.46E+03 5.73E+01 8.36E+01 5.18E+03 4.51E+05 9.00E+05
2 2.10E+05 2.90E+04 2.08E+04 3.06E+05 2.17E+05 6.12E+04 4.49E+04 3.19E+04 6.22E+02 1.06E+04 6.48E+03 2.57E+02 3.78E+03 5.02E+02 1.72E+01 3.22E+01 8.57E+03 9.44E+05
3 2.20E+05 2.77E+04 2.47E+04 2.95E+05 2.34E+05 5.68E+04 5.07E+04 3.05E+04 6.49E+02 1.02E+04 7.47E+03 3.99E+02 4.88E+03 4.22E+02 2.83E+01 1.18E+00 3.31E+02 9.64E+05
4 2.41E+05 2.87E+04 2.90E+04 2.86E+05 2.57E+05 6.55E+04 5.59E+04 3.10E+04 1.16E+04 8.16E+03 5.29E+02 6.98E+03 6.38E+02 4.82E+01 1.18E+00 6.28E+02 1.02E+06
5 2.59E+05 2.82E+04 3.33E+04 2.71E+05 2.68E+05 7.29E+04 6.05E+04 2.95E+04 5.23E+02 1.52E+04 8.41E+03 5.18E+02 8.48E+03 1.21E+03 1.28E+02 5.42E+00 3.20E+01 1.06E+06

June 16, 1998

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6 2.68E+05 2.71E+04 3.52E+04 2.59E+05 2.85E+05 6.45E+04 6.29E+04 2.80E+04 5.51E+02 1.59E+04 8.33E+03 6.01E+02 9.11E+03 1.49E+03 1.43E+02 5.83E+00 3.97E-01 1.07E+06
7 2.87E+05 2.83E+04 3.86E+04 2.86E+05 2.93E+05 7.46E+04 6.96E+04 3.06E+04 8.63E+02 1.42E+04 7.21E+03 6.49E+02 1.07E+04 1.49E+03 1.68E+02 7.56E+00 5.74E-01 1.15E+06
8 3.00E+05 2.70E+04 3.99E+04 2.61E+05 3.02E+05 7.17E+04 7.49E+04 2.78E+04 7.55E+02 1.52E+04 7.58E+03 1.00E+03 1.35E+04 1.89E+03 2.35E+02 9.45E+00 5.44E-01 1.15E+06
9 3.02E+05 2.47E+04 3.90E+04 2.37E+05 3.06E+05 7.06E+04 7.48E+04 2.52E+04 7.04E+02 1.63E+04 7.71E+03 7.06E+02 1.50E+04 2.31E+03 4.08E+02 2.57E+01 2.42E+00 1.22E+06
10 3.21E+05 2.56E+04 4.19E+04 2.62E+05 3.11E+05 8.22E+04 8.13E+04 2.73E+04 9.44E+02 1.55E+04 7.47E+03 7.40E+02 1.55E+04 2.58E+03 4.18E+02 3.07E+01 3.36E+00 1.20E+06
11 3.30E+05 2.50E+04 4.10E+04 2.47E+05 3.18E+05 7.15E+04 8.36E+04 2.64E+04 6.82E+02 1.95E+04 6.68E+03 7.98E+02 1.75E+04 3.12E+03 6.26E+02 5.41E+01 7.21E+00 1.19E+06
12 3.32E+05 2.33E+04 3.94E+04 2.26E+05 3.21E+05 7.18E+04 8.47E+04 2.47E+04 6.47E+02 1.73E+04 6.44E+03 7.68E+02 1.82E+04 3.53E+03 7.51E+02 5.64E+01 7.71E+00 1.17E+06
13 3.54E+05 2.47E+04 4.47E+04 2.60E+05 3.30E+05 8.21E+04 9.13E+04 2.69E+04 8.42E+02 1.86E+04 7.08E+03 7.46E+02 1.86E+04 3.36E+03 7.15E+02 6.38E+01 8.58E+00 1.26E+06
14 3.61E+05 2.50E+04 4.23E+04 2.57E+05 3.31E+05 7.88E+04 9.13E+04 2.64E+04 9.69E+02 2.02E+04 6.55E+03 6.78E+02 2.13E+04 4.08E+03 9.14E+02 8.25E+01 1.29E+01 1.27E+06
15 3.46E+05 2.00E+04 3.84E+04 2.18E+05 3.16E+05 7.22E+04 9.21E+04 2.25E+04 6.11E+02 1.89E+04 6.73E+03 7.81E+02 2.25E+04 4.27E+03 1.23E+03 1.22E+02 1.96E+01 1.18E+06
16 3.67E+05 2.10E+04 4.00E+04 2.32E+05 3.17E+05 7.74E+04 9.47E+04 2.29E+04 6.83E+02 2.17E+04 7.08E+03 7.45E+02 2.22E+04 4.50E+03 1.22E+03 1.18E+02 2.09E+01 1.23E+06
17 3.75E+05 2.24E+04 3.98E+04 2.51E+05 3.26E+05 8.34E+04 9.69E+04 2.47E+04 9.16E+02 2.17E+04 6.24E+03 7.22E+02 2.39E+04 5.38E+03 1.41E+03 1.36E+02 2.60E+01 1.28E+06
18 3.67E+05 2.01E+04 3.59E+04 2.10E+05 3.16E+05 6.92E+04 9.70E+04 2.25E+04 6.33E+02 2.05E+04 5.88E+03 6.49E+02 2.35E+04 5.20E+03 1.63E+03 1.87E+02 3.40E+01 1.20E+06
19 3.87E+05 2.03E+04 3.97E+04 2.24E+05 3.24E+05 7.79E+04 9.96E+04 2.28E+04 6.26E+02 2.44E+04 6.47E+03 6.78E+02 2.45E+04 6.28E+03 1.74E+03 1.77E+02 3.70E+01 1.26E+06
20 3.97E+05 2.27E+04 3.94E+04 2.45E+05 3.35E+05 7.89E+04 1.03E+05 2.53E+04 7.59E+02 2.18E+04 5.96E+03 6.16E+02 2.59E+04 6.04E+03 1.84E+03 1.84E+02 3.91E+01 1.31E+06
```

Monteburns grams of material at ends of steps for material 4

```
1001.50c 43099.50c 83209.50c 94239.55c actinide
0 9.59E+04 6.79E+05 3.24E+06 0.00E+00 0.00E+00
1 9.58E+04 6.39E+05 3.24E+06 0.00E+00 0.00E+00
2 1.16E+05 6.50E+05 3.92E+06 0.00E+00 0.00E+00
3 1.36E+05 6.43E+05 4.59E+06 0.00E+00 0.00E+00
4 1.56E+05 6.15E+05 5.27E+06 0.00E+00 0.00E+00
5 1.75E+05 5.71E+05 5.95E+06 0.00E+00 0.00E+00
6 1.95E+05 5.73E+05 6.63E+06 0.00E+00 0.00E+00
7 2.15E+05 6.52E+05 7.31E+06 0.00E+00 0.00E+00
8 2.35E+05 7.28E+05 7.98E+06 0.00E+00 0.00E+00
9 2.55E+05 7.97E+05 8.66E+06 0.00E+00 0.00E+00
10 2.75E+05 8.52E+05 9.34E+06 0.00E+00 0.00E+00
11 2.94E+05 9.24E+05 1.00E+07 0.00E+00 0.00E+00
12 3.14E+05 9.81E+05 1.07E+07 0.00E+00 0.00E+00
13 3.34E+05 1.03E+06 1.14E+07 0.00E+00 0.00E+00
14 3.54E+05 1.10E+06 1.20E+07 0.00E+00 0.00E+00
15 3.74E+05 1.13E+06 1.27E+07 0.00E+00 0.00E+00
16 3.93E+05 1.15E+06 1.34E+07 0.00E+00 0.00E+00
17 4.13E+05 1.20E+06 1.41E+07 0.00E+00 0.00E+00
18 4.33E+05 1.22E+06 1.48E+07 0.00E+00 0.00E+00
19 4.53E+05 1.23E+06 1.54E+07 0.00E+00 0.00E+00
20 4.72E+05 1.23E+06 1.61E+07 0.00E+00 0.00E+00
```

Monteburns inventory for material 4

Monteburns grams of feed per step for material 1

```
mat # days 92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
1 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
2 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
3 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
4 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
5 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
6 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
7 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
8 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
9 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
10 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
11 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
12 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
13 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
14 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
15 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
16 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
17 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
18 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
19 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
20 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
tot 2389.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
```

Monteburns grams produced (or destroyed) per step for material 1

```
1 92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
1 7.83E+03 -6.57E+03 3.61E+03 -8.45E+03 1.52E+03 -8.18E+03 1.17E+03 -8.44E+03 8.05E+02 1.78E+02 4.41E+03 9.11E+01 1.22E+03 1.75E+02 4.88E+02 8.76E+02 1.40E+03 -1.03E+05
2 1.55E+04 -1.19E+02 3.93E+03 -3.37E+03 1.92E+04 2.60E+03 4.75E+03 -3.27E+02 2.58E+02 9.09E+02 1.47E+03 1.10E+02 9.79E+02 1.80E+02 7.95E+02 2.51E+01 7.08E+02 4.60E+04
3 1.39E+04 2.06E+02 3.70E+03 -2.80E+03 1.77E+04 3.70E+03 3.56E+03 1.47E+02 6.84E+01 1.55E+03 6.27E+02 1.15E+02 1.31E+03 1.62E+02 8.60E+00 2.29E+01 6.99E+03 4.40E+04
4 2.25E+04 -1.07E+03 5.76E+03 -2.02E+04 2.16E+04 3.63E+03 6.40E+03 -1.52E+03 3.10E+01 2.27E+03 5.90E+02 1.44E+02 1.82E+03 4.42E+02 4.93E+01 2.57E+00 1.34E+01 4.25E+04
5 8.58E+03 -9.45E+02 2.61E+03 -6.45E+03 1.22E+04 -2.26E+03 4.71E+03 -9.11E+02 2.71E+01 -3.10E+02 -1.35E+02 5.17E+01 6.22E+02 7.31E+01 8.38E+00 7.01E+01 7.61E+02 1.79E+04
6 2.08E+04 6.67E+02 3.58E+03 -5.11E+03 1.79E+04 6.39E+03 5.21E+03 4.38E+02 7.99E+00 1.31E+03 2.87E+02 8.32E+01 2.06E+03 3.54E+02 4.11E+01 2.20E+00 1.31E+01 5.41E+04
7 1.42E+04 -1.31E+03 1.51E+03 -1.07E+04 3.20E+03 3.40E+03 -2.03E+03 -3.40E+01 2.49E+03 4.63E+02 4.58E+01 2.54E+03 5.85E+02 1.24E+02 9.81E+00 8.76E+01 1.17E+04
8 3.52E+03 -3.78E+03 -4.55E+02 -1.89E+04 1.24E+03 -2.82E+03 -4.39E+02 1.22E+02 2.89E+02 5.85E+01 1.06E+03 1.71E+02 7.13E+02 2.28E+02 2.28E+00 2.00E+00 4.74E+01 -1.46E+04
9 1.85E+04 9.94E+02 3.26E+03 1.83E+04 1.23E+04 7.58E+03 6.84E+03 1.95E+03 1.41E+02 -7.53E+00 -8.69E+01 -1.95E+01 6.33E+02 1.57E+02 3.19E+01 2.88E+00 3.99E+01 7.06E+04
10 9.47E+03 -1.13E+03 -4.93E+02 -1.28E+04 6.96E+02 -1.11E+03 3.26E+03 -1.93E+02 1.77E+02 1.47E+02 1.57E+02 2.78E+03 5.71E+02 1.76E+02 2.07E+01 3.85E+00 4.0E+03
11 4.38E+03 -1.32E+03 -1.28E+03 -1.63E+04 3.70E+03 2.78E+03 2.78E+02 -1.37E+03 -6.88E+01 4.32E+02 -4.55E+02 -1.40E+02 8.25E+02 4.85E+02 1.25E+02 8.28E+00 4.86E+01 -1.38E+04
12 2.15E+04 2.35E+03 4.36E+03 3.40E+04 1.44E+04 8.94E+03 7.85E+03 3.55E+03 1.78E+02 3.13E+02 -2.94E+02 -1.89E+01 -6.49E+01 -6.49E+01 -3.27E+01 5.42E+00 4.20E+01 9.70E+04
13 8.35E+03 -4.86E+02 -1.86E+03 -1.12E+04 2.09E+03 -5.94E+03 1.45E+02 -9.06E+02 -1.02E+02 2.38E+03 -5.50E+02 3.64E+00 2.46E+03 5.23E+02 2.18E+02 1.88E+01 4.94E+00 -4.74E+03
14 -9.52E+03 -3.78E+03 -4.50E+03 -3.10E+04 -1.59E+03 -4.02E+03 7.36E+02 -4.12E+03 -1.32E+02 -1.21E+03 9.64E+02 -1.72E+01 7.74E+02 5.07E+02 2.54E+02 2.96E+01 4.44E+00 -6.92E+04
15 1.63E+04 3.55E+02 2.09E+03 8.58E+03 5.06E+03 2.49E+03 5.16E+03 1.16E+02 1.06E+02 1.15E+03 8.61E+02 4.51E+01 1.06E+03 1.71E+02 7.13E+02 2.28E+02 2.00E+00 4.34E+04
16 1.35E+04 1.65E+03 1.05E+03 1.08E+04 1.02E+04 1.13E+03 1.17E+03 1.54E+03 8.01E+01 1.32E+03 -1.15E+03 -6.02E+01 1.81E+03 6.13E+02 1.82E+02 1.68E+01 4.66E+00 4.36E+04
17 -1.25E+04 -2.76E+03 -4.10E+03 -2.03E+04 -1.67E+04 -4.89E+03 3.70E+02 -2.04E+03 -1.96E+02 -1.09E+03 -4.10E+02 -2.79E+01 -2.17E+02 -1.06E+02 2.34E+02 3.58E+01 8.90E+00 -6.47E+04
18 2.16E+04 1.17E+03 3.17E+03 1.76E+04 1.13E+04 5.70E+03 3.93E+03 1.25E+03 -4.11E+00 2.27E+03 -9.37E+01 4.19E+01 1.75E+03 3.37E+02 4.33E+01 9.00E+00 1.78E+00 7.02E+04
19 1.16E+04 1.97E+03 4.12E+02 1.75E+04 1.15E+04 2.14E+03 1.95E+03 2.44E+03 2.13E+02 -6.40E+02 7.74E+01 3.68E+02 2.82E+02 1.07E+02 -9.41E+01 1.53E+00 4.96E+04
20 -1.11E+04 -2.63E+03 -4.90E+03 -3.49E+04 -1.90E+04 -9.15E+03 -2.21E+03 -3.12E+03 -2.06E+02 -8.56E+02 2.56E+02 -5.03E+01 -2.61E+02 -1.03E+01 2.49E+02 5.00E+01 1.35E+01 -8.78E+04
tot 1.83E+05 -1.53E+04 2.15E+04 -1.80E+05 1.21E+05 7.53E+03 5.90E+04 -1.81E+04 1.01E+04 6.27E+03 5.55E+02 2.37E+04 5.81E+03 1.91E+03 2.19E+02 4.85E+01 2.34E+05
```

Summary of inventory/feed/production for material 1 (MCNP Material Number 61)

```
92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
ini 1.52E+05 2.74E+04 8.54E+03 3.14E+05 1.45E+05 4.80E+04 2.93E+04 3.14E+04 3.85E+01 5.65E+03 0.00E+00 2.32E+01 1.10E+03 0.00E+00 0.00E+00 0.00E+00 7.61E+05
```

fin 3.35E+05 1.21E+04 3.00E+04 1.34E+05 2.66E+05 5.55E+04 8.83E+04 1.33E+04 1.05E+03 1.98E+04 6.27E+03 5.58E+02 2.48E+04 5.81E+03 1.91E+03 2.19E+02 4.85E+01 9.96E+05
fed 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
net 1.83E+05 -1.53E+04 2.15E+04 -1.80E+05 1.21E+05 7.53E+03 5.00E+04 -1.81E+04 1.01E+03 1.41E+04 6.27E+03 5.55E+02 2.37E+04 5.81E+03 1.91E+03 2.19E+02 4.85E+01 2.34E+05

Monteburns grams of feed per step for material 2

mat # days 92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
1 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
2 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
3 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
4 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
5 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
6 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
7 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
8 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
9 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
10 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
11 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
12 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
13 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
14 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
15 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
16 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
17 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
18 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
19 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
20 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
tot 2389.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

Monteburns grams produced (or destroyed) per step for material 2

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
1 5.84E+03 -4.81E+03 2.85E+03 -6.30E+04 1.66E+03 -6.20E+03 9.32E+02 3.33E+03 6.65E+02 1.45E+02 3.33E+03 4.43E+01 8.76E+02 2.22E+02 1.90E+02 7.44E+04
2 1.35E+04 -2.30E+02 4.30E+03 -9.13E+03 2.06E+04 3.49E+03 3.92E+03 -5.42E+02 1.27E+02 1.74E+03 1.67E+03 1.07E+02 1.27E+03 1.08E+02 3.26E+02 5.84E+02 9.90E+04 4.09E+04
3 2.37E+04 -9.27E+02 6.83E+03 -2.39E+04 2.67E+04 3.96E+03 3.77E+03 -1.61E+03 1.56E+02 2.44E+03 1.53E+03 1.83E+02 1.45E+03 4.21E+02 2.85E+01 9.07E+01 2.69E+02 4.79E+04
4 9.60E+03 -1.23E+03 3.60E+03 -9.68E+03 1.42E+04 3.79E+03 5.50E+03 1.42E+03 2.63E+02 1.25E+02 1.41E+02 9.42E+01 9.10E+02 2.97E+02 2.86E+01 1.14E+01 5.75E+02 5.42E+04
5 2.02E+04 6.45E+02 4.16E+03 -9.44E+03 2.08E+04 7.67E+03 5.34E+03 1.95E+02 -3.38E+01 1.34E+03 5.98E+02 1.22E+02 2.13E+03 2.97E+02 2.86E+01 1.14E+01 5.75E+02 5.42E+04
6 1.86E+04 9.48E+01 3.72E+03 -6.13E+03 1.02E+04 6.76E+03 4.41E+03 3.64E+02 -7.85E+01 1.06E+03 3.25E+02 -2.79E+01 1.61E+03 5.15E+02 8.69E+01 4.90E+01 3.48E+01 4.24E+04
7 6.83E+03 -1.55E+03 1.50E+03 -1.44E+04 1.58E+04 -4.54E+03 2.28E+03 -2.13E+03 -8.47E+01 5.59E+02 2.37E+02 1.05E+02 9.49E+02 3.13E+02 3.23E+01 1.93E+01 1.57E+01 4.13E+03
8 1.72E+04 8.34E+01 2.50E+03 3.32E+04 8.35E+03 7.54E+03 6.77E+03 1.05E+03 3.04E+02 -9.50E+02 2.26E+02 1.26E+01 1.53E+03 2.02E+02 4.13E+01 3.20E+01 3.47E+01 5.82E+04
9 1.43E+04 -5.28E+02 6.43E+02 -1.44E+04 5.50E+03 -1.54E+03 4.52E+03 -1.56E+03 -1.50E+02 1.70E+03 -4.98E+02 2.56E+02 2.33E+03 3.75E+02 1.38E+02 1.60E+01 2.46E+01 1.11E+04
10 1.48E+03 -2.00E+03 -9.54E+02 -2.20E+04 3.41E+03 -1.48E+03 -1.96E+02 -2.22E+03 -6.81E+01 -3.79E+01 -1.25E+02 -2.29E+02 1.38E+03 5.30E+02 1.06E+02 4.52E+01 1.04E+02 -2.24E+04
11 1.95E+04 1.60E+03 3.20E+03 3.01E+04 7.46E+03 1.06E+04 6.95E+03 2.87E+03 1.82E+02 4.68E+02 3.43E+02 1.56E+01 2.71E+02 6.08E+01 2.90E+02 3.57E+02 8.31E+01 8.21E+04
12 9.21E+03 -6.32E+02 -1.56E+03 -1.42E+04 4.92E+03 -9.15E+03 1.33E+03 -1.01E+03 -1.75E+02 3.54E+03 -5.80E+02 2.52E+02 2.27E+03 4.94E+02 2.00E+02 2.38E+01 4.24E+01 5.18E+03
13 1.36E+03 -1.59E+03 -1.38E+03 -1.71E+04 1.37E+03 1.28E+03 -1.57E+03 -7.35E+01 -1.86E+03 -1.65E+02 -2.47E+01 4.45E+02 4.15E+02 1.39E+02 6.50E+02 7.08E+01 7.08E+01 1.74E+04
14 1.91E+04 3.59E+02 3.91E+03 1.99E+04 6.46E+03 6.60E+03 6.12E+03 8.74E+02 2.13E+02 1.30E+03 1.03E+03 3.50E+02 7.34E+02 4.68E+01 -1.51E+01 7.51E+01 1.59E+02 6.72E+04
15 3.50E+03 -5.23E+02 -2.17E+03 7.55E+03 6.86E+03 6.60E+03 6.12E+03 8.74E+02 2.13E+02 1.30E+03 1.03E+03 3.50E+02 7.34E+02 4.68E+01 -1.51E+01 7.51E+01 1.59E+02 6.72E+04
16 -9.00E+03 -2.82E+03 -3.24E+03 -2.18E+04 -1.27E+04 -4.52E+03 4.45E+02 -1.14E+03 1.82E+02 1.60E+03 1.64E+02 -9.48E+01 2.72E+03 1.08E+03 2.52E+02 2.73E+01 6.12E+02 4.22E+03
17 1.91E+04 4.65E+02 2.02E+03 1.22E+04 4.51E+03 4.02E+03 3.26E+03 3.33E+01 -1.25E+02 -1.11E+03 2.21E+03 -3.25E+02 -2.99E+02 2.29E+02 3.00E+01 5.67E+01 5.67E+01 -5.84E+04
18 8.19E+03 1.44E+03 -1.04E+03 1.35E+04 5.59E+03 3.33E+03 1.38E+03 1.80E+03 2.91E+02 -2.58E+02 -6.31E+02 -7.45E+01 1.49E+03 3.94E+02 6.34E+01 7.20E+01 2.57E+01 5.11E+04
19 -6.02E+03 1.62E+03 -2.99E+03 2.93E+04 -7.66E+03 -1.01E+04 4.69E+02 -1.59E+03 -3.11E+02 -1.02E+03 -4.82E+02 -4.12E+01 -4.18E+02 -1.19E+02 2.17E+02 4.93E+01 9.07E+01 -6.10E+04
20 1.70E+04 -5.25E+02 2.97E+03 6.96E+03 5.59E+03 5.97E+03 2.53E+03 -6.15E+02 2.70E+01 3.26E+03 8.35E+02 3.12E+01 1.90E+03 9.53E+02 1.71E+02 3.06E+01 4.75E+01 4.73E+04
tot 2.02E+05 -1.43E+04 2.89E+04 -1.66E+05 1.43E+05 1.63E+04 6.41E+04 -1.66E+04 8.49E+02 1.72E+04 6.07E+03 6.24E+02 2.46E+04 6.39E+03 1.89E+03 1.97E+02 4.29E+01 3.16E+05

Summary of inventory/feed/production for material 2 (MCNP Material Number 63)

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
ini 1.73E+05 3.12E+04 9.73E+03 3.57E+05 1.65E+05 5.47E+04 3.34E+04 3.57E+04 4.39E+01 6.44E+03 0.00E+00 2.64E+01 1.25E+03 0.00E+00 0.00E+00 0.00E+00 8.68E+05
fin 3.74E+05 1.69E+04 3.86E+04 1.91E+05 3.08E+05 7.10E+04 9.74E+04 1.92E+04 8.93E+02 2.37E+04 6.07E+03 6.50E+02 2.59E+04 6.39E+03 1.89E+03 1.97E+02 4.29E+01 1.18E+06
fed 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
net 2.02E+05 -1.43E+04 2.89E+04 -1.66E+05 1.43E+05 1.63E+04 6.41E+04 -1.66E+04 8.49E+02 1.72E+04 6.07E+03 6.24E+02 2.46E+04 6.39E+03 1.89E+03 1.97E+02 4.29E+01 3.16E+05

Monteburns grams of feed per step for material 3

mat # days 92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 96242.50c 96243.35c 96244.50c 96245.35c 96246.35c 96247.35c 96248.35c actinide
1 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
2 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
3 106.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
4 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
5 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
6 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
7 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
8 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
9 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
10 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
11 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
12 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
13 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
14 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
15 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
16 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
17 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
18 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
19 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
20 121.76 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
tot 2389.54 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

Monteburns grams produced (or destroyed) per step for material 3

92238.50c 93237.55c 94238.50c 94239.55c 94240.50c 94241.50c 94242.50c 95241.50c 95242.50c 95243.50c 9

[illegible]

Production/Decurtation rate (g/day) for material (MCNP Material Number 61)	92238.50	92337.55c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.55c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c	actinide
1	7.35E+01	-1.17E+01	3.39E+01	-8.02E+02	1.44E+01	-7.68E+01	1.10E+01	-7.92E+01	7.54E+00	1.67E+00	1.41E+01	8.55E+01	1.15E+01	1.64E+00	4.58E+02	8.22E+04	1.31E+05	-9.67E+02
2	1.45E+02	-1.12E+02	3.69E+01	-3.16E+02	1.40E+02	2.44E+01	4.40E+01	3.07E+02	2.42E+00	8.53E+00	1.38E+01	1.03E+00	9.19E+00	1.39E+00	7.46E+02	2.36E+03	6.65E+05	4.32E+02
3	1.30E+02	1.93E+02	3.47E+01	-2.63E+01	1.66E+02	3.47E+01	3.34E+01	1.38E+00	6.42E+01	1.45E+01	5.89E+00	1.08E+00	1.23E+01	1.52E+00	8.07E+02	2.15E+03	6.56E+05	4.13E+02
4	1.85E+02	0.97E+00	4.73E+01	-1.66E+02	1.77E+02	2.98E+01	5.26E+01	-1.25E+01	2.55E+01	1.86E+01	4.85E+00	1.18E+00	1.49E+01	3.63E+00	4.05E+01	2.11E+01	1.10E+03	3.49E+02
5	7.05E+01	-7.76E+00	2.14E+01	-5.30E+01	1.00E+02	-1.86E+01	3.87E+01	-7.48E+00	2.23E+01	-2.55E+00	-1.11E+00	4.25E+01	5.11E+00	6.00E+01	6.88E+02	5.76E+03	6.25E+04	1.47E+02
6	1.71E+02	5.48E+00	2.94E+01	-4.20E+01	1.47E+02	5.25E+01	4.28E+01	3.60E+00	6.56E+02	1.08E+01	2.36E+00	6.83E+01	1.69E+01	2.91E+00	3.38E+01	1.81E+02	1.08E+03	4.44E+02
7	1.45E+02	1.40E+02	1.24E+01	-1.75E+01	1.24E+02	2.90E+01	2.90E+01	1.79E+01	2.90E+01	1.80E+01	3.75E+01	2.90E+01	4.20E+00	1.02E+00	8.06E+02	7.19E+03	9.61E+01	
8	2.89E+01	-1.80E+01	3.34E+00	-3.55E+02	1.55E+01	-4.48E+01	0.02E+01	3.32E+01	3.61E+01	8.23E+00	2.37E+00	4.80E+01	1.03E+01	2.9E+00	2.98E+01	1.2E+02	3.89E+03	
9	1.52E+02	0.16E+00	2.68E+01	1.50E+02	1.01E+02	6.23E+01	5.62E+01	1.60E+01	1.16E+00	-6.18E+02	-7.14E+01	-1.60E+01	5.45E+00	1.29E+00	2.62E+01	2.37E+02	3.28E+03	5.80E+02
10	7.78E+01	-9.28E+00	-4.05E+00	-1.34E+02	5.72E+00	-9.12E+00	2.68E+01	-1.59E+01	-1.16E+00	1.45E+01	-1.21E+00	1.29E+00	2.28E+01	4.69E+00	1.45E+00	1.70E+01	3.16E+02	1.15E+01
11	3.60E+01	-1.08E+01	-1.05E+01	-1.05E+02	3.04E+01	-1.77E+01	2.28E+00	-1.13E+01	-5.65E+01	-3.55E+00	-3.74E+00	-1.15E+00	6.78E+00	3.98E+00	1.39E+00	6.80E+02	3.99E+03	-1.13E+02
12	1.77E+02	1.93E+01	3.58E+01	2.79E+02	1.18E+02	7.34E+01	6.45E+01	2.92E+01	1.46E+00	2.57E+00	-2.41E+00	-1.55E+01	-7.96E+01	-5.33E+01	-2.69E+01	4.45E+02	3.45E+03	7.97E+02
13	6.86E+01	-3.99E+00	-1.53E+01	-9.20E+01	1.72E+01	4.88E+01	1.19E+00	-7.44E+00	-8.38E+01	1.95E+01	-4.52E+00	2.99E+02	2.02E+01	4.30E+00	1.79E+00	1.54E+01	4.06E+02	-3.89E+01
14	7.82E+01	-3.10E+01	-3.70E+01	-2.55E+02	-1.31E+02	-3.38E+00	-6.04E+00	-3.38E+01	-1.08E+00	-9.94E+00	7.92E+00	-1.41E+01	6.36E+00	4.16E+00	2.09E+00	2.43E+01	3.65E+02	-5.68E+02
15	1.34E+02	2.92E+02	1.72E+01	7.05E+01	4.16E+01	2.05E+01	4.24E+01	9.53E+01	8.71E+01	9.44E+00	7.07E+00	3.70E+01	8.71E+00	1.40E+00	5.86E+02	1.87E+02	1.67E+02	3.56E+02
16	1.10E+02	1.36E+00	8.62E+01	8.87E+01	8.38E+01	9.61E+01	2.65E+00	5.55E+00	1.15E+00									

[illegible]

Production/Destruction rates (g/day) for material 2 (MCNP Material Number 63)																													
92238.50c	92377.55c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.55c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c	actinide												
1.501E+01	-4.51E+01	2.68E+01	-5.91E+02	1.56E+01	-5.82E+01	8.75E+00	-5.66E+01	6.24E+00	1.36E+00	3.13E+01	4.16E+01	8.22E+00	1.01E+00	1.78E+02	2.08E+04	2.08E+06	-6.98E+02												
2.127E+02	-2.16E+00	4.00E+01	-8.57E+01	1.93E+02	3.28E+01	3.68E+01	-5.09E+00	1.19E+00	1.63E+01	1.57E+01	1.00E+00	1.19E+01	1.01E+00	3.06E+02	5.89E+04	9.29E+06	3.84E+02												
2.22E+02	-8.70E+00	6.41E+01	-2.24E+02	2.51E+02	3.72E+01	6.35E+01	-1.51E+01	1.46E+00	2.29E+01	1.44E+01	1.72E+00	1.36E+01	3.95E+00	2.68E+01	8.51E+03	2.52E+04	4.50E+02												
4.788E+01	-1.01E+01	2.96E+01	-7.95E+01	1.17E+02	-3.11E+01	4.52E+01	-1.00E+01	2.16E+01	-4.32E+00	1.16E+00	7.74E+01	7.47E+00	-1.32E+01	7.21E+02	7.18E+03	4.27E+04	1.45E+02												
5.166E+02	5.39E+00	3.42E+01	-7.75E+01	1.71E+02	6.30E+01	4.39E+01	1.60E+00	-2.78E+01	1.10E+01	4.91E+00	1.00E+00	1.75E+01	2.44E+00	2.35E+01	9.36E+03	4.72E+04	4.45E+02												
6.53E+02	7.70E+01	3.06E+01	-5.03E+01	8.36E+01	5.55E+01	3.62E+01	-2.99E+00	-6.45E+01	2.63E+01	-2.67E+00	-1.88E+01	1.32E+01	4.21E+00	7.14E+01	4.02E+02	2.86E+03	3.48E+02												
6.53E+02	7.70E+01	3.06E+01	-5.03E+01	8.36E+01	5.55E+01	3.62E+01	-2.99E+00	-6.45E+01	2.63E+01	-2.67E+00	-1.88E+01	1.32E+01	4.21E+00	7.14E+01	4.02E+02	2.86E+03	3.48E+02												
4.11E+02	6.85E+01	2.05E+00	-1.08E+02	6.86E+01	6.19E+01	5.56E+01	8.62E+00	2.50E+00	-7.80E+00	1.86E+00	1.03E+01	1.26E+01	1.66E+00	3.23E+02	2.83E+03	2.43E+04	4.39E+01												
9.117E+02	-4.34E+00	5.28E+00	-1.18E+02	4.52E+01	-1.16E+01	3.71E+01	-1.28E+01	-1.23E+00	1.40E+01	-4.09E+00	2.10E+01	1.91E+01	3.08E+01	1.13E+00	1.31E+02	2.02E+02	9.12E+01												
10.122E+01	-1.64E+01	-7.84E+00	-1.81E+02	2.80E+01	-1.22E+01	-1.61E+01	-1.82E+01	-5.61E+01	-3.11E+01	-1.03E+00	-1.88E+00	1.13E+01	4.35E+00	8.71E+01	3.71E+02	8.54E+05	-1.84E+02												
11.60E+02	1.31E+01	2.63E+01	2.47E+02	6.13E+01	8.71E+01	5.71E+01	2.36E+01	1.49E+00	3.84E+00	2.82E+00	1.28E+01	2.23E+00	4.99E+01	2.38E+02	2.93E+02	6.82E+03	6.74E+02												
12.756E+01	-5.19E+00	-1.28E+01	-1.17E+02	4.04E+01	-7.51E+01	1.09E+01	-8.30E+00	-1.44E+00	2.91E+01	-4.76E+00	2.07E+01	1.86E+01	4.06E+00	1.71E+00	1.95E+01	3.49E+02	-4.25E+01												
13.12E+01	-1.31E+01	-1.13E+01	-1.40E+02	1.13E+00	1.05E+00	9.86E+00	-1.29E+01	-6.04E+01	-1.53E+01	-1.36E+00	-2.03E+01	3.65E+00	3.41E+00	1.14E+00	5.41E+02	5.81E+03	-1.43E+02												
14.575E+02	2.95E+00	3.21E+01	1.63E+02	5.63E+01	5.42E+01	5.03E+01	7.18E+00	1.75E+00	1.07E+01	8.46E+00	2.87E+02	6.03E+00	-3.84E+01	-1.24E+01	6.17E+02	1.31E+02	5.52E+02												
15.287E+04	-4.30E+01	-1.78E+01	-6.20E+01	-5.12E+00	-1.31E+01	9.36E+01	-1.16E+01	-1.49E+01	1.31E+01	1.35E+00	-7.79E+03	2.23E+01	8.87E+00	2.07E+00	2.24E+01	5.03E+02	-3.47E+01												
15.287E+04	-4.30E+01	-1.78E+01	-6.20E+01	-5.12E+00	-1.31E+01	9.36E+01	-1.16E+01	-1.49E+01	1.31E+01	1.35E+0																			

Feed rate (g/day) for material 3 (MCNP Material Number 64)	92238.50c	92327.55c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.35c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c	actinide
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	6.75E+02	1.21E+02	3.78E+01	1.39E+03	6.41E+02	2.12E+02	1.30E+02	1.39E+02	1.84E+01	2.50E+01	0.00E+00	9.18E+02	4.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.38E+03
3	6.37E+02	1.15E+02	3.57E+01	1.31E+03	6.05E+02	2.01E+02	1.22E+02	1.31E+02	1.74E+01	2.37E+01	0.00E+00	8.67E+02	4.58E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.19E+03
4	5.95E+02	1.07E+02	3.33E+01	1.22E+03	5.58E+02	1.87E+02	1.17E+02	1.26E+02	1.67E+01	2.20E+01	0.00E+00	8.04E+02	4.40E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.06E+03
5	5.95E+02	1.07E+02	3.33E+01	1.22E+03	5.58E+02	1.87E+02	1.17E+02	1.26E+02	1.67E+01	2.20E+01	0.00E+00	8.04E+02	4.40E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E+03
6	5.80E+02	1.04E+02	3.25E+01	1.19E+03	5.51E+02	1.82E+02	1.12E+02	1.19E+02	1.58E+01	2.15E+01	0.00E+00	7.88E+02	4.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.90E+03
7	5.68E+02	1.02E+02	3.18E+01	1.17E+03	5.40E+02	1.78E+02	1.09E+02	1.17E+02	1.54E+01	2.10E+01	0.00E+00	7.72E+02	4.08E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E+03
8	5.56E+02	1.00E+02	3.11E+01	1.14E+03	5.29E+02	1.75E+02	1.07E+02	1.14E+02	1.51E+01	2.06E+01	0.00E+00	7.56E+02	4.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E+03
9	5.46E+02	9.77E+01	3.06E+01	1.13E+03	5.19E+02	1.72E+02	1.05E+02	1.13E+02	1.49E+01	2.02E+01	0.00E+00	7.43E+02	3.93E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E+03
10	5.37E+02	9.59E+01	3.00E+01	1.11E+03	5.08E+02	1.69E+02	1.03E+02	1.10E+02	1.46E+01	1.99E+01	0.00E+00	7.31E+02	3.86E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E+03
11	5.30E+02	9.53E+01	2.96E+01	1.09E+03	5.03E+02	1.67E+02	1.02E+02	1.09E+02	1.45E+01	1.96E+01	0.00E+00	7.20E+02	3.79E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E+03
12	5.24E+02	9.44E+01	2.93E+01	1.08E+03	4.98E+02	1.65E+02	1.00E+02	1.08E+02	1.42E+01	1.94E+01	0.00E+00	7.12E+02	3.72E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.62E+03

13	5.19E+02	9.28E+01	2.91E+01	1.07E+03	4.93E+02	1.63E+02	9.94E+01	1.07E+02	1.41E-01	1.92E+01	0.00E+00	7.05E-02	3.73E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E+03
14	5.14E+02	9.20E+01	2.87E+01	1.06E+03	4.88E+02	1.62E+02	9.86E+01	1.06E+02	1.40E-01	1.91E+01	0.00E+00	6.99E-02	3.70E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E+03
15	5.09E+02	9.13E+01	2.83E+01	1.05E+03	4.83E+02	1.61E+02	9.78E+01	1.05E+02	1.39E-01	1.90E+01	0.00E+00	6.96E-02	3.67E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E+03
16	5.03E+02	9.03E+01	2.83E+01	1.03E+03	4.79E+02	1.59E+02	9.69E+01	1.03E+02	1.37E-01	1.86E+01	0.00E+00	6.85E-02	3.62E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E+03
17	5.00E+02	8.95E+01	2.80E+01	1.03E+03	4.76E+02	1.58E+02	9.61E+01	1.03E+02	1.36E-01	1.86E+01	0.00E+00	6.80E-02	3.60E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+03
18	4.96E+02	8.95E+01	2.78E+01	1.02E+03	4.71E+02	1.56E+02	9.53E+01	1.02E+02	1.35E-01	1.84E+01	0.00E+00	6.75E-02	3.56E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E+03
19	4.93E+02	8.87E+01	2.76E+01	1.01E+03	4.68E+02	1.55E+02	9.44E+01	1.01E+02	1.34E-01	1.82E+01	0.00E+00	6.70E-02	3.54E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E+03
20	4.89E+02	8.79E+01	2.73E+01	1.00E+03	4.65E+02	1.54E+02	9.36E+01	1.00E+02	1.33E-01	1.81E+01	0.00E+00	6.64E-02	3.52E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E+03

Production	92238.50c	92337.75c	94238.50c	94239.55c	94240.50c	94241.50c	94242.50c	95241.50c	95242.50c	95243.50c	96242.50c	96243.35c	96244.50c	96245.35c	96246.35c	96247.35c	96248.35c	actinide
1	-4.80E+01	-1.33E+01	2.85E+01	-5.47E+02	5.03E+01	-3.70E+01	4.75E+00	-5.05E+01	2.68E+00	1.18E+01	3.20E+01	7.51E+01	1.01E+01	5.38E+01	7.85E+01	4.86E+05	4.23E+07	-5.72E+02
2	-4.48E+02	-1.34E+02	2.78E+01	-1.69E+03	5.08E+01	-1.25E+02	-6.05E+01	-1.61E+02	2.53E+00	4.12E+00	2.88E+01	1.30E+00	7.58E+00	4.18E+00	1.54E+01	2.98E+03	8.00E+05	-2.97E+03
3	-5.50E+02	-1.27E+02	6.32E+01	-1.41E+03	4.51E+02	-2.41E+02	-6.66E+01	-1.45E+02	6.80E+02	-2.71E+01	9.35E+00	1.25E+00	5.74E+00	-7.53E+01	1.03E+01	8.09E+03	2.31E+04	-3.00E+03
4	-4.33E+02	-1.02E+02	1.40E+00	-1.34E+03	-3.93E+02	-1.22E+02	7.47E+01	1.22E+02	-5.88E+01	1.13E+01	5.62E+00	9.86E+01	1.28E+01	1.78E+00	1.64E+01	4.05E+03	2.44E+04	-2.58E+03
5	-4.50E+02	-1.12E+02	1.68E+01	-1.35E+03	-4.76E+02	-1.25E+02	-7.65E+01	-1.35E+02	-7.78E+01	7.15E+00	2.09E+00	-1.72E+01	8.07E+00	4.72E+00	6.58E+01	3.07E+02	2.12E+03	-2.69E+03
6	-5.08E+02	-1.13E+02	6.99E+01	-1.29E+03	-4.78E+02	-2.51E+02	-9.20E+01	-1.31E+02	7.80E+02	-1.59E+01	-6.66E+01	6.04E+01	1.02E+00	2.31E+00	1.25E+01	3.38E+03	6.28E+04	-2.83E+03
7	-4.08E+02	-9.28E+01	-3.70E+00	-9.53E+02	-4.62E+02	-9.53E+01	-5.41E+01	-9.53E+01	-2.41E+00	-3.48E+01	-9.20E+00	3.12E+01	9.12E+00	-6.30E+02	1.20E+01	1.42E+02	1.45E+03	-2.19E+03
8	-4.13E+02	-1.31E+02	1.37E+01	-1.37E+03	-4.62E+02	-1.05E+02	-1.05E+02	-1.05E+02	2.57E+01	3.06E+00	2.84E+01	1.77E+01	3.2	2.38E+01	1.29E+01	1.32E+02	1.61E+02	-2.78E+03
9	-5.30E+02	-1.17E+02	3.80E+01	-1.32E+03	4.89E+02	-1.81E+02	1.06E+02	-1.34E+02	5.71E+01	9.97E+01	0.6E+00	0.0E+00	0.0E+00	5.53E+00	9.9E+00	-1.07E+04	4.04E+03	-2.04E+03
10	-3.86E+02	-8.95E+01	-6.27E+00	-9.03E+02	-6.88E+02	-7.38E+01	-5.00E+01	-9.36E+01	1.82E+00	-2.65E+01	-1.19E+00	2.05E+01	1.28E+01	2.18E+00	8.71E+02	4.12E+02	7.77E+03	-3.09E+03
11	-4.54E+02	-1.00E+02	-3.72E+01	-1.22E+03	-4.45E+02	-2.55E+02	-8.30E+01	-1.17E+02	-2.30E+00	1.36E+01	-6.46E+00	4.05E+01	3.42E+01	4.42E+00	1.70E+00	1.92E+01	3.15E+02	-2.69E+03
12	-5.03E+02	-1.08E+02	-4.22E+01	-1.28E+03	-4.75E+02	-1.63E+02	-9.20E+01	-1.22E+02	-4.31E+01	-3.79E+01	-2.03E+00	-3.15E+01	2.05E+00	3.44E+00	1.03E+00	1.89E+02	4.13E+03	-2.79E+03
13	-3.45E+02	-8.11E+01	-1.37E+01	-7.88E+02	-4.16E+02	-7.92E+01	-4.53E+01	-8.87E+01	1.46E+00	-8.02E+00	5.27E+00	-2.55E+01	-5.56E+01	-1.43E+00	2.98E+01	6.03E+02	7.11E+03	-1.83E+03
14	-4.53E+02	-8.95E+01	-4.83E+01	-1.08E+03	-4.82E+02	-1.89E+02	-9.77E+01	-1.10E+02	9.03E+01	-6.29E+00	-4.30E+00	-6.28E+01	1.88E+01	5.94E+00	1.63E+00	1.54E+01	3.52E+02	-2.53E+03
15	-6.33E+02	-1.32E+02	-6.04E+01	-1.36E+03	-6.02E+02													

Feed rate (g/day) for material 4 (MCNP Material Number 6)
1001 50c 43000 50c 83200 50c 94230 55c actinide

	0.0150e	0.0090e	0.0200e	0.0230e	act/mise
1	1.65E+02	1.33E+03	0.00E+00	0.00E+00	0.00E+00
2	1.65E+02	1.33E+03	0.00E+00	0.00E+00	0.00E+00
3	1.89E+02	1.33E+03	6.57E+03	0.00E+00	0.00E+00
4	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
5	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
6	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
7	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
8	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
9	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
10	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
11	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
12	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
13	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
14	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
15	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
16	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
17	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
18	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
19	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00
20	1.65E+02	1.17E+03	5.58E+03	0.00E+00	0.00E+00

Production/Destruction rate (g/day) for material 4 (MCNP Material Number 6)

1	401.50	43099.50	83209.50	94239.55c	actinide
1	-6.00E-01	-3.76E+02	-3.92E+02	0.00E+00	0.00E+00
2	-1.27E+00	-1.23E+03	-7.07E+00	0.00E+00	0.00E+00
3	-1.60E+00	-1.40E+03	-8.64E+00	0.00E+00	0.00E+00
4	-1.30E+00	-1.30E+03	-8.00E+00	0.00E+00	0.00E+00
5	-6.63E+00	-1.52E+03	-1.29E+01	0.00E+00	0.00E+00
6	-2.63E+00	-1.16E+03	-1.34E+01	0.00E+00	0.00E+00
7	-1.56E+00	-5.16E+02	-8.21E+00	0.00E+00	0.00E+00
8	-1.56E+00	-5.40E+02	-8.21E+00	0.00E+00	0.00E+00
9	-1.97E+00	-5.96E+02	-9.94E+00	0.00E+00	0.00E+00
10	-2.90E+00	-7.21E+02	-1.34E+01	0.00E+00	0.00E+00
11	-2.90E+00	-7.21E+02	-1.34E+01	0.00E+00	0.00E+00
12	-2.14E+00	-7.02E+02	-1.34E+01	0.00E+00	0.00E+00
13	-2.22E+00	-7.47E+02	-1.51E+01	0.00E+00	0.00E+00
14	-2.05E+00	-6.41E+02	-1.17E+01	0.00E+00	0.00E+00
15	-2.46E+00	-8.46E+02	-1.51E+01	0.00E+00	0.00E+00
16	-3.39E+00	-1.03E+03	-1.86E+01	0.00E+00	0.00E+00
17	-3.39E+00	-1.03E+03	-1.86E+01	0.00E+00	0.00E+00
18	-3.93E+00	-1.03E+03	-2.03E+01	0.00E+00	0.00E+00
19	-3.39E+00	-1.00E+03	-1.86E+01	0.00E+00	0.00E+00
20	-4.35E+00	-1.19E+03	-2.37E+01	0.00E+00	0.00E+00

TimeStep Feed#PowFr mat#BeginAndEnd(-1=previous)RemovalGroup#FractionF.P.Removed

	(14)	(18.2)	(7.3)	(14)	(18)	grams/day	(278.1)
1	106.54	1.000	1	0	0.0	0.0	-1.990!
		2	0	0.0	0.0	0.000!	
		3	0	0.0	0.0	0.000!	
		4	0	0.0	0.0	-2.999!	
2	106.54	1.000	2	0	0.0	0.0	-1.990!
		3	0	0.0	0.0	0.000!	
		1	1	-2.0	2700.0	0.000!	
		4	2	-2.0	26716.9	-2.999!	
3	106.54	1.000	2	0	0.0	0.0	-1.990!
		3	0	0.0	0.0	0.000!	
		1	1	-2.0	2550.0	0.000!	
		4	2	-2.0	26716.9	-2.999!	


```

4 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2450.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
5 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2380.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
6 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2320.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
7 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2270.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
8 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2225.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
9 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2185.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
10 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2150.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
11 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2120.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
12 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2095.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
13 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2075.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
14 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2055.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
15 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2035.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
16 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2015.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
17 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 2000.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
18 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 1985.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
19 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 1970.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
20 121.76 1.000 2 0 0.0 0.0 -1 0.990!
  3 0 0.0 0.0 0 0.000!
  1 1 -2.0 1955.0 0 0.000!
  4 2 -2.0 23377.3 -2 0.999!
2  !# of feed specs
12 !# iso in Feed #1, TC-99, LWR Discharge
92238 .250000
93237 .044916
94238 .014001
94239 .514214
94240 .237591
94241 .078681
94242 .048014
95241 .051421
95242 .000068
95243 .009262
96243 .000034
96244 .001797
4
1001 .007061
25055 .003161
43099 .050031
83209 .238545
2  !# of removal groups
2  !# of ranges for Feed #1 removal step
10 79 !1st range for Feed #1
92 92 !2nd range for Feed #1
1  !# of ranges in rem group #2
1 95 !remove everything, natural iso's retained

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End of Appendix F
End of Manual