INEL-95/0458

May 1996

Idaho National Engineering Laboratory

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Thomas D. Burns, Jr.

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A MONTE CARLO MODEL SYSTEM FOR CORE ANALYSIS AND EPITHERMAL NEUTRON BEAM DESIGN AT THE WASHINGTON STATE UNIVERSITY RADIATION CENTER

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Published May 1996

Idaho National Engineering Laboratory
Lockheed Idaho Technologies Company
Idaho Falls, Idaho

Prepared for the
U.S. Department of Energy
Office of Energy Research
Udert DOE Idaho Operations Office
Contract DE-AC07-761D01570

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ABSTRACT

The Monte Carlo Model System (MCMS) for the Washington State University (WSU) Radiation Center provides a means through which core criticality and power distributions can be calculated, as well as providing a method for neutron and photon transport necessary for BNCT epithermal neutron beam design. The computational code used in this Model System is MCNP4A. The geometric capability of this Monte Carlo code allows the WSU system to be modeled very accurately. A working knowledge of the MCNP4A neutron transport code increases the flexibility of the Model System and is recommended, however, the eigenvalue/ power density problems can be run with little direct knowledge of MCNP4A. Neutron and photon particle transport require more experience with the MCNP4A code.

The Model System consists of two coupled subsystems; the Core Analysis and Source Plane Generator Model (CASP), and the BeamPort Shell Particle Transport Model (BSPT). The CASP Model incorporates the $S(\alpha,\beta)$ thermal treatment, and is run as a criticality problem yielding the system eigenvalue (k_{eff}), the core power distribution, and an implicit surface source for subsequent particle transport in the BSPT Model.

The BSPT Model uses the source plane generated by a CASP run to transport particles through the thermal column beamport. The user can create filter arrangements in the beamport and then calculate characteristics necessary for assessing the BNCT potential of the given filter arrangement. Examples of the characteristics to be calculated are: neutron fluxes, neutron currents, fast neutron KERMAs and gamma KERMAs.

The MCMS is a useful tool for the WSU system. Those unfamiliar with the MCNP4A code can use the MCMS transparently for core analysis, while more experienced users will find the particle transport capabilities very powerful for BNCT filter design.

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CORE ANALYSIS AND SOURCE PLANE GENERATOR MODEL (CASP MODEL)

The following discussion of the Core Analysis and Source Plane Generator Model will present the model in a transparent fashion, for the users not familiar with MCNP4A. Points where a more in depth treatment would benefit the experienced MCNP4A user are included under the ***Model Point*** subheadings. Diagrams with the actual surface and cell designations for the grid model and grid elements are included in Appendix A. These will be useful to the experienced MCNP4A user if he desires to modify the model geometry. The user may also desire to change or add to the materials in the default model. The user should refer to the MCNP4A manual for a discussion on material designations, however, adjusting materials is discouraged for those without experience with MCNP4A.

There are three main steps in transparently constructing a core configuration. First, the core elements must be mapped into the core grid. Next, the control blade and transient rod heights must be set. Finally, the type and number of simulation particles to be run must to be established.

1.1 Core Grid Mapping

The core model is a 9 x 7 grid of primarily 3 inch x 3 inch element locations. The four corner locations are slightly larger (4 inches x 4 inches) and are of fixed content. The remaining 59 element locations are not of fixed content and can be filled with any of the following elements:

1. Standard Fuel Element
2. FLIP Fuel Element
3. Graphite Reflector Block
4. Rotator Tube Element
5. Transient Rod Element

Each element location in the grid has a cell number which corresponds to its place in the grid. The first digit is the row number in which the cell is located while the second digit is the column number in which the cell is located. A plan view schematic of the Core Grid Model is shown in Figure 1.

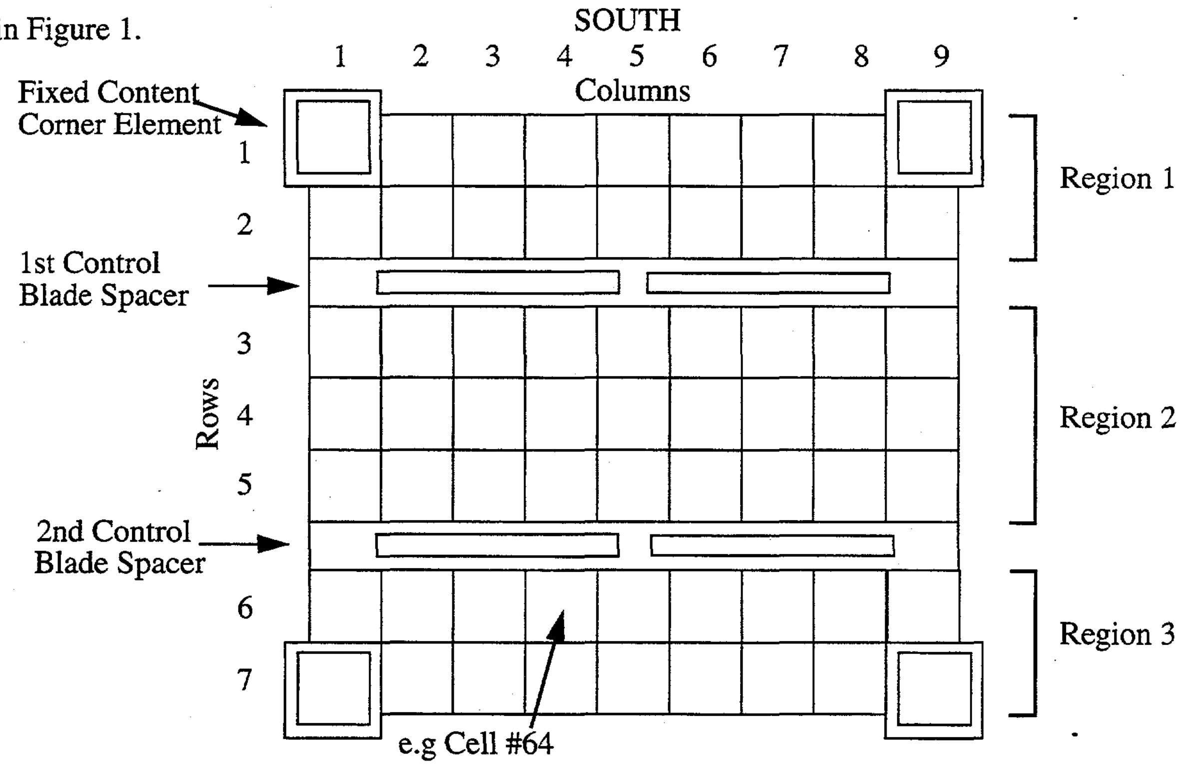


Figure 1. - Plan View Schematic of Core Grid Model

There are three regions of the grid; Region 1 - the two rows above the first control blade spacer, Region 2 - the three rows between the first and second control blade spacers, Region 3 - the two rows below the second control blade spacer. Each of the non-corner cells in these three regions can be filled with any of the five aforementioned elements, or with water, by specifying the appropriate ***element number*** on the ***fill*** space of the cell definition card or filled with water by specifying the "**1 -1.0**" string in the ***material number/material density*** section of the cell definition card. The first digit of the ***element number*** is the Region that the cell is in and the second digit is a number 1-5 corresponding to the desired element (numbers 1-5 correspond to the above list of elements).

The following are two examples of typical ***cell cards*** in the CASP Model input. The first is an example of an element location in Region 2 that is filled with a standard fuel element. The second is an example of an element in any Region (the specific example is for element 64, which is in Region 3) that is filled with water.

Example 1.

32 [0] 2 -3 -12 121 -21 22 imp:n=1 imp:p=1 [fill=21]

Cell #
Row 3 Col. 2

Mat. #/Mat. Dens.
Use a 0 here when the fill option is employed

Cell Surface Definitions
irrelevant for transparent users

Cell Importance Weights
irrelevant for transparent users

Element #
Region 2
Element 1
(Standard Fuel)

Example 2.

64 [1 -1.0] 4 -5 -151 15 -21 22 imp:n=1 imp:p=1 [fill=]

Cell #
Row 6 Col. 4

Mat. #/Mat. Dens.
When filling an element location with water replace the 0 with the string 1 -1.0

Cell Surface Definitions
irrelevant for transparent users

Cell Importance Weights
irrelevant for transparent users

Element #
When filling an element with water leave this blank

Once the core grid has been mapped for the particular core configuration of interest, the next step is to set the heights of the four control blades. The next section will discuss how to set these heights.

Model Point

The element numbers actually correspond to universes which are infinite lattices of each of the different elements. The reason that there are 15 universes (element numbers) for the 5 elements is that the control blade spacers of the Core Grid Model put the three Regions out of phase. Thus, the 5 universe lattices that are in phase with the middle Region (Region 2) need to be translated up by the width of a control blade spacer (yielding 10 lattices) and translated down by the width of a control blade spacer (yielding 15 lattices).

If the user desires to add another element to the existing bank of core elements (1-5) there are five steps that should be followed. Define a unique set of surfaces to build the new element cells, build the unique set of new element cells in phase with the center Region (Region 2), group the cells into an infinite lattice and define this lattice as a universe, translate the lattice up (with the "like" "but" card) to be in phase with Region 1 and define this as a different universe, and finally translate the lattice down (with the "like" "but" card) to be in phase with Region 3 and define this again as a different universe.

It may appear that using this lattice/universe system introduces unnecessary complexity into the model, as opposed to simply defining each cell to be used in a given problem once and then translating it into the desired grid spaces individually without using the infinite lattice. The benefit to the lattice/universe system is that it makes subsequent core configuration changes much easier and more straightforward (especially for the transparent user). It is the opinion of the author that the initial complexity in setting up the lattice/universe system is more than offset by the benefit of smooth core configuration adjustments in future use of the MCMS Model.

1.2 Control Blade and Transient Rod Height Adjustment

There are four control blades (three Boral blades and one Stainless Steel blade) in the CASP Model and each of these can be set to independent heights. There is also a Transient Rod Core Element which contains three TRIGA fuel rods and one boron carbide control rod (see Appendix A). This Transient Rod Core Element can be placed in as many of the core grid element locations as the user desires, however, the height of all of the transient rods in the model are controlled by the same surface, thus they are not independent.

The schematic of the control blade locations and their cell numbers is shown in Figure 2.

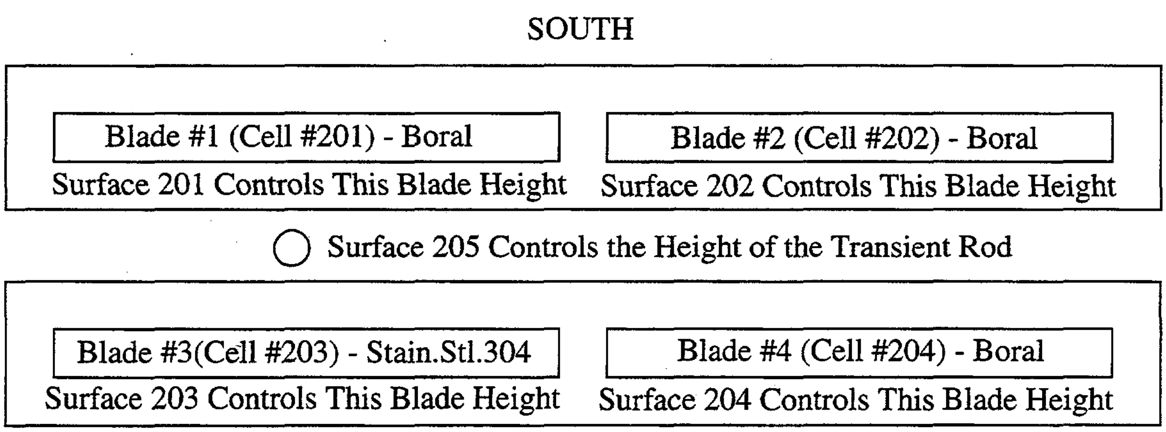


Figure 2. - Control Blade Content and Location Schematic

The procedure for adjusting the rod heights is as follows. First, locate the section of the input file for the CASP Model where control blade/transient rod surfaces are defined, then change the numerical value on the surface card corresponding to the blade or rod that is to be adjusted. The numerical entries on the cards are in centimeters and can range in value from -19.05 to 42.00. The active fuel height ranges from -19.05 to 19.05, and the top of the core is at 42.365. The entry for a fully inserted blade or rod would be -19.05.

Model Point

The Transient Rod Element is defined once and then declared as a universe consisting of an infinite lattice, thus the height of the boron carbide rod in every Transient Rod Element (hence, any Transient Rod Element specified in the Core Grid Model) is controlled by the same surface.

If the user wanted to use more than one Transient Rod Element in a given core configuration, each having independent rod height control, then he would have to add additional core elements to the CASP Model. These new core elements would be identical to the existing Transient Rod Element, but with unique sets of surface and cell numbers. The process for adding a new core element is outlined in the ***Model Point*** discussion of section **1.1 Core Grid Mapping**.

1.3 Setting the Type and Number of Particles to Run

The MCMS can run both neutron only transport problems, and coupled neutron and photon transport problems. The default is to transport neutrons only. If the user desires to run a coupled neutron and photon problem he need only go to the ***mode*** card in the input file and uncomment it out.

To set the number of particles to be run the user must go to the ***kcode*** card in the CASP Model input file. The CASP Model runs 100 cycles, and the actual number that is input is the number of particles to run per cycle. The total number of particles to be run therefore, is 100*(Number Input by User). An example of the ***kcode*** card for a problem to be run for 250,000 total particles is given in Example 3.

Example 3.

Number of Cycles
to be Skipped
irrelevant for transparent users

kcode $\boxed{2500}$ 1.1 5 100

Number of Particles
per Cycle
input by the user

Initial K_{eff} Guess
irrelevant for transparent users

Number of Cycles
to be Run
irrelevant for transparent users

Model Point

The ***kcode*** card can be modified any way that the user desires. The number of total cycles can be varied, and the number of inactive cycles can also be varied. The CASP Model has a SRCTP file which eliminates the need to skip a large number of cycles. If this file is not available for whatever reason, there is a KSRC card included (yet commented out) with an explicit set of source points. To use this card just uncomment it out.

The initial K_{eff} guess may need to be adjusted if core configurations that are either extremely supercritical or extremely subcritical have problems running.

The number of particles that a user should run depends upon the accuracy that he is looking for and the amount of computer time that he wants to spend. To help the user determine the appropriate number of particles to run, plots of **computer time** vs. **number of particles run,** **error in K_{eff}** vs. **number of particles run,** and **percent error in power density** vs. **number of particles run** are included for CASP Model runs of 25,000; 250,000; and 2,500,000 particles on a 100 MHz HP workstation. These plots are shown in Figures 3, 4, and 5, respectively. A good rule of thumb is that when increasing the number of particles from one run to the next, the user should expect to see the error drop by the square root of the ratio of particle increase.

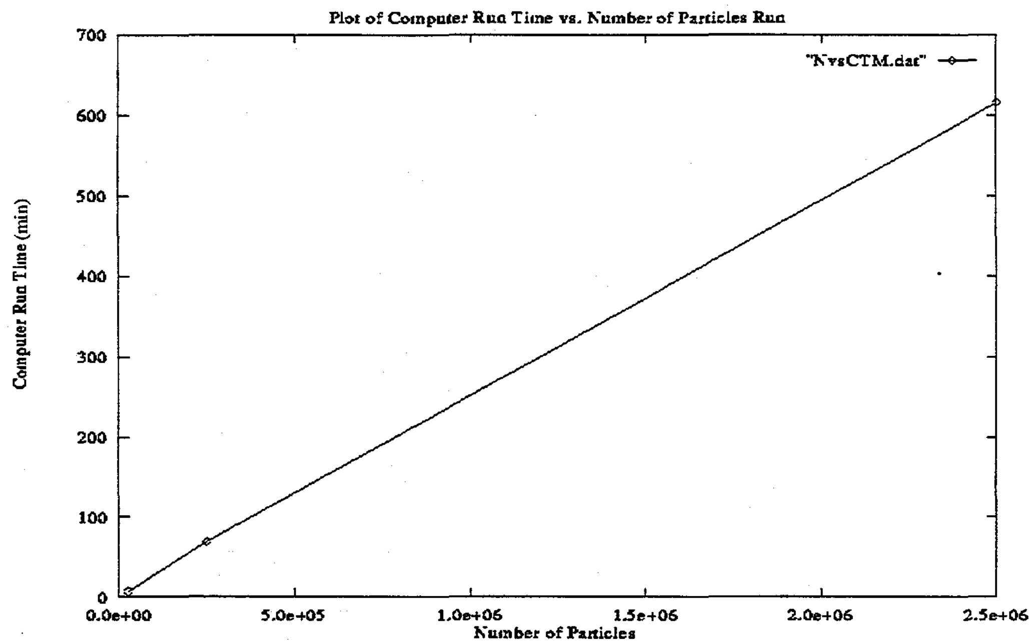


Figure 3.

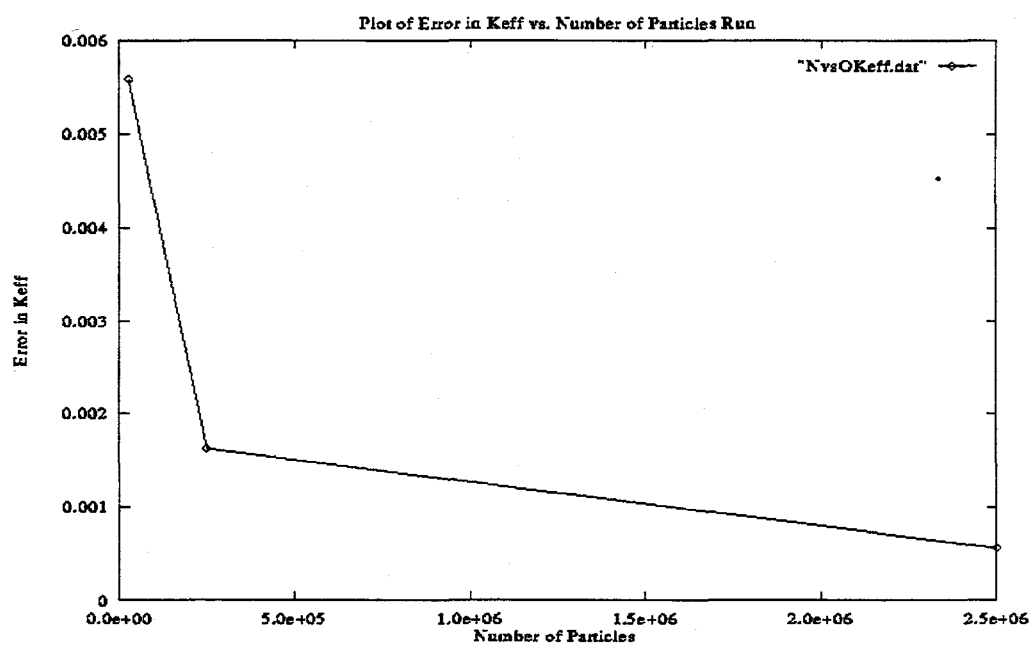


Figure 4.

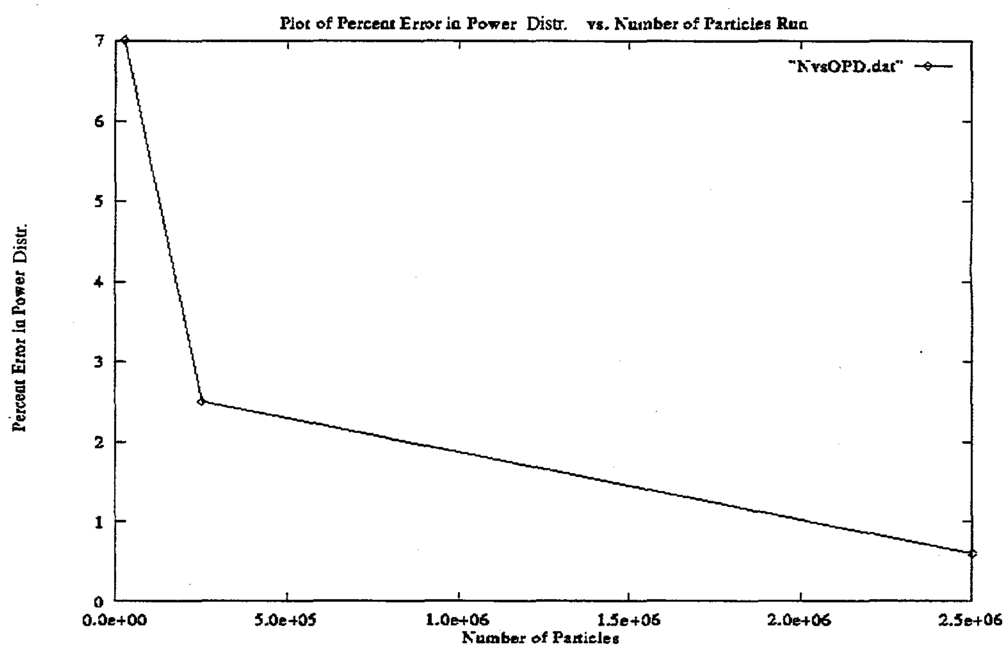


Figure 5.

Model Point

The models that were run to generate these plots all used the same importance weighting field. The field that they used is the default on the input model. Importance weighting can have a significant effect on computer run time and tally statistics, thus if the user desires to modify the importance field these plots may no longer be valid.

1.4 Running the CASP Model

The procedure for running the CASP Model is simply the standard MCNP4A execution procedure. This discussion assumes that the user has the MCNP4A executable file and all of the associated data files properly loaded and compiled on their machine and that the code is running properly.

The flow of a CASP Model run is as follows:

1. The original CASP Model input file is WSUc. To generate a new core configuration, the user should open the WSUc file, make the desired modifications, then save the modified file under a new name. One logical convention is to label the configurations in an ascending numerical order (i.e. WSUc1, WSUc2, etc...), however, this is solely a matter of personal preference. Your input files must be in your MCNP4A working directory (the directory containing the MCNP4A XSDIR files or the directory with a link to these files).

2. Once the input configuration file is generated the user needs to invoke the MCNP4A program. The command line for this is shown in the following example:

mcnp4a i="input file name" o="output file name"

The input file name is the name of the user modified CASP model file, and the output file name is chosen by the user and it is where the output from the run will be written. One convention for labeling output files is to use the input file name with an "o" appended, however, this is solely a matter of personal preference.

Sometimes, it is useful to plot the model geometry to confirm that the configuration model is correct. MCNP4A has a very useful internal plotting routine, however, the user should consult the MCNP4A manual for further instructions on using this feature.

Finally, it is often desirable to run these models in the background. The UNIX "nohup" command is useful for this purpose. Recall that when using "nohup" command a dump for the standard output and standard error must be given with the "> 'dump file name'" string. An example of the command line for a background job is as follows:

nohup mcnp4a i="input file name" o="output file name" >"dump file name" &

3. The MCNP4A run produces the some default files with each run. A list of these files and a brief description are given below.

Files generated from all CASP Model runs:

runtpe - The model run tape. This file is used for any continuation runs of a problem. It contains all of the information about the model run to which it corresponds. The ***prdmp*** card controls the generation of this file. Further discussion can be found in the MCNP4A manual.

srctp - This file contains criticality source distribution information. The default srctp file was written by the WSUc default core configuration. The code uses this file for its initial source distribution when running a criticality problem. When a new configuration is used it is recommended that two runs be performed; one with the old srctp file, which will generate a new srctp file (the new file will be named srctq and the user will need to remove the old srctp file and then change the srctq file to srctp), and then one with the new srctp file for better convergence.

Optionally generated files:

comout - This file is generated when the MCNP4A internal plotting routine is employed. It is generally not of any concern for the CASP Model user, however, if the user desires more information he should consult the MCNP4A manual.

wssa -This file is created by a CASP Model run using the Surface Source Generation option. The wssa file is used as the implicit particle source file for subsequent transport calculations in the BSPT Model.

1.5 Using the Surface Source Generation Option

The two subsystems of the MCMS, the CASP and the BSPT, are coupled together via the generated Surface Source. This Surface Source provides the particle source for transport calculations in the BSPT Model, and it is generated in a CASP Model criticality run. To enact the Surface Source Generation option in the CASP Model, the user must go to the ***ssw*** card in the input file and remove the comment character preceding the card. This will cause the wssa file containing all of the Surface Source information to be created. Instructions on how to use the Surface Source from the wssa file to transport particles in the beamport are given in the later sections discussing the BSPT Model.

Model Point

The model surface to which the Surface Source is written is number 1002. This is the delimiting surface at the beginning of the beamport (the opening edge of the conical region of the beamport). There are more model surfaces further out axially in the x-direction, and the Surface

Source can be written to any of these by simply replacing surface number 1002 by the new surface. If the user decides to change the surface to which the source is written in the CASP Model, he must also change the surface from which the source is read in the BSPT Model. The card where this change is made in the BSPT Model is the ***ssr*** card, and the new surface number will be the same as in the CASP Model because all overlapping cells and surfaces have the same cell and surface descriptor numbers in both the CASP and BSPT Models. It should be noted that the author feels that the default source surface is more than adequate and discourages the user from making modifications

Finally, the filter region of the CASP Model that overlaps the BSPT Model should match the BSPT Model. Normally these adjustments will entail little more than a change of material in previously defined cells or the translation of a pre-existing surface. For "first cut" scoping calculations, the default CASP Model Surface Source will be adequate for all but the most drastically modified BSPT filter models. However, when the final designs are being analyzed in detail, the Surface Source employed should have been generated from a CASP Model run which matches the BSPT Model being evaluated.

1.6 CASP Model Output

The CASP Model output is written to a file specified by the user in the command line when he begins a CASP Model run. This output file is in the standard MCNP4A format. Some adjustments in the MCNP4A output files can be made using the ***prdmp*** card. If the user is interested in information on what adjustments can be made and how to make them he should consult the MCNP4A manual.

The user will need to peruse the output file to get acquainted with the format, and after a few times should be able to find the tally information of interest. The eigenvalue information is simply a scalar value confidence interval, hence it requires no post processing for graphical displays. Conversely, the power density data is an array of values that requires a small amount of post processing for a meaningful graphical display. The method of post processing and the graphical routines employed are solely a matter of personal preference.

The author uses a combination of VI editor commands and some short customized fortran data manipulation codes to put the output data into a format readable by the GNUPLOT graphical display software. This method of post processing has been amenable to the needs of the author, however, it might not be right for the needs of each user. Therefore, the author makes no recommendation on the post processing and graphical display method.

An MCNP4A generated plot of the proposed core configuration for BNCT, and the subsequent GNUPLOT generated contour plot of the power density data are given in Figures 6 and 7.

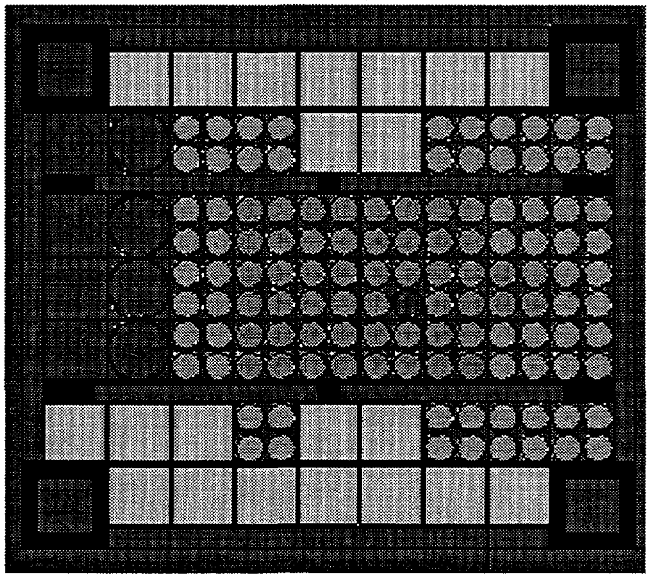


Figure 6. - MCNP4A Generated Plot of BNCT Core Configuration

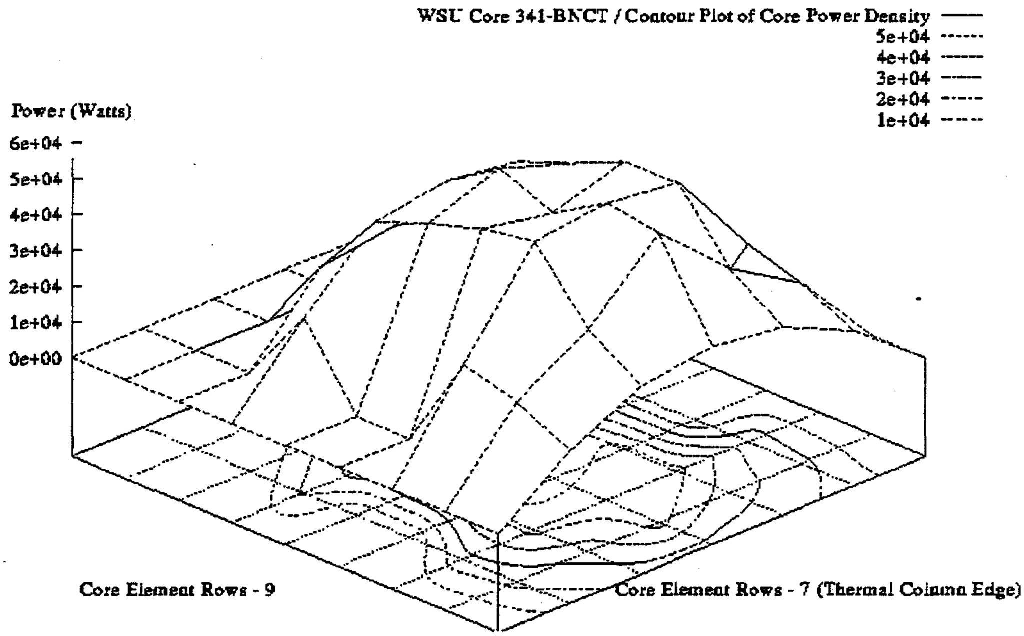


Figure 7. - GNUPLOT Generated Contour Plot of Core Power Distribution

BEAMPORT SHELL PARTICLE TRANSPORT MODEL (BSPT MODEL)

The use of the BSPT model requires a working knowledge of the MCNP4A code. Therefore the user will not be able to run the model transparently. The discussion here will concentrate on two areas; identifying the descriptor numbers of surfaces and cells to be modified when adding a new filter to the BSPT Model, and explaining the procedure used to run the model using a Surface Source generated in the CASP Model.

Diagrams with the actual surface and cell designations for the BSPT Model are included in Appendix B.

2.1 The Filter Regions

For the MCMS, the filter region is defined as the inner volume of the beamport where the graphite thermal column was housed. There is a base case Al/CF_2 filter arrangement in the default BSPT Model input file (WSUsh). The user cannot change the filter model in a transparent fashion. To make modifications to the filter region the user must be able to create MCNP4A surfaces and define MCNP4A cells.

There are ranges of surface and cell numbers that have been "earmarked" for use in defining the filter region model. The user is free to use any surface or cell number that is unique in his creation of a filter region model, however, it is the authors opinion that using the "earmarked" cells and surfaces will make the input file more clear.

The surfaces numbering **3000 - 4999** and the cells numbering **3000 - 4999** are the ranges "earmarked" for use in building filter region models. Some of these surfaces and cells have already been used in the creation of the default model, therefore the user needs to be careful not to overdefine cells or surfaces when creating a new filter arrangement. Some adjustments to the default model can be very minor, encompassing only a change of materials in previously defined cells or the small translation of an existing surface. Other adjustments may not be so trivial. The user may desire to analyze a model which requires him to redefine the entire cell structure of the filter region. Although a redefinition is not a trivial matter, it should not pose any challenge to the experienced MCNP4A user.

As a final note, the user needs to be cognizant of how modifications to the filter region will affect the importance field of the overall model. The default model has an importance field that is optimized for the existing filter region model. If the user makes drastic modifications to the geometry of the filter region, then he should reset the entire importance field appropriately for the new model. Often the user can do this "by hand," however, if problems persist, the author recommends using the MCNP4A internal Weight Window Generation option. This feature of the transport code is discussed in the manual.

2.2 Running the BSPT Model

There are four steps the user must follow to run a BSPT Model using a Surface Source generated from a previous CASP Model.

1. The implicit Surface Source file generated in the CASP run is named wssa, however, the BSPT Model will look to read its Surface Source input from the file rssa. Thus, the user must rename the wssa file rssa.

2. The user must decide which type of particles to transport; neutrons only or coupled neutrons and photons. If the CASP Model run that generated the Surface Source was a neutron only problem, then the subsequent BSPT Model can transport only neutrons. If the Surface Source was generated from a coupled neutron and photon run, then the user can choose whether to run the BSPT Model in the neutron only or coupled neutron and photon mode. The default is to run in the neutron only mode. If the user desires to run in the coupled mode, two things must be done: uncomment out the ***mode*** card in the input file, and uncomment out all of the photon dose tally cards (*f62***) at the end of the input file.

3. The user needs to set the number of particles to be run. This is done by going to the ***nps*** card in the input file and setting the value there to the desired magnitude. The user gains nothing by setting this number higher than the number of particles ran in the CASP Model that generated the Surface Source.

4. Finally, the user must invoke the MCNP4A program by following the standard MCNP4A execution procedure. This procedure has been discussed previously in section **2.1 Running the CASP Model**.

2.3 BSPT Model Output

The BSPT Model gives the following default output:

All runs

1. Average neutron flux (over a 15cm diameter disc) axially along the centerline of the thermal column for total, thermal (0-0.4eV), epithermal (0.4eV-10keV), and fast (10keV-20MeV) neutrons.

2. Neutron current (over a 15cm diameter disc) axially along the centerline of the thermal column for total, thermal (0-0.4eV), epithermal (0.4eV-10keV), and fast (10keV-20MeV) neutrons.

3. The total and three group dose rates in tissue at the beam exit in cGy/min.

Optionally generated by uncommenting out existing lines in the input file

4. A fine group energy breakdown of the neutron flux at the beam exit. The energy bins are as follows (in MeV); $1x10^{-7}$, $2x10^{-7}$, $3x10^{-7}$,...., 8, 9, 10. This output can be plotted as a flux per unit lethargy histogram. At least $10x10^{6}$ particles need to be run to get good statistics with this tally.

5. Photon dose rate in tissue at the beam exit in rem/hr. This tally can only be used when running a coupled neutron and photon problem.

These five tallies have been provided in the default input file, however, the user is free to tally for any quantity that MCNP4A allows. The user should consult the MCNP4A manual for further instruction on how to modify the model to tally for non-default information which is of interest.

A GNUPLOT generated plot of the three group neutron fluxes vs. axial position along the beam centerline for the default WSUsh model is shown in Figure 8. Figure 9. gives a GNUPLOT generated flux per unit lethargy histogram for the default WSUsh model.

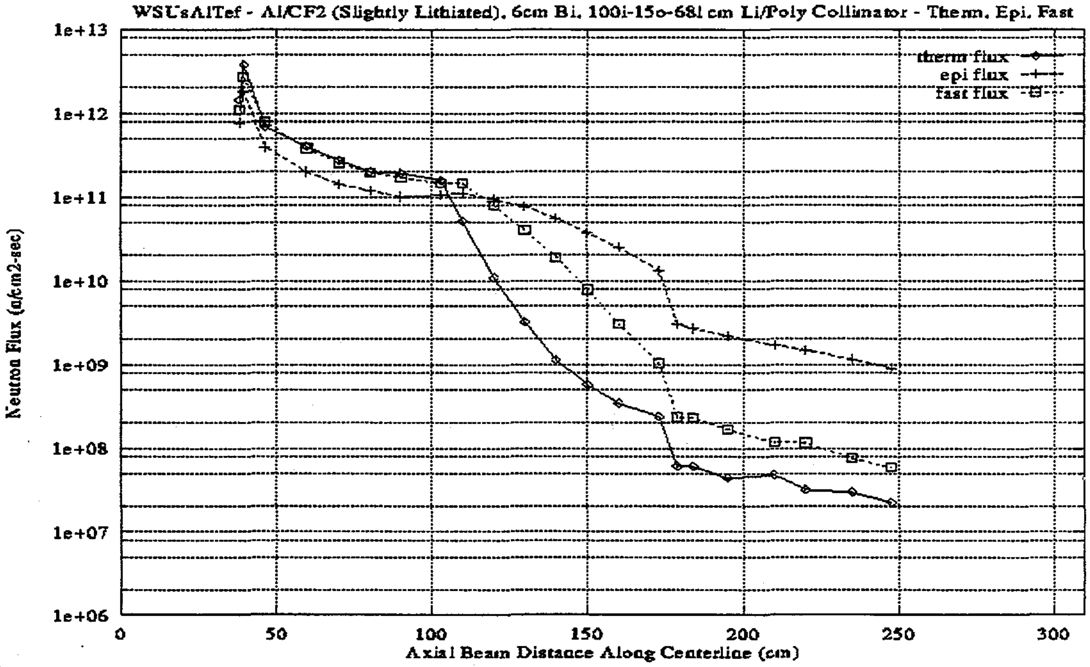


Figure 8. - Neutron Fluxes vs. Axial Beam Position

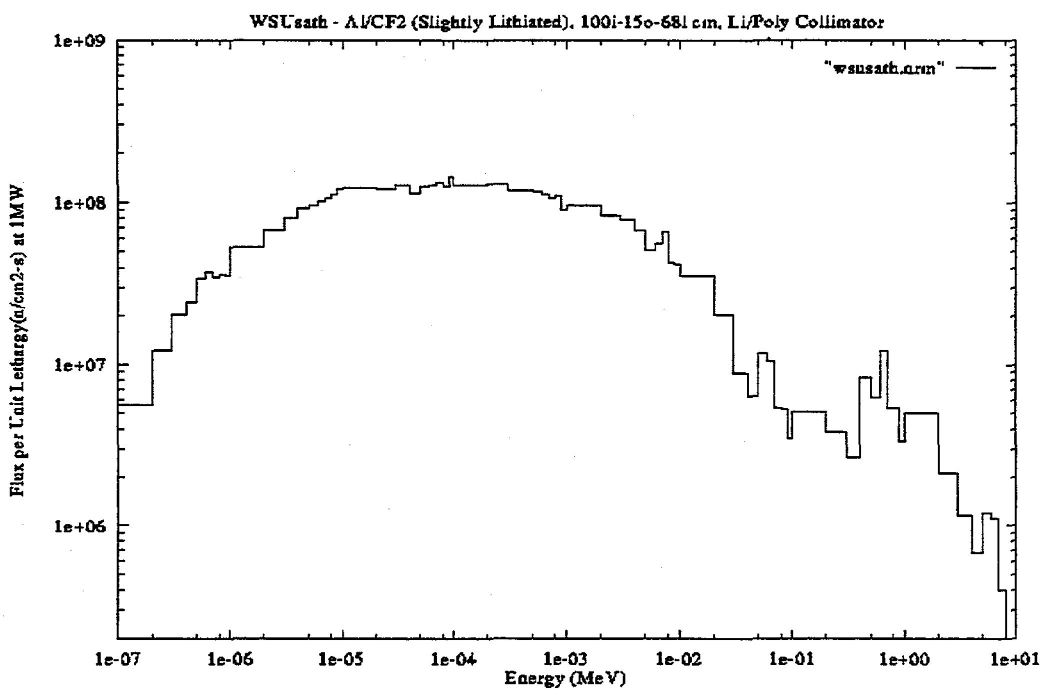


Figure 9. - Flux per Unit Lethargy Histogram

2.4 Validation of the Surface Source

The CASP Model and BSPT model have a common region where one model overlaps the other. In order to verify that the Surface Source was yielding the same results as the full criticality source, a comparison was made in this region between the flux output generated by the criticality source and the flux output generated by the Surface Source. The agreement between the criticality generated flux and the Surface Source generated flux was outstanding. Figures 10, 11, and 12 are plots (from a set of runs with a 68cm Al/CF2 filter, large Bi collimator model) of the criticality and Surface Source generated fluxes vs. axial beam position for thermal, epithermal and fast neutrons, respectively.

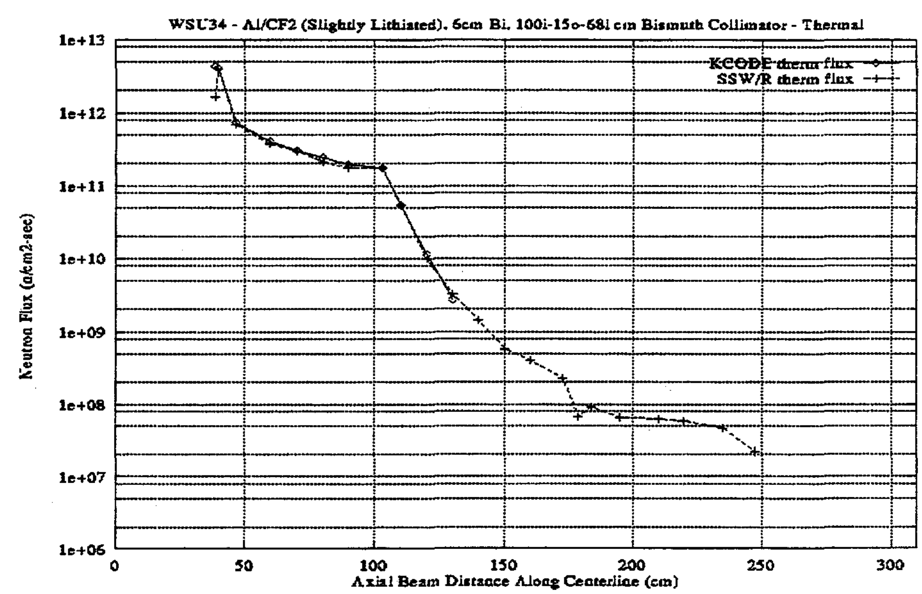


Figure 10. - Comparison of Criticality and Surface Source Generated Thermal Fluxes

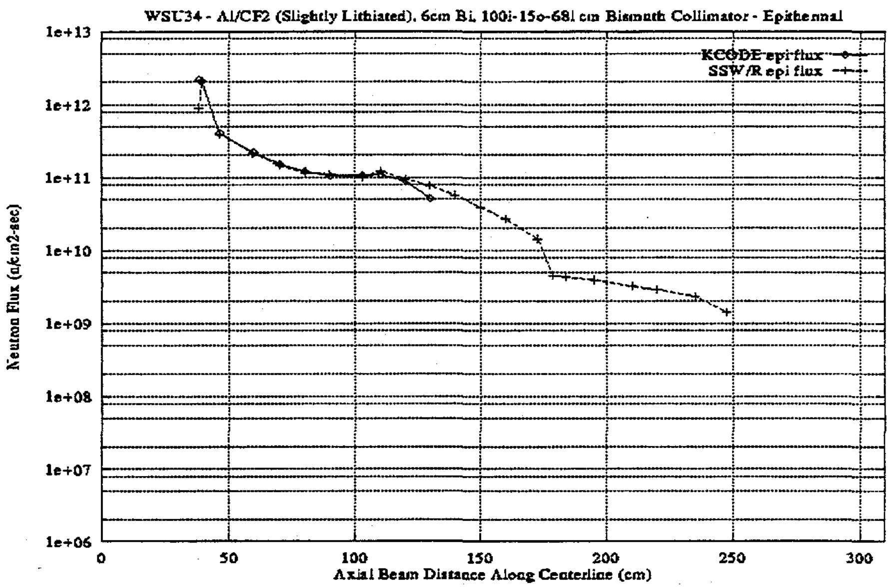


Figure 11. - Comparison of Criticality and Surface Source Generated Epithermal Fluxes

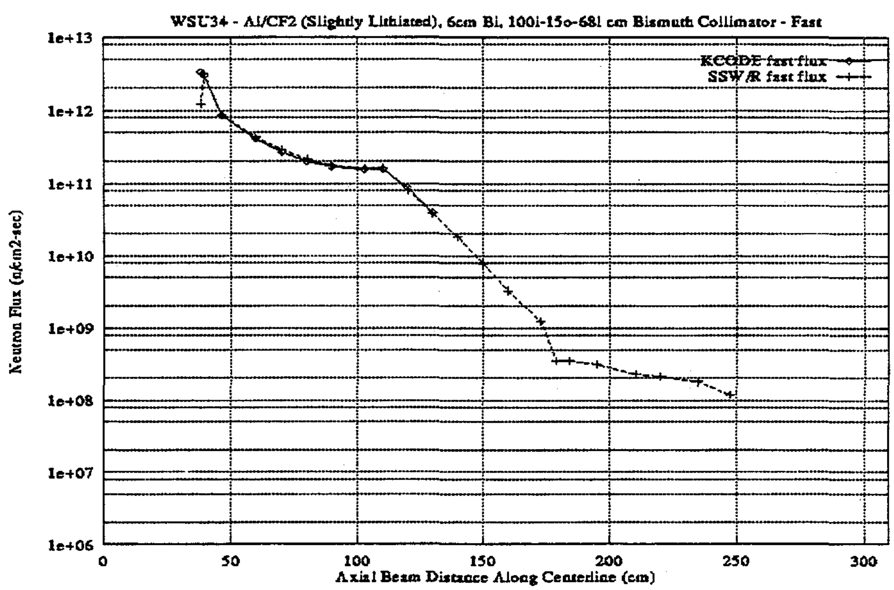


Figure 12. - Comparison of Criticality and Surface Source Generated Fast Fluxes

Appendix A

CASP Model Surface and Cell Diagrams

This appendix includes the CASP Model default input deck and the following diagrams:

1. WSUc Model

2. Core Grid Model

3. Aluminum Cone / Lead Thermal Shield Model

4. Standard and FLIP Fuel Element Model

5. Transient Rod Element Model

6. Graphite Element Model

7. Rotator Tube Element Model

In the Surface and Cell Diagrams the following font convention is used:

1000 - designates a Surface number

1000 - designates a Cell number

```
MCNP4A - Washington State University Reactor Facility Beam Model
c       CELL CARDS
c
c    ***********************************************************
c    ************* Main Core Grid Cells **********************
c    ***********************************************************
c       Fill Each Main Grid Cell With the Appropriate Element:
c
c            11,21,31 - Standard Fuel Element
c            12,22,32 - FLIP Fuel Element
c            13,23,33 - Reflector Block
c            14,24,34 - Rotator Tube Element
c            15,25,35 - Transient Rod Element
c
c   ************** Region 1 - Use 11,12,13,14,15 **************
c       Row 1
12   0   2 -3 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
13   0   3 -4 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
14   0   4 -5 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
15   0   5 -6 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
16   0   6 -7 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
17   0   7 -8 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
18   0   8 -9 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
c       Row 2
21   1   -1.0  1 -2 -12 121 -21 22 imp:n=1   imp:p=1  fill=
22   0   2 -3 -12 121 -21 22 imp:n=1   imp:p=1   fill=14
23   0   3 -4 -12 121 -21 22 imp:n=1   imp:p=1   fill=11
24   0   4 -5 -12 121 -21 22 imp:n=1   imp:p=1   fill=11
25   0   5 -6 -12 121 -21 22 imp:n=1   imp:p=1   fill=13
26   0   6 -7 -12 121 -21 22 imp:n=1   imp:p=1   fill=13
27   0   7 -8 -12 121 -21 22 imp:n=1   imp:p=1   fill=11
28   0   8 -9 -12 121 -21 22 imp:n=1   imp:p=1   fill=11
29   0   9 -10 -12 121 -21 22 imp:n=1   imp:p=1 fill=11
c
c   ************** Region 2 - Use 21,22,23,24,25 ***************
c       Row 3
31   1   -1.0   1 -2 -131 13 -21 22 imp:n=1   imp:p=1  fill=
32   0   2 -3   -131 13 -21 22 imp:n=1    imp:p=1   fill=24
33   0   3 -4   -131 13 -21 22 imp:n=1    imp:p=1   fill=21
34   0   4 -5   -131 13 -21 22 imp:n=1    imp:p=1   fill=22
35   0   5 -6   -131 13 -21 22 imp:n=1    imp:p=1   fill=22
36   0   6 -7   -131 13 -21 22 imp:n=1    imp:p=1   fill=22
37   0   7 -8   -131 13 -21 22 imp:n=1    imp:p=1   fill=22
38   0   8 -9   -131 13 -21 22 imp:n=1    imp:p=1   fill=21
39   0   9 -10 -131 13 -21 22 imp:n=1    imp:p=1   fill=21
c       Row 4
41   1   -1.0  1 -2  -13 14 -21 22 imp:n=1   imp:p 1  fill=
42   0   2 -3   -13 14 -21 22 imp:n=1   imp:p 1   fill=24
43   0   3 -4   -13 14 -21 22 imp:n=1   imp:p 1   fill=21
44   0   4 -5   -13 14 -21 22 imp:n=1   imp:p 1   fill=22
45   0   5 -6   -13 14 -21 22 imp:n=1   imp:p 1   fill=22
46   0   6 -7   -13 14 -21 22 imp:n=1   imp:p 1   fill=25
47   0   7 -8   -13 14 -21 22 imp:n=1   imp:p 1   fill=22
48   0   8 -9   -13 14 -21 22 imp:n=1   imp:p 1   fill=22
49   0   9 -10 -13 14 -21 22 imp:n=1   imp:p 1   fill=21
c       Row 5
51   1   -1.0  1 -2   -14 141 -21 22 imp:n=1   imp:p=1  fill=
52   0   2 -3   -14 141 -21 22 imp:n=1    imp:p=1   fill=24
53   0   3 -4   -14 141 -21 22 imp:n=1    imp:p=1   fill=21
54   0   4 -5   -14 141 -21 22 imp:n=1    imp:p=1   fill=22
55   0   5 -6   -14 141 -21 22 imp:n=1    imp:p=1   fill=22
56   0   6 -7   -14 141 -21 22 imp:n=1    imp:p=1   fill=22
57   0   7 -8   -14 141 -21 22 imp:n=1    imp:p=1   fill=22
58   0   8 -9   -14 141 -21 22 imp:n=1    imp:p=1   fill=21
59   0   9 -10 -14 141 -21 22 imp:n=1    imp:p=1   fill=21
c
```

```
c    ************ Region 3- Use 31,32,33,34,35 ****************
c        Row 6
61   0   1 -2   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
62   0   2 -3   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
63   0   3 -4   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
64   0   4 -5   -151 15 -21 22 imp:n=1    imp:p=1   fill=31
65   0   5 -6   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
66   0   6 -7   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
67   0   7 -8   -151 15 -21 22 imp:n=1    imp:p=1   fill=31
68   0   8 -9   -151 15 -21 22 imp:n=1    imp:p=1   fill=31
69   0   9 -10 -151 15 -21 22 imp:n=1    imp:p=1   fill=31
c        Row 7
72   0   2 -3 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
73   0   3 -4 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
74   0   4 -5 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
75   0   5 -6 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
76   0   6 -7 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
77   0   7 -8 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
78   0   8 -9 -15 16 -21 22 imp:n=1   imp:p=1   fill=33
c
c     ****************** Corner Grid Elements *****************
c
c         Row 1
11    2   0.06020  (31 -2 -33 12 -21 22) (-927:928:931:-932) imp:n=1 imp:p=1
711   1  -1.0  927 -928 -931 932 -21 22                       imp:n=1 imp:p=1
c
19    2   0.06020  (9 -32 -33 12 -21 22) (-929:930:931:-932) imp:n=1 imp:p=1
719   1  -1.0  929 -930 -931 932 -21 22                       imp:n=1 imp:p=1
c         Row 7
71    2   0.06020  (31 -2 -15 34 -21 22) (-927:928:933:-934) imp:n=1 imp:p=1
771   1  -1.0  927 -928 -933 934 -21 22                       imp:n=1 imp:p=1
c
79    2   0.06020  (9 -32 -15 34 -21 22) (-929:930:933:-934) imp:n=1 imp:p=1
779   1  -1.0  929 -930 -933 934 -21 22                       imp:n=1 imp:p=1
c
c     ****************** Control Region Elements ***************
c
c         Guides
100  2 0.06020    1 -101 -121 131 -21 22 imp:n=1  imp:p=1
101  2 0.06020  101 -102 -121 111 -21 22 imp:n=1  imp:p=1
102  2 0.06020  101 -102 -112 131 -21 22 imp:n=1  imp:p=1
103  2 0.06020  102 -103 -121 131 -21 22 imp:n=1  imp:p=1
104  2 0.06020  103 -104 -121 111 -21 22 imp:n=1  imp:p=1
105  2 0.06020  103 -104 -112 131 -21 22 imp:n=1  imp:p=1
106  2 0.06020  104 -10  -121 131 -21 22 imp:n=1  imp:p=1
c
107  2 0.06020    1 -101 -141 151 -21 22 imp:n=1  imp:p=1
108  2 0.06020  101 -102 -141 113 -21 22 imp:n=1  imp:p=1
109  2 0.06020  101 -102 -114 151 -21 22 imp:n=1  imp:p=1
110  2 0.06020  102 -103 -141 151 -21 22 imp:n=1  imp:p=1
111  2 0.06020  103 -104 -141 113 -21 22 imp:n=1  imp:p=1
112  2 0.06020  103 -104 -114 151 -21 22 imp:n=1  imp:p=1
113  2 0.06020  104 -10  -141 151 -21 22 imp:n=1  imp:p=1
c         Control Blades - Upper Region
201  5 0.08881  101 -102 -111 112 -21 201  imp:n=1  imp:p=1
202  5 0.08881  103 -104 -111 112 -21 202  imp:n=1  imp:p=1
203  3 0.08647  101 -102 -113 114 -21 203  imp:n=1  imp:p=1
204  5 0.08881  103 -104 -113 114 -21 204  imp:n=1  imp:p=1
c         Control Blades - Lower Water Gap Region
211  1 -1.0  101 -102 -111 112 -201 22  imp:n=1  imp:p=1
212  1 -1.0  103 -104 -111 112 -202 22  imp:n=1  imp:p=1
213  1 -1.0  101 -102 -113 114 -203 22  imp:n=1  imp:p=1
214  1 -1.0  103 -104 -113 114 -204 22  imp:n=1  imp:p=1
c
c      ************** Core Grid Lattices ********************
c
```

```
c         Standard Element Lattices - Region 1,2,3
801  0    900 -901 902 -903 imp:n=1 imp:p=1 lat=1 u=21 fill=1
802  like 801 but   trcl=( 0  2.54  0)              u=11
803  like 801 but   trcl=( 0 -2.54  0)              u=31
c
c         FLIP Element Lattices - Region 1,2,3
804  like 801 but                                   u=22 fill=2
805  like 804 but   trcl=( 0  2.54  0)              u=12
806  like 804 but   trcl=( 0 -2.54  0)              u=32
c
c         Graphite Element Lattices - Region 1,2,3
807  like 801 but                                   u=23 fill=3
808  like 807 but   trcl=( 0  2.54  0)              u=13
809  like 807 but   trcl=( 0 -2.54  0)              u=33
c
c         Rotator Tube Lattices - Region 1,2,3
810  like 801 but                                   u=24 fill=4
811  like 810 but   trcl=( 0  2.54  0)              u=14
812  like 810 but   trcl=( 0 -2.54  0)              u=34
c
c         Transient Rod Element Lattices - Region 1,2,3
813  like 801 but                                   u=25 fill=5
814  like 813 but   trcl=( 0  2.54  0)              u=15
815  like 814 but   trcl=( 0 -2.54  0)              u=35
c
c       ************* Universe Element Cells ****************
c
c         Standard Element
c
901  6  0.09344  -909 -905 +906      imp:n=1 imp:p=1 u=1
902  4  -1.6     -909  905 -904      imp:n=1 imp:p=1 u=1
903  4  -1.6     -909 -906 +907      imp:n=1 imp:p=1 u=1
904  8  0.09532  -910  904           imp:n=1 imp:p=1 u=1
905  3  0.08647  -910 -907  908      imp:n=1 imp:p=1 u=1
906  9  0.08293  -910 -908           imp:n=1 imp:p=1 u=1
907  3  0.08647   909 -910 -904 907  imp:n=1 imp:p=1 u=1
c
908  6  0.09344  -911 -905 +906      imp:n=1 imp:p=1 u=1
909  4  -1.6     -911  905 -904      imp:n=1 imp:p=1 u=1
910  4  -1.6     -911 -906 +907      imp:n=1 imp:p=1 u=1
911  8  0.09532  -912  904           imp:n=1 imp:p=1 u=1
912  3  0.08647  -912 -907  908      imp:n=1 imp:p=1 u=1
913  9  0.08293  -912 -908           imp:n=1 imp:p=1 u=1
914  3  0.08647   911 -912 -904 907  imp:n=1 imp:p=1 u=1
c
915  6  0.09344  -913 -905 +906      imp:n=1 imp:p=1 u=1
916  4  -1.6     -913  905 -904      imp:n=1 imp:p=1 u=1
917  4  -1.6     -913 -906 +907      imp:n=1 imp:p=1 u=1
918  8  0.09532  -914  904           imp:n=1 imp:p=1 u=1
919  3  0.08647  -914 -907  908      imp:n=1 imp:p=1 u=1
920  9  0.08293  -914 -908           imp:n=1 imp:p=1 u=1
921  3  0.08647   913 -914 -904 907  imp:n=1 imp:p=1 u=1
c
922  6  0.09344  -915 -905 +906      imp:n=1 imp:p=1 u=1
923  4  -1.6     -915  905 -904      imp:n=1 imp:p=1 u=1
924  4  -1.6     -915 -906 +907      imp:n=1 imp:p=1 u=1
925  8  0.09532  -916  904           imp:n=1 imp:p=1 u=1
926  3  0.08647  -916 -907  908      imp:n=1 imp:p=1 u=1
927  9  0.08293  -916 -908           imp:n=1 imp:p=1 u=1
928  3  0.08647   915 -916 -904 907  imp:n=1 imp:p=1 u=1
c
929  1  -1.0      910 912 914 916    imp:n=1 imp:p=1 u=1
c
c         FLIP Element
c
930  7  0.09016  -909 -905 +906      imp:n=1 imp:p=1 u=2
```

```
931  4  -1.6       -909  905 -904       imp:n=1 imp:p=1 u=2
932  4  -1.6       -909 -906 +907       imp:n=1 imp:p=1 u=2
933  8  0.09532    -910  904            imp:n=1 imp:p=1 u=2
934  3  0.08647    -910 -907  908       imp:n=1 imp:p=1 u=2
935  9  0.08293    -910 -908            imp:n=1 imp:p=1 u=2
936  3  0.08647     909 -910 -904 907   imp:n=1 imp:p=1 u=2
c
937  7  0.09016    -911 -905 +906       imp:n=1 imp:p=1 u=2
938  4  -1.6       -911  905 -904       imp:n=1 imp:p=1 u=2
939  4  -1.6       -911 -906 +907       imp:n=1 imp:p=1 u=2
940  8  0.09532    -912  904            imp:n=1 imp:p=1 u=2
941  3  0.08647    -912 -907 908        imp:n=1 imp:p=1 u=2
942  9  0.08293    -912 -908            imp:n=1 imp:p=1 u=2
943  3  0.08647     911 -912 -904 907   imp:n=1 imp:p=1 u=2
c
944  7  0.09016    -913 -905 +906       imp:n=1 imp:p=1 u=2
945  4  -1.6       -913  905 -904       imp:n=1 imp:p=1 u=2
946  4  -1.6       -913 -906 +907       imp:n=1 imp:p=1 u=2
947  8  0.09532    -914  904            imp:n=1 imp:p=1 u=2
948  3  0.08647    -914 -907 908        imp:n=1 imp:p=1 u=2
949  9  0.08293    -914 -908            imp:n=1 imp:p=1 u=2
950  3  0.08647     913 -914 -904 907   imp:n=1 imp:p=1 u=2
c
951  7  0.09016    -915 -905 +906       imp:n=1 imp:p=1 u=2
952  4  -1.6       -915  905 -904       imp:n=1 imp:p=1 u=2
953  4  -1.6       -915 -906 +907       imp:n=1 imp:p=1 u=2
954  8  0.09532    -916  904            imp:n=1 imp:p=1 u=2
955  3  0.08647    -916 -907 908        imp:n=1 imp:p=1 u=2
956  9  0.08293    -916 -908            imp:n=1 imp:p=1 u=2
957  3  0.08647     915 -916 -904 907   imp:n=1 imp:p=1 u=2
c
958  1  -1.0        910 912 914 916    imp:n=1 imp:p=1 u=2
c
c        Graphite Reflector Element
c
959  4  -1.6          (917 -918 919 -920) -904 908    imp:n=1 imp:p=1 u=3
960  2   0.06020     (-917:918:-919:920) -904 908     imp:n=1 imp:p=1 u=3
961  8   0.09532       904                           imp:n=1 imp:p=1 u=3
962  9   0.08293      -908                           imp:n=1 imp:p=1 u=3
c
c        Rotator Tube Element
c
963  2  0.06020     -924 923 921         imp:n=1 imp:p=1 u=4
964  1  -1.0        -923 921             imp:n=1 imp:p=1 u=4
965  2  0.06020     -924 -921 922        imp:n=1 imp:p=1 u=4
966  2  0.06020     -926 925 -922        imp:n=1 imp:p=1 u=4
967  1  -1.0        -925 -922            imp:n=1 imp:p=1 u=4
c
968  1  -1.0         926 -922            imp:n=1 imp:p=1 u=4
969  1  -1.0         924  922            imp:n=1 imp:p=1 u=4
c
c        Transient Rod Element
c
970  2  0.04816    -936  935  907       imp:n=1 imp:p=1 u=5
971  10 0.13848    -935  205            imp:n=1 imp:p=1 u=5
972  1  -1.0       -935 -205  907       imp:n=1 imp:p=1 u=5
973  9  0.08293    -936 -907            imp:n=1 imp:p=1 u=5
c
974  7  0.09016    -911 -905 +906       imp:n=1 imp:p=1 u=5
975  4  -1.6       -911  905 -904       imp:n=1 imp:p=1 u=5
976  4  -1.6       -911 -906 +907       imp:n=1 imp:p=1 u=5
977  8  0.09532    -912  904            imp:n=1 imp:p=1 u=5
978  3  0.08647    -912 -907 908        imp:n=1 imp:p=1 u=5
979  9  0.08293    -912 -908            imp:n=1 imp:p=1 u=5
980  3  0.08647     911 -912 -904 907   imp:n=1 imp:p=1 u=5
c
```

```
981  7  0.09016   -913 -905 +906      imp:n=1 imp:p=1 u=5
982  4  -1.6      -913  905 -904      imp:n=1 imp:p=1 u=5
983  4  -1.6      -913 -906 +907      imp:n=1 imp:p=1 u=5
984  8  0.09532   -914  904           imp:n=1 imp:p=1 u=5
985  3  0.08647   -914 -907 908       imp:n=1 imp:p=1 u=5
986  9  0.08293   -914 -908           imp:n=1 imp:p=1 u=5
987  3  0.08647    913 -914 -904 907  imp:n=1 imp:p=1 u=5
c
988  7  0.09016   -909 -905 +906      imp:n=1 imp:p=1 u=5
989  4  -1.6      -909  905 -904      imp:n=1 imp:p=1 u=5
990  4  -1.6      -909 -906 +907      imp:n=1 imp:p=1 u=5
991  8  0.09532   -910  904           imp:n=1 imp:p=1 u=5
992  3  0.08647   -910 -907 908       imp:n=1 imp:p=1 u=5
993  9  0.08293   -910 -908           imp:n=1 imp:p=1 u=5
994  3  0.08647    909 -910 -904 907  imp:n=1 imp:p=1 u=5
c
995  1  -1.0       936 912 914 910    imp:n=1 imp:p=1 u=5
c
c     *********************************************************
c     ***************** Beamport Cells ***********************
c     *********************************************************
c
c     ************ Core Side Water Region ********************
c
1000  1 -1.0  31 -1 -12 15 -21 22  imp:n=1  imp:p=1
1001  1 -1.0  10 -32 -12 15 -21 22 imp:n=1  imp:p=1
c
1002  1 -1.0      2 -8 11 -33 -21 22  imp:n=1 imp:p=1
1003  1 -1.0      8 -9 11 -33 -21 22  imp:n=1 imp:p=1   $ Pb Box
c
1004  1 -1.0      2 -8 -16 34 -21 22  imp:n=1 imp:p=1
1005  1 -1.0      8 -9 -16 34 -21 22  imp:n=1 imp:p=1   $ Pb Box
c
c     ******************* Water Box Cells ********************
c
1006  1 -1.0  (-31:32:33:-34:21:-22) (1001 -8 1005 -1006 1009 -1010) &
      imp:n=1 imp:p=1
1007  1 -1.0  1001 -1002 1003 -1004 1007 -1008 (-1005:1006:-1009:1010) &
      imp:n=0.25 imp:p=0.25
1008  1 -1.0   (5002:-5003:21:-22) 8 -1002 1005 -1006 1009 -1010  &
      imp:n=1 imp:p=1
1009  1 -1.0   32 -1002 -33 34 -21 22  imp:n=1 imp:p=1
c
1010  1 -1.0   8 -1002 33 -5002 -21 22 imp:n=1 imp:p=1  $ Pb Box
1011  1 -1.0   8 -1002 -34 5003 -21 22 imp:n=1 imp:p=1  $ Pb Box
c
c     ********* Aluminum Cone Grid & Lead Thermal Shield ******
c      Aluminum Grid
1100  2 0.06020  1002 -1100 -1999                      imp:n=2 imp:p=2
c
1101  2 0.06020  1100 -1102 -2000 -1103 1104           imp:n=2 imp:p=2
1102  2 0.06020  1100 -1102 -2000 -1105 1106           imp:n=2 imp:p=2
c
1103  2 0.06020  1100 -1102 -1107 1108 -1106 -2000 imp:n=2 imp:p=2
1104  2 0.06020  1100 -1102 -1107 1108 -1104  1105 imp:n=2 imp:p=2
1105  2 0.06020  1100 -1102 -1107 1108  1103 -2000 imp:n=2 imp:p=2
c
1106  2 0.06020  1100 -1102 -1109 1110 -1106 -2000 imp:n=2 imp:p=2
1107  2 0.06020  1100 -1102 -1109 1110 -1104  1105 imp:n=2 imp:p=2
1108  2 0.06020  1100 -1102 -1109 1110  1103 -2000 imp:n=2 imp:p=2
c      Lead Thermal Shield
1109  11 0.03298 1100 -1101 -1106 1107 -2000       imp:n=2 imp:p=2
1110  11 0.03298 1100 -1101 -1104 1105  1107 -2000 imp:n=2 imp:p=2
1111  11 0.03298 1100 -1101  1103 1107 -2000       imp:n=2 imp:p=2
c
1112  11 0.03298 1100 -1101 -1108 1109 -1106 -2000 imp:n=2 imp:p=2
```

```
1113  11 0.03298 1100 -1101 -1108 1109 -1104  1105 imp:n=2 imp:p=2
1114  11 0.03298 1100 -1101 -1108 1109  1103 -2000 imp:n=2 imp:p=2
c
1115  11 0.03298 1100 -1101 -1106 -1110 -2000      imp:n=2 imp:p=2
1116  11 0.03298 1100 -1101 -1104 1105 -1110 -2000 imp:n=2 imp:p=2
1117  11 0.03298 1100 -1101  1103 -1110 -2000      imp:n=2 imp:p=2
c     Void Region
1118  0            1101 -1102 -1106 1107 -2000  5001      imp:n=2 imp:p=2 $ Rf
1119  0            1101 -1102 -1106 1107 -5001            imp:n=2 imp:p=2
1120  0            1101 -1102 -1104 1105  1107 -2000 5001 imp:n=2 imp:p=2 $ Rf
1121  0            1101 -1102 -1104 1105  1107 -5001      imp:n=2 imp:p=2
1122  0            1101 -1102  1103 1107 -2000  5001      imp:n=2 imp:p=2 $ Rf
1123  0            1101 -1102  1103 1107 -5001            imp:n=2 imp:p=2
c
1124  0            1101 -1102 -1108 1109 -1106 -2000 5001 imp:n=2 imp:p=2 $ Rf
1125  0            1101 -1102 -1108 1109 -1106 -5001      imp:n=2 imp:p=2
1126  0            1101 -1102 -1108 1109 -1104  1105      imp:n=2 imp:p=2
1127  0            1101 -1102 -1108 1109  1103 -2000 5001 imp:n=2 imp:p=2 $ Rf
1128  0            1101 -1102 -1108 1109  1103 -5001      imp:n=2 imp:p=2
c
1129  0            1101 -1102 -1106 -1110 -2000 5001      imp:n=2 imp:p=2 $ Rf
1130  0            1101 -1102 -1106 -1110 -5001           imp:n=2 imp:p=2
1131  0            1101 -1102 -1104 1105 -1110 -2000 5001 imp:n=2 imp:p=2 $ Rf
1132  0            1101 -1102 -1104 1105 -1110 -5001      imp:n=2 imp:p=2
1133  0            1101 -1102  1103 -1110 -2000 5001      imp:n=2 imp:p=2 $ Rf
1134  0            1101 -1102  1103 -1110 -5001           imp:n=2 imp:p=2
c
c    ******************** Conical Region Cells ***************
c
2000  1 -1.0     1002 -3000 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=0.75 imp:p=0.75
2001  1 -1.0     1002 -3000 2024 -2025 2042 -2043 1999     imp:n=2 imp:p=2
2002  2 0.06020  1100 -3000 2000 -1999                     imp:n=2 imp:p=2
c
c
2003  1 -1.0     3000 -2001 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=0.75 imp:p=0.75
2004  1 -1.0     3000 -2001 2024 -2025 2042 -2043 1999     imp:n=3 imp:p=3
2005  2 0.06020  3000 -2001 2000 -1999                     imp:n=3 imp:p=3
c
c
2006  1 -1.0  2001 -2002 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=0.75 imp:p=0.75
2007  1 -1.0  2001 -2002 2024 -2025 2042 -2043 (-2014:2015:-2032:2033) &
     imp:n=3 imp:p=3
2008  2 0.06020  2001 -2002 2014 -2015 2032 -2033 2000     imp:n=3 imp:p=3
c
c    ****************** Boral Lined Region Cells *************
c
2100 12   0.07965  2002 -2003 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=3 imp:p=3
2101 12   0.07965  2002 -2003 2024 -2025 2042 -2043 (-2014:2015:-2032:2033) &
      imp:n=9 imp:p=9
2102 3    0.08647  2002 -2003 2014 -2015 2032 -2033 (-2012:2013:-2030:2031) &
      imp:n=9 imp:p=9
2103 5    0.08881  2002 -2003 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=9 imp:p=9
c
c    ******************* Inner Beam Cells *****************
c
3000  0            1102 -3000 -2000  5001                 imp:n=4 imp:p=4
3001  0            1102 -3000 -5001                       imp:n=4 imp:p=4
c
3002  0            3000 -3001 -2000  5001                 imp:n=6 imp:p=6
3003  0            3000 -3001 -5001                       imp:n=6 imp:p=6
c
```

```
3004  0            3001 -3002 -2000  5001                    imp:n=6 imp:p=6
3005  0            3001 -3002 -5001                          imp:n=6 imp:p=6
c
3006   0           3002 -2002 -2000  5001                     imp:n=6 imp:p=6
3007   0           3002 -2002 -5001                           imp:n=6 imp:p=6
c
c     Filter Region of Inner Beam
c
4000  15   -3.97      2002 -3003 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=6 imp:p=6
4001  14  0.06970     2002 -3003 4002 -4003 4004 -4005
       imp:n=12 imp:p=12
c
4002  15   -3.97      3003 -3004 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=12 imp:p=12
4003  14  0.06970     3003 -3004 4002 -4003 4004 -4005
       imp:n=24 imp:p=24
c
4004  15   -3.97      3004 -3005 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=24 imp:p=24
4005  14  0.06970     3004 -3005 4002 -4003 4004 -4005
       imp:n=48 imp:p=48
c
4006  15   -3.97      3005 -2003 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=48 imp:p=48
4007  14  0.06970     3005 -2003 4002 -4003 4004 -4005
       imp:n=96 imp:p=96
c
c    *************** Outside World Void Region *************
c
5000 0           -1001:2003:-1003:1004:-1007:1008   imp:n=0 imp:p=0
c

c    *****************************************************
c    ***************** Core Surface Cards *****************
c    *****************************************************
c
c        Core Grid Definition Surfaces (X-Axis)
c
c        Main Grid
1     px  -34.29
2     px  -26.67
3     px  -19.05
4     px  -11.43
5     px   -3.81
6     px    3.81
7     px   11.43
8     px   19.05
9     px   26.67
10    px   34.29
c        Corner Elements
31    px  -36.83
32    px   36.83
c        Control Plates
101   px  -28.311
102   px   -1.26
103   px    1.26
104   px   28.311
c
c        Core Definition Surfaces (Y-Axis)
c
c        Main Grid
11    py   29.21
12    py   21.59
121   py   13.97
131   py   11.43
```

```
13    py    3.81
14    py   -3.81
141   py  -11.43
151   py  -13.97
15    py  -21.59
16    py  -29.21
c         Corner Elements
33    py   31.75
34    py  -31.75
c         Control Plates
111   py   13.716
112   py   11.684
113   py  -11.684
114   py  -13.716
c
c         Core Definition Surfaces (Z-Axis)
c
c         Main Grid
21    pz   42.365
22    pz  -48.715
c         Control Plates
201   pz   15.0          $ This surface controls the height of Plate 1 (Boral)
202   pz   15.0          $ This surface controls the height of Plate 2 (Boral)
203   pz   15.0          $ This surface controls the height of Plate 3 (SS)
204   pz   15.0          $ This surface controls the height of Plate 4 (Boral)
205   pz   15.0          $ This surface controls the Transient Rod height (B4C)
c
c         Element Universe Surface Cards
c
c         Standard and FLIP Elements
c
900   px  -3.8101
901   px   3.8101
c
902   py  -3.8101
903   py   3.8101
c
904   pz   27.76
905   pz   19.05
906   pz  -19.05
907   pz  -27.76
908   pz  -32.84
c
909   c/z  -1.905  1.905  1.74
910   c/z  -1.905  1.905  1.791
c
911   c/z   1.905  1.905  1.74
912   c/z   1.905  1.905  1.791
c
913   c/z  -1.905 -1.905  1.74
914   c/z  -1.905 -1.905  1.791
c
915   c/z   1.905 -1.905  1.74
916   c/z   1.905 -1.905  1.791
c
c          Graphite Reflector Elements
c
917   px   -3.65125
918   px    3.65125
c
919   py   -3.65125
920   py    3.65125
c
c          Rotator Tube Elements
c
921   pz   -36.015
```

```
922  pz   -38.555
c
923  cz    3.683
924  cz    3.810
925  cz    2.540
926  cz    3.250
c
c         Corner Grid Elements
c
927  px   -35.125
928  px   -28.375
929  px    28.375
930  px    35.125
c
931  py    30.045
932  py    23.295
933  py   -23.295
934  py   -30.045
c
c         Transient Rod Elements
c
935  c/z   1.905  -1.905  1.7526
936  c/z   1.905  -1.905  1.8796
c
c
c    *******************************************************************
c    ******************** Beam Port Surface Cards ******************
c    *******************************************************************
c
c    Water Box Definition Surfaces
c
1001  px  -51.83
1002  px   38.1
c
1003  py  -121.92
1004  py   121.92
1005  py   -62.00
1006  py    62.00
c
1007  pz   -121.92
1008  pz    121.92
1009  pz    -62.00
1010  pz     62.00
c
c    Conical Region Surfaces
c
1999  kx  -109.906  0.13069  1
2000  kx  -106.156  0.13069  1
c
2001  px   101.60
2002  px   102.87
c
c    Aluminum Face Grid
1100  px    39.37
1101  px    46.355
1102  px    59.69
c
1103  py    22.86
1104  py    20.32
1105  py   -20.32
1106  py   -22.32
c
1107  pz    22.86
1108  pz    20.32
1109  pz   -20.32
1110  pz   -22.86
```

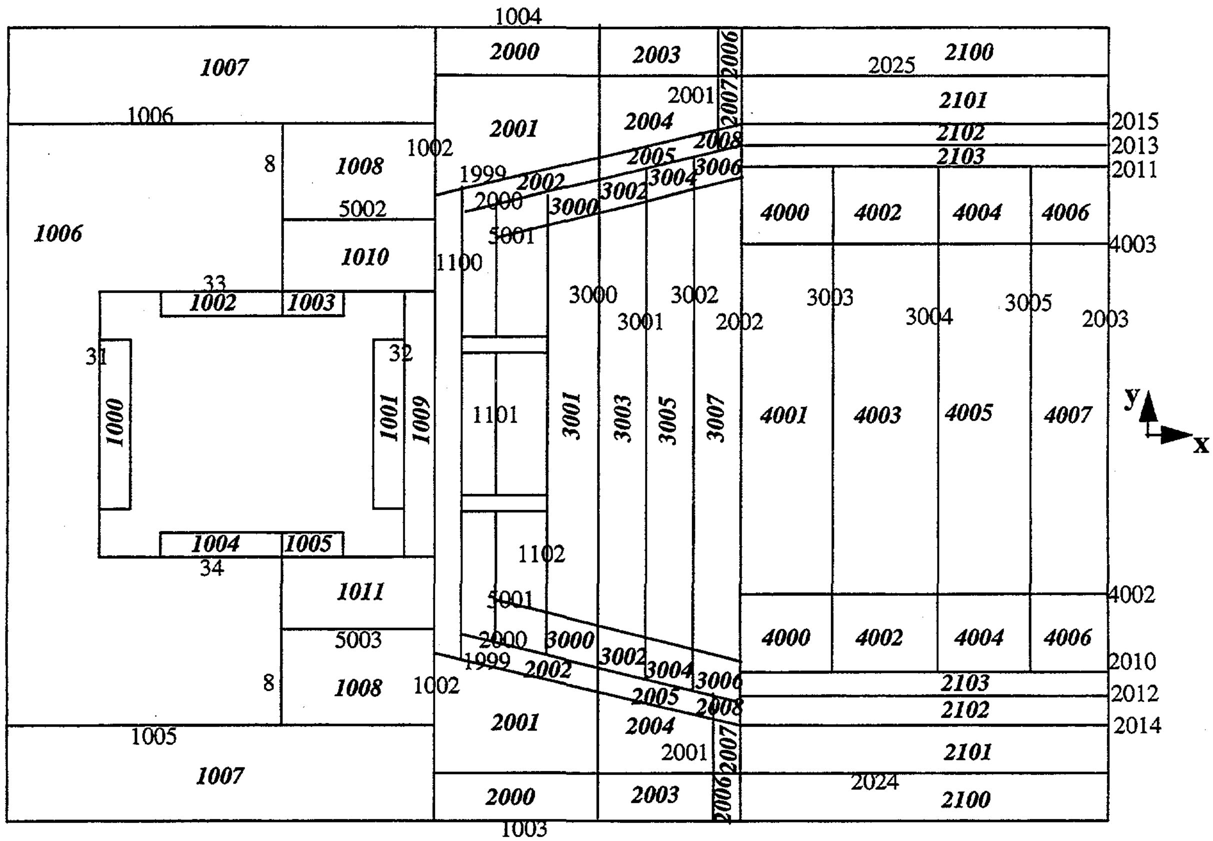
```
c
c    Leaded Region Surfaces
c
2003  px   139.70
c
2010  py   -75.565
2011  py    75.565
2012  py   -76.2
2013  py    76.2
2014  py   -77.47
2015  py    77.47
c
2024  py   -91.44
2025  py    91.44
c
2028  pz   -75.565
2029  pz    75.565
2030  pz   -76.2
2031  pz    76.2
2032  pz   -77.47
2033  pz    77.47
c
2042  pz   -91.44
2043  pz    91.44
c
c    Inner Shell Region of the Beam Port Surfaces
c
3000  px    70
3001  px    80
3002  px    90
c
3003  px   110
3004  px   120
3005  px   130
c
4002  py  -60.96
4003  py   60.96
c
4004  pz  -60.96
4005  pz   60.96
c    *********************** Tally Segment Surface *****************
c
5000  cx   7.5
c    *********************** Lead Box and Relector Surfaces *********
5001  kx  -97.3   0.13069  1
c
5002  py   52.15
5003  py  -52.15

c    *************************************************************
c    ********************** CRITICALITY DATA CARDS *****************
c    *************************************************************
kcode 2500  1.1  5  100
c  ksrc  -17.145  19.685  0      -9.525  15.875  0      13.335  19.685  0
c      20.955  15.875  0      32.385  19.685  0    -17.145   9.525  0
c      -9.525   5.715  0      -1.905   9.525  0      5.715   5.715  0
c      13.335   9.525  0      20.955   5.715  0     28.575   9.525  0
c     -17.145  -1.905  0      -9.525   1.905  0     -1.905  -1.905  0
c       5.715   1.905  0      13.335  -1.905  0     20.955   1.905  0
c      28.575  -1.905  0     -17.145  -9.525  0     -9.525  -5.715  0
c      -1.905  -9.525  0       5.715  -5.715  0     13.335  -9.525  0
c      20.955  -5.715  0      32.385  -9.525  0     -9.525 -19.685  0
c      17.145 -19.685  0      32.385 -19.685  0
c
c     -17.145  19.685  12     -9.525  15.875  12     13.335  19.685  12
c      20.955  15.875  12     32.385  19.685  12    -17.145   9.525  12
```

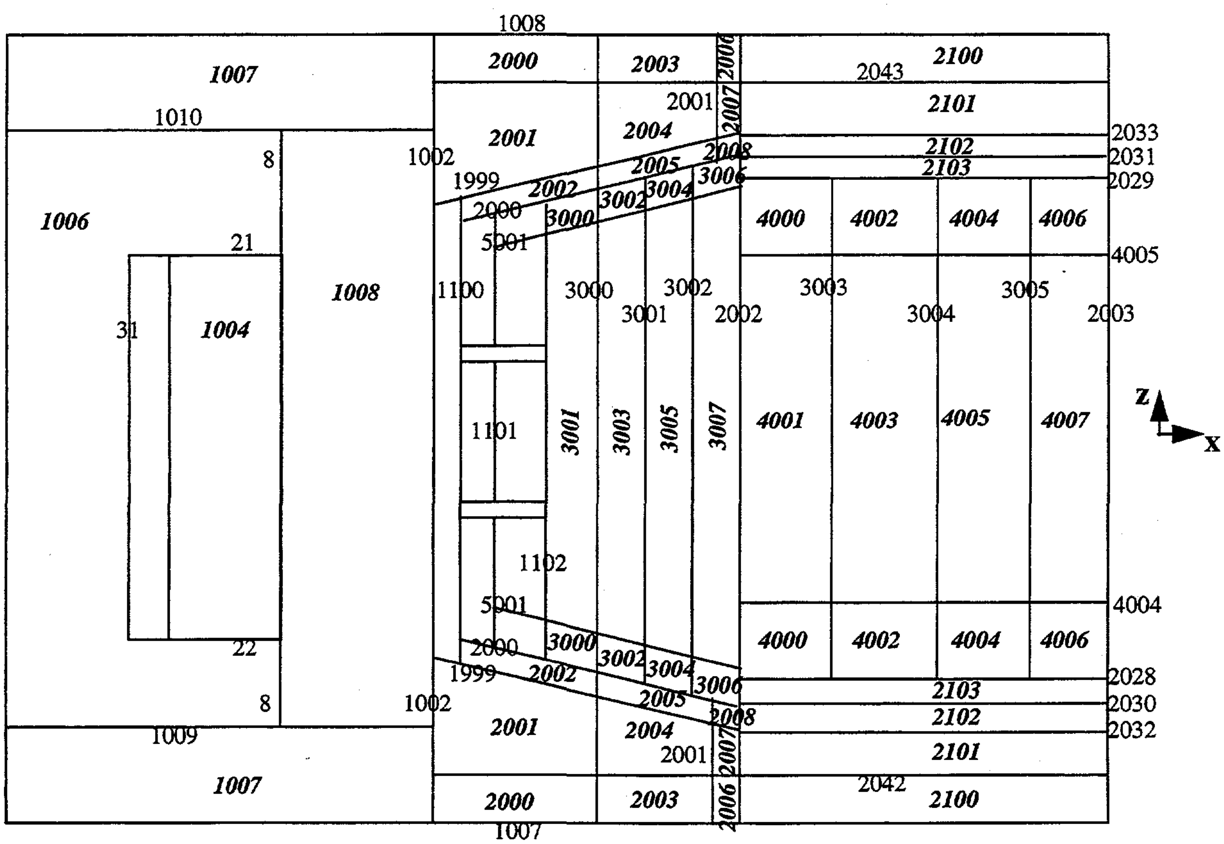
```
c      -9.525    5.715   12        -1.905    9.525   12        5.715    5.715   12
c      13.335    9.525   12        20.955    5.715   12       28.575    9.525   12
c     -17.145   -1.905   12        -9.525    1.905   12       -1.905   -1.905   12
c       5.715    1.905   12        13.335   -1.905   12       20.955    1.905   12
c     28.575   -1.905   12      -17.145   -9.525   12      -9.525   -5.715   12
c      -1.905   -9.525   12         5.715   -5.715   12       13.335   -9.525   12
c      20.955   -5.715   12        32.385   -9.525   12       -9.525  -19.685   12
c      17.145  -19.685   12        32.385  -19.685   12
c
c     -17.145   19.685  -12        -9.525   15.875  -12       13.335   19.685  -12
c      20.955   15.875  -12        32.385   19.685  -12      -17.145    9.525  -12
c      -9.525    5.715  -12        -1.905    9.525  -12        5.715    5.715  -12
c      13.335    9.525  -12        20.955    5.715  -12       28.575    9.525  -12
c     -17.145   -1.905  -12        -9.525    1.905  -12       -1.905   -1.905  -12
c       5.715    1.905  -12        13.335   -1.905  -12       20.955    1.905  -12
c      28.575   -1.905  -12       -17.145   -9.525  -12       -9.525   -5.715  -12
c      -1.905   -9.525  -12         5.715   -5.715  -12       13.335   -9.525  -12
c      20.955   -5.715  -12        32.385   -9.525  -12       -9.525  -19.685  -12
c      17.145  -19.685  -12        32.385  -19.685  -12
c
c     ***************************** Mode Card **********************
c
c      mode n p
c
c     ********************** Surface Source Write Card ***************
c     ssw   1002
c
c     ********************** Print Dump Control Card ****************
prdmp j 100 j 2
c
c     ********************** MATERIAL CARDS *************************
c
c
c      Water
m1       1001.50c   0.667
         8016.50c   0.333
mt1      lwtr.07t
c
c      Aluminum
m2      13027.50c  1.0
c
c      304 Stainles Steel (WSU)
m3      26000.55c  0.730
        24000.50c  0.191
        28000.50c  0.075
         6012.50c  0.004
c
c      Graphite (Carbon)
m4       6012.50c  1.0
mt4      grph.01t
c
c      Boral (from ARH-600, 35% B4C 65% Al)
m5       5010.50c  0.090
         5011.56c  0.364
         6012.50c  0.114
        13027.50c  0.432
c
c      Standard Fuel Meat
m6      92235.53c  0.0027
        92238.53c  0.0106
         1001.53c  0.6129
        40000.53c  0.3738
mt6      h/zr.01t
         zr/h.01t
c
c      FLIP Fuel Meat
```

```
m7      92235.53c  0.0098
        92238.53c  0.0041
         1001.53c  0.6016
        40000.53c  0.3826
        68166.81c  0.0011
        68167.81c  0.0008
mt7      h/zr.01t
         zr/h.01t
c
c      Top of Fuel Region (homogenized)
m8      26000.55c  0.1364
        24000.50c  0.0357
        28000.50c  0.0141
         6012.50c  0.0007
        13027.50c  0.0322
         1001.50c  0.5207
         8016.50c  0.2602
mt8      lwtr.07t
c
c      Bottom of Fuel Region (homogenized)
m9      26000.55c  0.0274
        24000.50c  0.0071
        28000.50c  0.0028
         6012.50c  0.0001
        13027.50c  0.3041
         1001.50c  0.4390
         8016.50c  0.2195
mt9      lwtr.07t
c
c      Boron Carbide (Transient Fuel Rod)
m10      5010.50c  0.1583
         5011.56c  0.6417
         6012.50c  0.2000
c
c      Lead
m11     82000.50c  1.0
c
c      Ordinary Concrete
m12     1001.50c   0.18667
        8016.50c   0.52127
       26000.55c   0.00247
        6000.50c   0.04788
       14000.50c   0.07579
       12000.50c   0.00738
       13027.50c   0.00924
       20000.50c   0.14549
       11023.50c   0.00381
c
c      Heavy Concrete
m13     1001.50c   0.10078
        8016.50c   0.55034
       25055.50c   0.00025
       26000.55c   0.19460
       14000.50c   0.01960
       12000.50c   0.01714
       16032.50c   0.00114
       20000.50c   0.03238
       24000.50c   0.00023
       15031.50c   0.00013
       22000.50c   0.08318
       23000.50c   0.00023
c
c      Al/Teflon
m14    13027.50c   0.5185
        6012.50c   0.1555
        9019.50c   0.3111
```

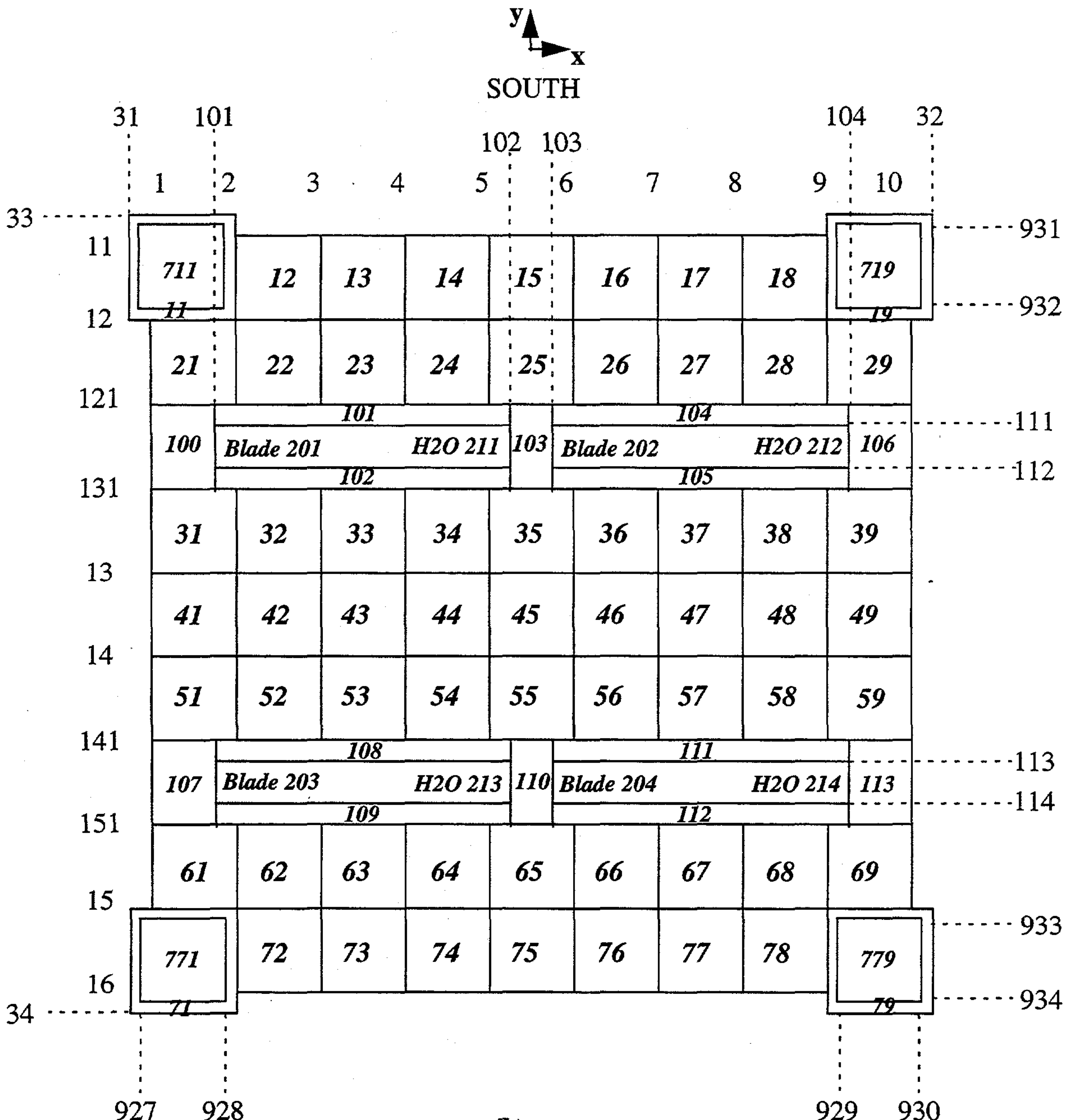
```
         3006.50c   0.0011
         3007.55c   0.0137
c
c       Aluminum Oxide (Al2O3)
m15     13027.50c  -0.5292
         8016.50c  -0.4708
c
c       Li(nat)-Poly
m17      1001.50c   0.5262
         8016.50c   0.1007
         6012.50c   0.2968
         3006.50c   0.0725
         3007.55c   0.0038
c
c       Bismuth
m18     83209.50c   1.0
c
c     ********************** TALLY SPECIFICATION CARDS ********************
c
c       Neutron Flux Over a 7.5cm(radius) Disk Along the Beam's Axial Centerline
f2:n     1002 1100 1101 1102 3000 3001 3002 2002 3003 3004 3005
fm2:n    7.53e16
fs2     -5000
sd2      (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)
fq2      f e
e2       4.14e-7  0.01  20
c
c       Neutron Current Over a 7.5cm(radius) Disk Along the Beam's Axial Centerline
f1:n     1002 1100 1101 1102 3000 3001 3002 2002 3003 3004 3005
fm1:n    7.53e16
fs1     -5000
sd1      (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)
fq1      f e
e1       4.14e-7  0.01  20
c
c       ********************** Power Density Tallies ****************************
c
f17:n       12 13 14 15 16 17 18
fm17     13152
sd17     1 1 1 1 1 1 1
f27:n    21 22 23 24 25 26 27 28 29
fm27     13152
sd27     1 1 1 1 1 1 1 1 1
f37:n    31 32 33 34 35 36 37 38 39
fm37     13152
sd37      1 1 1 1 1 1 1 1 1
f47:n    41 42 43 44 45 46 47 48 49
fm47     13152
sd47      1 1 1 1 1 1 1 1 1
f57:n    51 52 53 54 55 56 57 58 59
fm57     13152
sd57      1 1 1 1 1 1 1 1 1
f67:n    61 62 63 64 65 66 67 68 69
fm67     13152
sd67     1 1 1 1 1 1 1 1 1
f77:n    72 73 74 75 76 77 78
fm77     13152
sd77     1 1 1 1 1 1 1
c
```

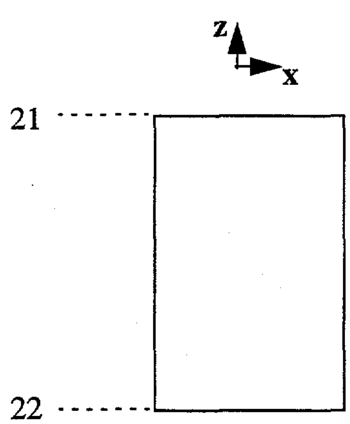
WSUc Model - Surface and Cell Diagram



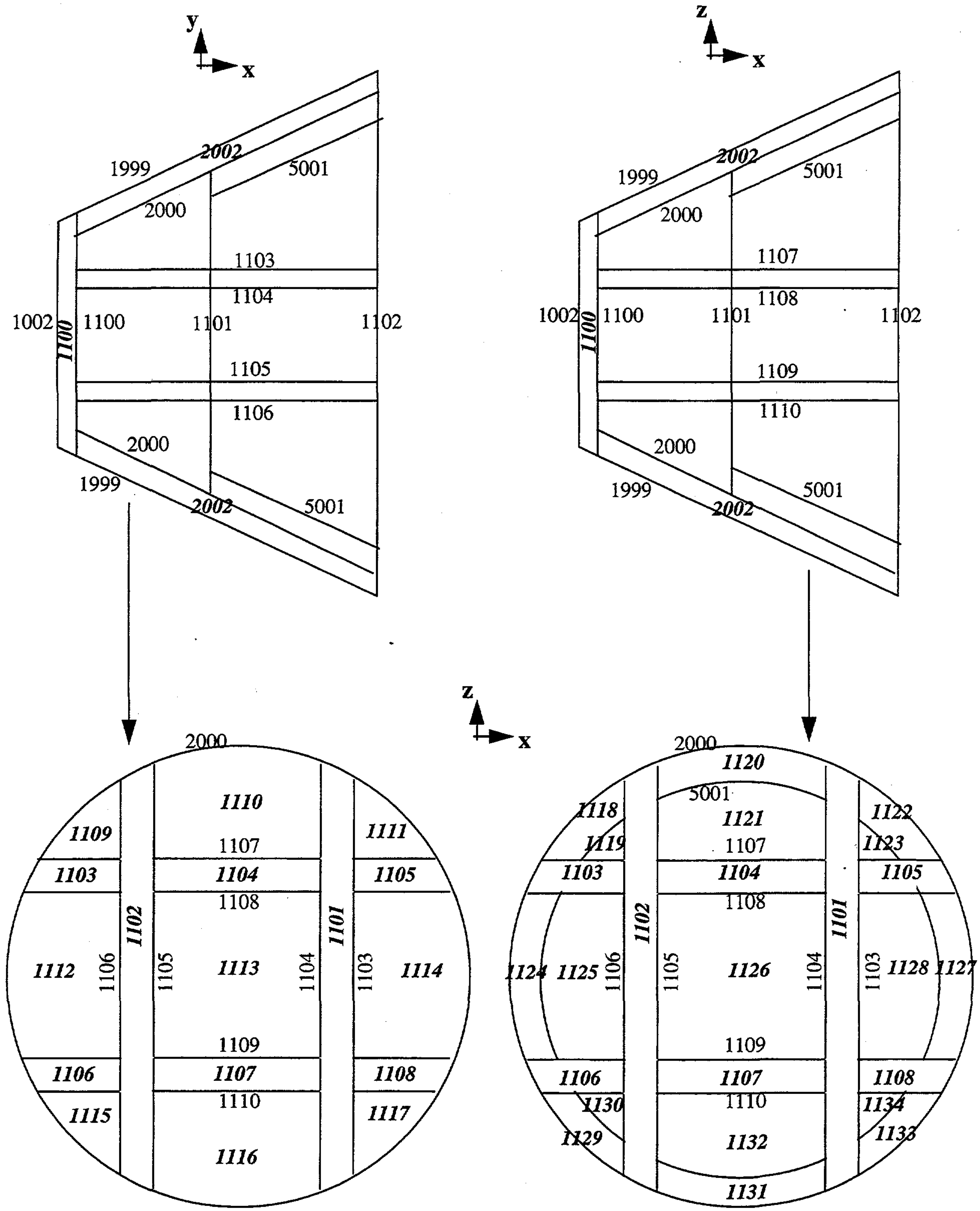


Core Grid Model - Surface and Cell Diagram

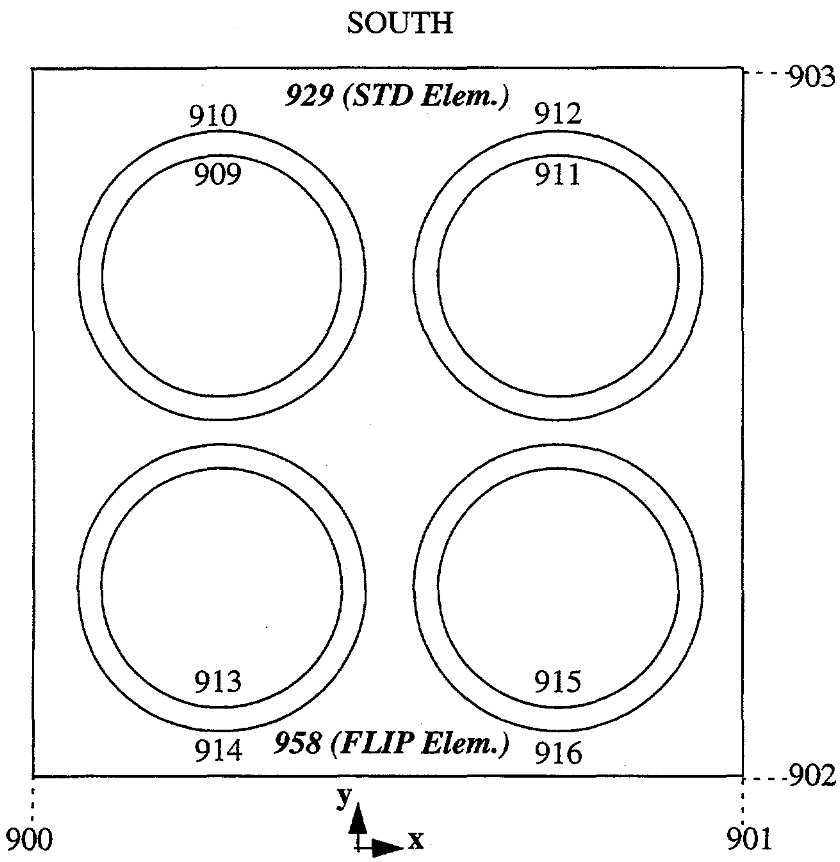


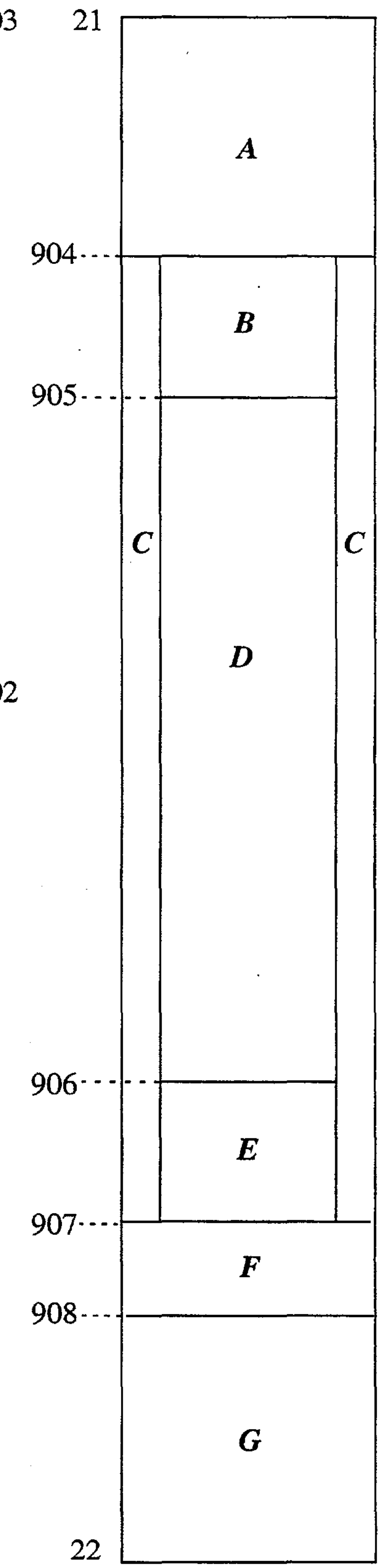


Aluminum Cone / Lead Thermal Shield Model - Surface and Cell Diagram



Standard & FLIP Fuel Element Model - Surface and Cell Diagram

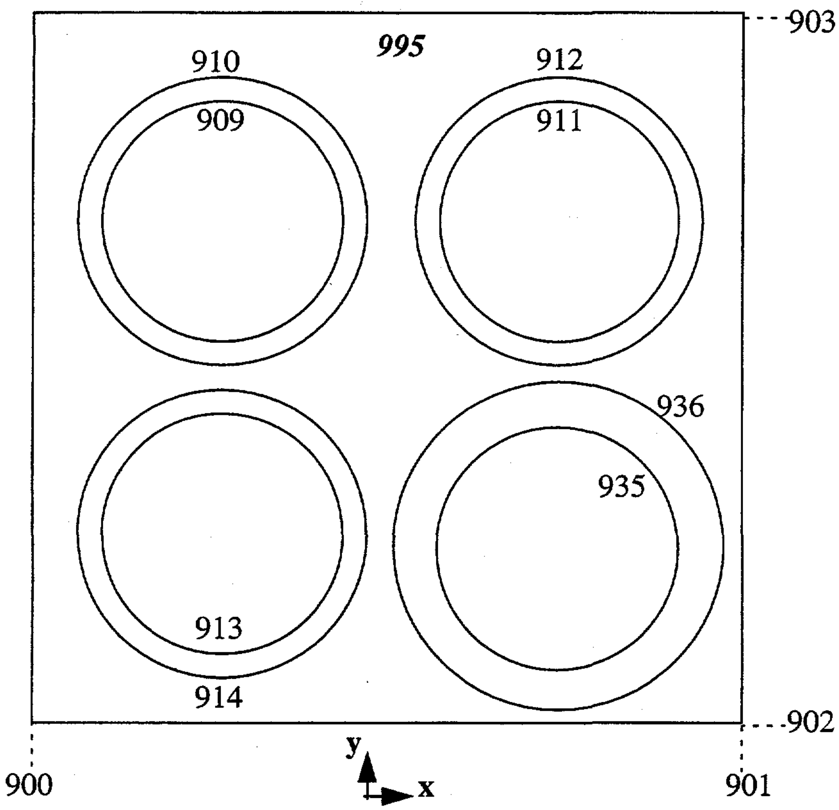


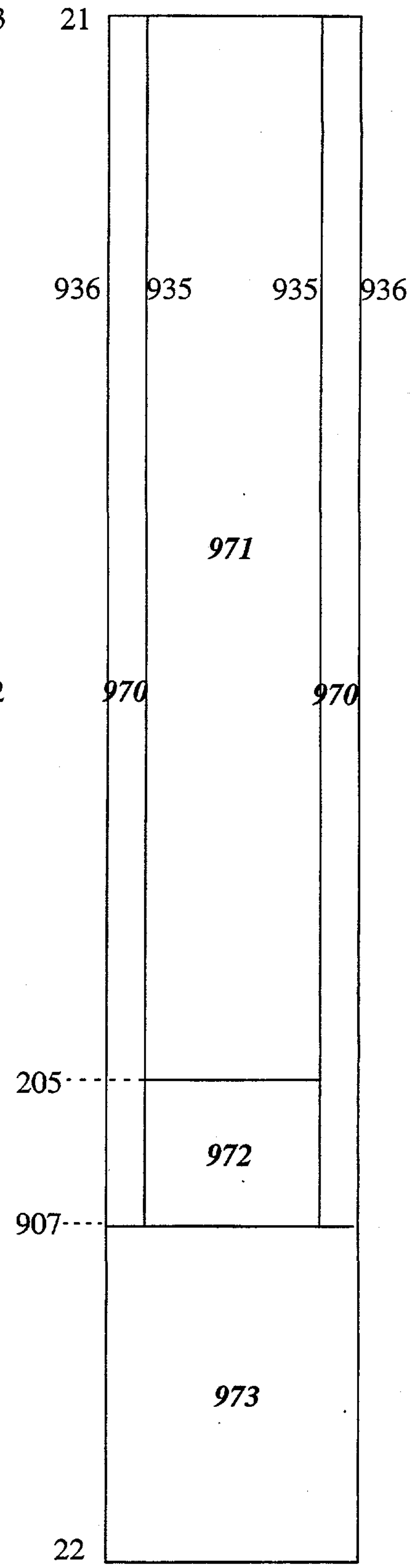


Note: The elevation view of the fuel rod is generic for any of the four rods in the Standard or FLIP element models (eight total rods). The table below matches the letter of the cell in the figure with the cell number corresponding to each of the eight different rods.

	A	B	C	D	E	F	G
Upper Left STD Rod	904	902	907	901	903	905	906
Lower Left STD Rod	918	916	921	915	917	919	920
Upper Right STD Rod	911	909	914	908	910	912	913
Lower Right STD Rod	925	923	928	922	924	926	927
Upper Left FLIP Rod	933	931	936	930	932	934	935
Lower Left FLIP Rod	947	945	950	944	946	948	949
Upper Right FLIP Rod	940	938	943	937	939	941	942
Lower RightFLIP Rod	951	952	953	954	955	956	957

Transient Rod Element Model - Surface and Cell Diagram



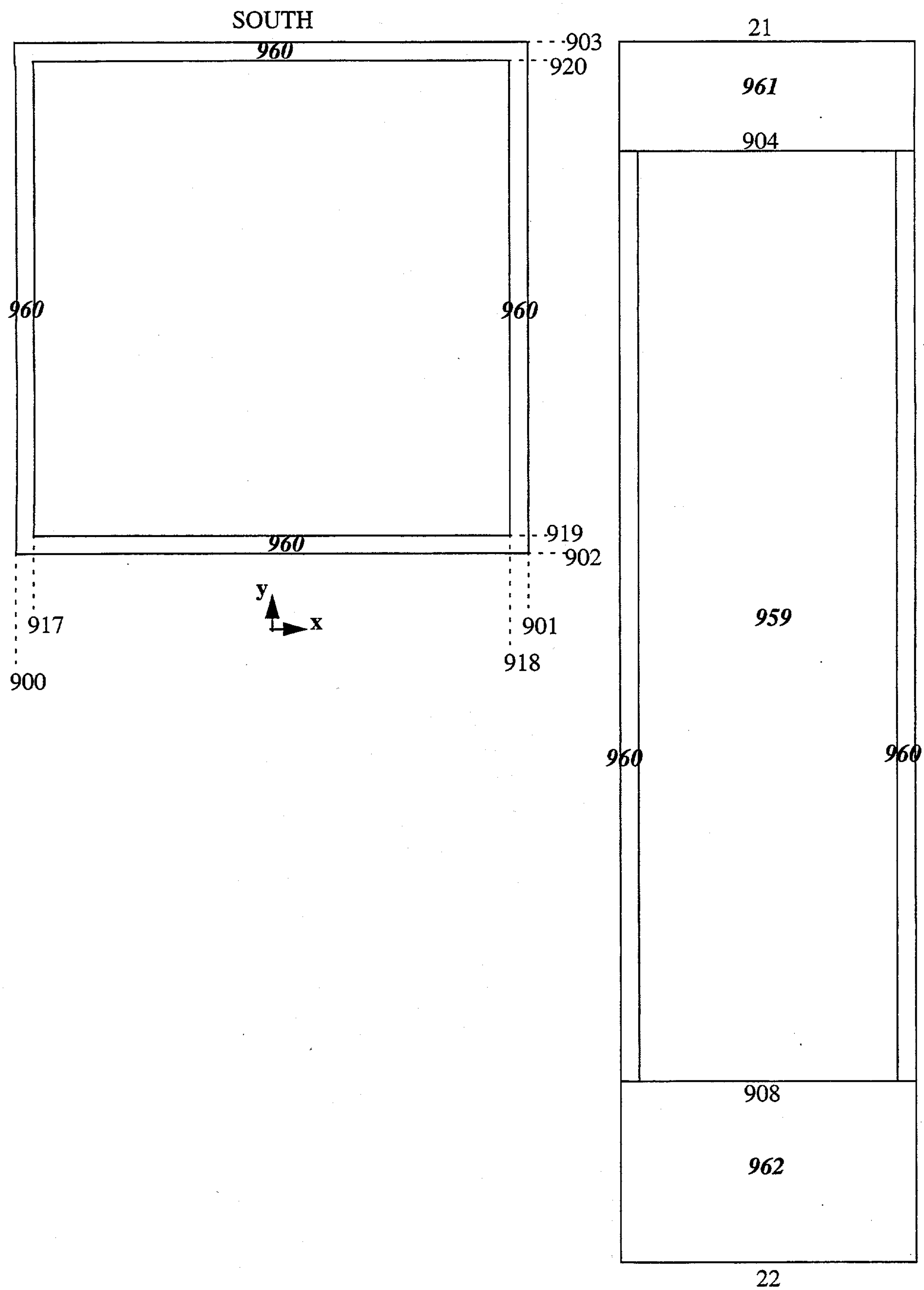


Note: The elevation view is of the Transient Rod. The fuel rods in a Transient Rod Element are identical to those in the Standard and FLIP Elements, and a diagram of these can be found on the Standard and FLIP Element sheet. The table below matches the letters from the Standard and FLIP rod diagram with the cells in the three Transient Rod Element fuel rods.

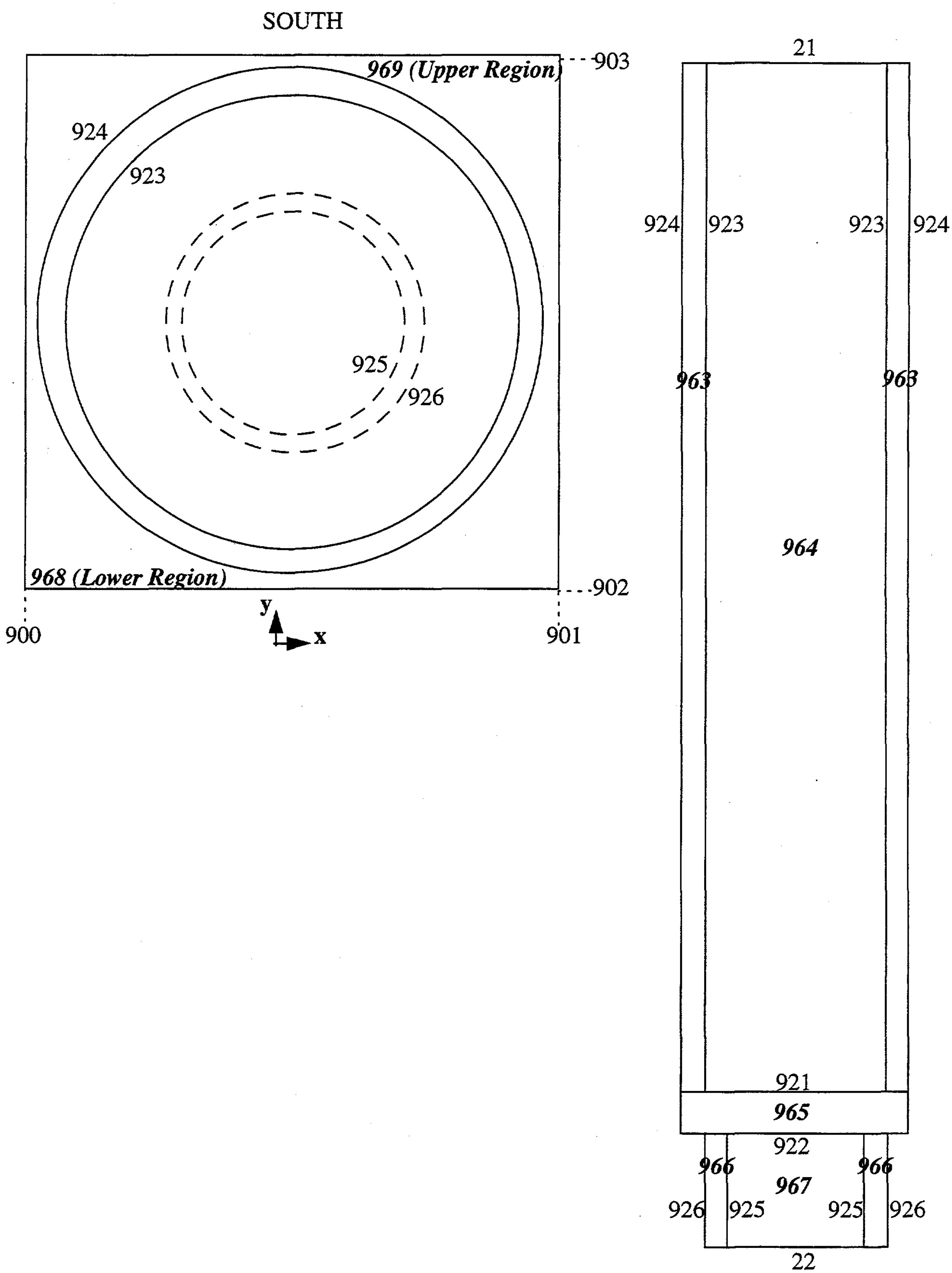
	A	*B*	*C*	*D*	*E*	*F*	*G*
Upper Left TR Rod	*991*	*989*	*994*	*988*	*990*	*992*	*993*
Lower Left TR Rod	*984*	*982*	*987*	*981*	*983*	*985*	*986*
Upper Right TR Rod	*977*	*975*	*980*	*974*	*976*	*978*	*979*

Note: In the default model the ***970*** cell is filled with aluminum at 80% density. This approximates the porosity of the transient rod sheath region.

Graphite Element Model -Surface and Cell Diagram



Rotator Tube Element Model - Surface and Cell Diagram



Appendix B

BSPT Model Surface and Cell Diagrams

This appendix includes the BSPT Model default input deck and the following diagrams:

1. BSPT Model Surface Diagram

2. BSPT Model Cell Diagram

```
MCNP4A - Washington State University Reactor Facility Beam Model
c       CELL CARDS
c
c     ******************************************************
c     ***************** Beamport Cells **********************
c     ******************************************************
c
c     ******************* Water Box Cells ********************
c
1000  0           1001 -1002 1003 -1004 1007 -1008  imp:n=1 imp:p=1
c
c     ********* Aluminum Cone Grid & Lead Thermal Shield ******
c      Aluminum Grid
1100  2 0.06020  1002 -1100 -1999                  imp:n=2 imp:p=2
c
1101  2 0.06020  1100 -1102 -2000 -1103 1104       imp:n=2 imp:p=2
1102  2 0.06020  1100 -1102 -2000 -1105 1106       imp:n=2 imp:p=2
c
1103  2 0.06020  1100 -1102 -1107 1108 -1106 -2000 imp:n=2 imp:p=2
1104  2 0.06020  1100 -1102 -1107 1108 -1104  1105 imp:n=2 imp:p=2
1105  2 0.06020  1100 -1102 -1107 1108  1103 -2000 imp:n=2 imp:p=2
c
1106  2 0.06020  1100 -1102 -1109 1110 -1106 -2000 imp:n=2 imp:p=2
1107  2 0.06020  1100 -1102 -1109 1110 -1104  1105 imp:n=2 imp:p=2
1108  2 0.06020  1100 -1102 -1109 1110  1103 -2000 imp:n=2 imp:p=2
c      Lead Thermal Shield
1109  11 0.03298 1100 -1101 -1106 1107 -2000       imp:n=2 imp:p=2
1110  11 0.03298 1100 -1101 -1104 1105  1107 -2000 imp:n=2 imp:p=2
1111  11 0.03298 1100 -1101  1103 1107 -2000       imp:n=2 imp:p=2
c
1112  11 0.03298 1100 -1101 -1108 1109 -1106 -2000 imp:n=2 imp:p=2
1113  11 0.03298 1100 -1101 -1108 1109 -1104  1105 imp:n=2 imp:p=2
1114  11 0.03298 1100 -1101 -1108 1109  1103 -2000 imp:n=2 imp:p=2
c
1115  11 0.03298 1100 -1101 -1106 -1110 -2000      imp:n=2 imp:p=2
1116  11 0.03298 1100 -1101 -1104 1105 -1110 -2000 imp:n=2 imp:p=2
1117  11 0.03298 1100 -1101  1103 -1110 -2000      imp:n=2 imp:p=2
c      Void Region
1118  0             1101 -1102 -1106 1107 -2000  5001      imp:n=2 imp:p=2 $Rf
1119  0             1101 -1102 -1106 1107 -5001            imp:n=2 imp:p=2
1120  0             1101 -1102 -1104 1105  1107 -2000 5001 imp:n=2 imp:p=2 $Rf
1121  0             1101 -1102 -1104 1105  1107 -5001      imp:n=2 imp:p=2
1122  0             1101 -1102  1103 1107 -2000  5001      imp:n=2 imp:p=2 $Rf
1123  0             1101 -1102  1103 1107 -5001            imp:n=2 imp:p=2
c
1124  0             1101 -1102 -1108 1109 -1106 -2000 5001 imp:n=2 imp:p=2 $Rf
1125  0             1101 -1102 -1108 1109 -1106 -5001      imp:n=2 imp:p=2
1126  0             1101 -1102 -1108 1109 -1104  1105      imp:n=2 imp:p=2
1127  0             1101 -1102 -1108 1109  1103 -2000 5001 imp:n=2 imp:p=2 $Rf
1128  0             1101 -1102 -1108 1109  1103 -5001      imp:n=2 imp:p=2
c
1129  0  1101 -1102 -1106 -1110 -2000 5001      imp:n=2 imp:p=2 $Rf
1130  0             1101 -1102 -1106 -1110 -5001           imp:n=2 imp:p=2
1131  0  1101 -1102 -1104 1105 -1110 -2000 5001 imp:n=2 imp:p=2 $Rf
1132  0             1101 -1102 -1104 1105 -1110 -5001      imp:n=2 imp:p=2
1133  0  1101 -1102  1103 -1110 -2000 5001      imp:n=2 imp:p=2 $Rf
1134  0             1101 -1102  1103 -1110 -5001           imp:n=2 imp:p=2
c
c     ******************* Conical Region Cells ***************
c
2000  1 -1.0     1002 -3000 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=0.75 imp:p=0.75
2001  1 -1.0     1002 -3000 2024 -2025 2042 -2043 1999      imp:n=2 imp:p=2
2002  2 0.06020  1100 -3000 2000 -1999                      imp:n=2 imp:p=2
c
c
```

```
2003  1 -1.0     3000 -2001 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=0.75 imp:p=0.75
2004  1 -1.0     3000 -2001 2024 -2025 2042 -2043 1999      imp:n=3 imp:p=3
2005  2 0.06020  3000 -2001 2000 -1999                      imp:n=3 imp:p=3
c
c
2006  1 -1.0  2001 -2002 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=0.75 imp:p=0.75
2007  1 -1.0  2001 -2002 2024 -2025 2042 -2043 (-2014:2015:-2032:2033) &
     imp:n=3 imp:p=3
2008  2 0.06020  2001 -2002 2014 -2015 2032 -2033 2000      imp:n=3 imp:p=3
c
c    ****************** Boral Lined Region Cells *************
c
2100 12  0.07965  2002 -2003 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=3 imp:p=3
2101 12  0.07965  2002 -2003 2024 -2025 2042 -2043 (-2014:2015:-2032:2033) &
      imp:n=9 imp:p=9
2102 3   0.08647  2002 -2003 2014 -2015 2032 -2033 (-2012:2013:-2030:2031) &
      imp:n=9 imp:p=9
2103 5   0.08881  2002 -2003 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=9 imp:p=9
c
c
2104 12  0.07965  2003 -2004 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=3 imp:p=3
2105 12  0.07965  2003 -2004 2024 -2025 2042 -2043 (-2018:2019:-2036:2037) &
      imp:n=9 imp:p=9
2106 3   0.08647  2003 -2004 2018 -2019 2036 -2037 (-2012:2013:-2030:2031) &
      imp:n=9 imp:p=9
2107 5   0.08881  2003 -2004 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=9 imp:p=9
c
c
2108 12  0.07965  2004 -3009 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=9 imp:p=9
2109 12  0.07965  2004 -3009 2024 -2025 2042 -2043 (-2018:2019:-2036:2037) &
      imp:n=60 imp:p=60
2110 3   0.08647  2004 -3009 2018 -2019 2036 -2037 (-2016:2017:-2034:2035) &
      imp:n=60 imp:p=60
2111 11  0.03298  2004 -3009 2016 -2017 2034 -2035 (-2012:2013:-2030:2031) &
      imp:n=60 imp:p=60
2112 5   0.08881  2004 -3009 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=60 imp:p=60
c
2113 12  0.07965  3009 -2005 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=48 imp:p=48
2114 12  0.07965  3009 -2005 2024 -2025 2042 -2043 (-2018:2019:-2036:2037) &
      imp:n=192 imp:p=192
2115 3   0.08647  3009 -2005 2018 -2019 2036 -2037 (-2016:2017:-2034:2035) &
      imp:n=192 imp:p=192
2116 11  0.03298  3009 -2005 2016 -2017 2034 -2035 (-2012:2013:-2030:2031) &
      imp:n=192 imp:p=192
2117 5   0.08881  3009 -2005 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=192 imp:p=192
c
c
2118 13  0.08050  2005 -2006 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=48 imp:p=48
2119 13  0.08050  2005 -2006 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
      imp:n=192 imp:p=192
2120 3   0.08647  2005 -2006 2022 -2023 2040 -2041 (-2016:2017:-2034:2035) &
      imp:n=192 imp:p=192
2121 11  0.03298  2005 -2006 2016 -2017 2034 -2035 (-2012:2013:-2030:2031) &
      imp:n=192 imp:p=192
2122 5   0.08881  2005 -2006 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
```

```
     imp:n=192 imp:p=192
c
c
2123 13  0.08050  2006 -3012 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=48 imp:p=48
2124 13  0.08050  2006 -3012 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
     imp:n=192 imp:p=192
2125 3   0.08647  2006 -3012 2022 -2023 2040 -2041 (-2020:2021:-2038:2039) &
     imp:n=192 imp:p=192
2126 11  0.03298  2006 -3012 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
     imp:n=192 imp:p=192
2127 5   0.08881  2006 -3012 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
     imp:n=192 imp:p=192
c
2128 13  0.08050  3012 -3015 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=96 imp:p=96
2129 13  0.08050  3012 -3015 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
     imp:n=384 imp:p=384
2130 3   0.08647  3012 -3015 2022 -2023 2040 -2041 (-2020:2021:-2038:2039) &
     imp:n=384 imp:p=384
2131 11  0.03298  3012 -3015 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
     imp:n=384 imp:p=384
2132 5   0.08881  3012 -3015 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
     imp:n=384 imp:p=384
c
2133 13  0.08050  3015 -2007 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=96 imp:p=96
2134 13  0.08050  3015 -2007 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
     imp:n=384 imp:p=384
2135 3   0.08647  3015 -2007 2022 -2023 2040 -2041 (-2020:2021:-2038:2039) &
     imp:n=384 imp:p=384
2136 11  0.03298  3015 -2007 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
     imp:n=384 imp:p=384
2137 5   0.08881  3015 -2007 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
     imp:n=384 imp:p=384
c
c
2138 13  0.08050  2007 -2008 1003 -1004 1007 -1008 (-2026:2027:-2044:2045) &
     imp:n=96 imp:p=96
2139 3   0.08647  2007 -2008 2026 -2027 2044 -2045 (-2020:2021:-2038:2039) &
     imp:n=384 imp:p=384
2140 11  0.03298  2007 -2008 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
     imp:n=384 imp:p=384
2141 5   0.08881  2007 -2008 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
     imp:n=384 imp:p=384
c
c    ********************** End Region Cells ****************************
c
2142 13  0.08050  2008 -3017 1003 -1004 1007 -1008 (-2026:2027:-2044:2045) &
     imp:n=96 imp:p=96
2143 3   0.08647  2008 -3017 2026 -2027 2044 -2045 (-2024:2025:-2042:2043) &
     imp:n=384 imp:p=384
c
2144 13  0.08050  3017 -2009 1003 -1004 1007 -1008 (-2026:2027:-2044:2045) &
     imp:n=96 imp:p=96
2145 3   0.08647  3017 -2009 2026 -2027 2044 -2045 (-2024:2025:-2042:2043) &
     imp:n=96 imp:p=96
c
2146 13  0.08050  2009 -1011 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=24 imp:p=24
c
c    ****************** Inner Beam Cells *****************
c
3000  0           1102 -3000 -2000  5001                 imp:n=4 imp:p=4 $Rf
3001  0           1102 -3000 -5001                       imp:n=4 imp:p=4
c
```

```
3002  0           3000 -3001 -2000  5001                      imp:n=6 imp:p=6 $Rf
3003  0           3000 -3001 -5001                            imp:n=6 imp:p=6
c
3004  0           3001 -3002 -2000  5001                      imp:n=6 imp:p=6 $Rf
3005  0           3001 -3002 -5001                            imp:n=6 imp:p=6
c
3006   0          3002 -2002 -2000  5001                       imp:n=6 imp:p=6 $Rf
3007   0          3002 -2002 -5001                             imp:n=6 imp:p=6
c
c     Filter Region of Inner Beam
c
4000  15   -3.97     2002 -3003 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=6 imp:p=6
4001  14  0.06970    2002 -3003 4002 -4003 4004 -4005
       imp:n=12 imp:p=12
c
4002  15   -3.97     3003 -3004 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=12 imp:p=12
4003  14  0.06970    3003 -3004 4002 -4003 4004 -4005
       imp:n=24 imp:p=24
c
4004  15   -3.97     3004 -3005 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=24 imp:p=24
4005  14  0.06970    3004 -3005 4002 -4003 4004 -4005
       imp:n=48 imp:p=48
c
4006  15   -3.97     3005 -3006 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=48 imp:p=48
4007  14  0.06970    3005 -3006 4002 -4003 4004 -4005
       imp:n=96 imp:p=96
c
4008  15   -3.97     3006 -3007 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=96 imp:p=96
4009  14  0.06970    3006 -3007 4002 -4003 4004 -4005
       imp:n=192 imp:p=192
c
4010  15   -3.97     3007 -3008 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=192 imp:p=192
4011  14  0.06970    3007 -3008 4002 -4003 4004 -4005
       imp:n=384 imp:p=384
c
4012  15   -3.97     3008 -3009 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=384 imp:p=384
4013  14  0.06970    3008 -3009 4002 -4003 4004 -4005
       imp:n=768 imp:p=768
c
4014  11  0.03298    3009 -3010 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
       imp:n=768 imp:p=768
4015  11  0.03298    3009 -3010 4002 -4003 4004 -4005
       imp:n=1536 imp:p=1536
c
c
c
4016  17  0.10351   3010 -3011  2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
             imp:n=768 imp:p=768
4017  17  0.10351   3010 -3011  4002 -4003 4004 -4005 4001                    &
             imp:n=768 imp:p=768
4018  17  0.10351   3010 -3011  4000 -4001         imp:n=768 imp:p=768
4019  0             3010 -3011 -4000               imp:n=1536 imp:p=1536
c
4020  17  0.10351   3011 -3012  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                         imp:n=192 imp:p=192
4021  0           3011 -3012  4006 -4007 4008 -4009 4001 imp:n=384 imp:p=384
4022  17  0.10351   3011 -3012  4000 -4001                imp:n=768 imp:p=768
4023  0             3011 -3012 -4000                    imp:n=1536 imp:p=1536
c
```

```
4024  17  0.10351   3012 -3013  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                      imp:n=384 imp:p=384
4025  0             3012 -3013  4006 -4007 4008 -4009 4001 imp:n=576 imp:p=576
4026  17  0.10351   3012 -3013  4000 -4001              imp:n=1152 imp:p=1152
4027  0             3012 -3013 -4000                   imp:n=2304 imp:p=2304
c
4028  17  0.10351   3013 -3014  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                      imp:n=384 imp:p=384
4029  0             3013 -3014  4006 -4007 4008 -4009 4001 imp:n=768 imp:p=768
4030  17  0.10351   3013 -3014  4000 -4001              imp:n=1536 imp:p=1536
4031  0             3013 -3014 -4000                   imp:n=3072 imp:p=3072
c
4032  17  0.10351   3014 -3015  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                      imp:n=384 imp:p=384
4033  0             3014 -3015  4006 -4007 4008 -4009 4001 imp:n=1152 imp:p=1152
4034  17  0.10351   3014 -3015  4000 -4001              imp:n=2304 imp:p=2304
4035  0             3014 -3015 -4000                   imp:n=4608 imp:p=4608
c
4036  17  0.10351   3015 -2008  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                      imp:n=384 imp:p=384
4037  0             3015 -2008  4006 -4007 4008 -4009 4001 imp:n=1536 imp:p=1536
4038  17  0.10351   3015 -2008  4000 -4001              imp:n=3072 imp:p=3072
4039  0             3015 -2008 -4000                   imp:n=6144 imp:p=6144
c
c     End Region
c
4040  17 0.10351  2008 -3016  2024 -2025 2042 -2043 (-4006:4007:-4008:4009)  &
                                                      imp:n=384 imp:p=384
4041  0           2008 -3016  4006 -4007 4008 -4009 5000 imp:n=1536 imp:p=1536
4042  0           2008 -3016 -5000                   imp:n=6144 imp:p=6144
c
4043  17  0.10351 3016 -3017  2024 -2025 2042 -2043 (-4010:4011:-4012:4013)  &
                                                      imp:n=384 imp:p=384
4044  0           3016 -3017  4010 -4011 4012 -4013 5000 imp:n=1536 imp:p=1536
4045  0           3016 -3017 -5000                   imp:n=6144 imp:p=6144
c
4046  17  0.10351 3017 -3018  2024 -2025 2042 -2043 (-4010:4011:-4012:4013)  &
                                                      imp:n=96 imp:p=96
4047  0           3017 -3018  4010 -4011 4012 -4013 5000 imp:n=384 imp:p=384
4048  0           3017 -3018 -5000                   imp:n=1536 imp:p=1536
c
4049  17  0.10351 3018 -1011  2024 -2025 2042 -2043 (-4010:4011:-4012:4013)  &
                                                      imp:n=24 imp:p=24
4050  0           3018 -1011  4010 -4011 4012 -4013 5000 imp:n=96 imp:p=96
4051  0           3018 -1011 -5000                   imp:n=384 imp:p=384
c
c    *************** Outside World Void Region *************
c
5000 0          -1001:1011:-1003:1004:-1007:1008   imp:n=0 imp:p=0

c    ***************************************************************
c    ******************** Beam Port Surface Cards ******************
c    ***************************************************************
c
c    Water Box Definition Surfaces
c
1001  px   36
1002  px   38.1
c
1003  py  -121.92
1004  py   121.92
c
1007  pz   -121.92
1008  pz    121.92
c
1011  px    323.85
```

```
c
c     Conical Region Surfaces
c
1999  kx  -109.906  0.13069  1
2000  kx  -106.156  0.13069  1
5001  kx    -97.3   0.13069  1
c
2001  px   101.60
2002  px   102.87
c
c    Aluminum Face Grid
1100  px    39.37
1101  px    46.355
1102  px    59.69
c
1103  py    22.86
1104  py    20.32
1105  py   -20.32
1106  py   -22.32
c
1107  pz    22.86
1108  pz    20.32
1109  pz   -20.32
1110  pz   -22.86
c
c    Leaded Region Surfaces
c
2003  px   139.70
2004  px   140.97
2005  px   185.42
2006  px   186.69
2007  px   246.38
2008  px   247.65
2009  px   308.61
c
2010  py   -75.565
2011  py    75.565
2012  py   -76.2
2013  py    76.2
2014  py   -77.47
2015  py    77.47
2016  py   -78.74
2017  py    78.74
2018  py   -80.01
2019  py    80.01
2020  py   -81.28
2021  py    81.28
2022  py   -82.55
2023  py    82.55
2024  py   -91.44
2025  py    91.44
2026  py   -92.71
2027  py    92.71
c
2028  pz   -75.565
2029  pz    75.565
2030  pz   -76.2
2031  pz    76.2
2032  pz   -77.47
2033  pz    77.47
2034  pz   -78.54
2035  pz    78.54
2036  pz   -80.01
2037  pz    80.01
2038  pz   -81.28
2039  pz    81.28
```

```
2040  pz   -82.55
2041  pz    82.55
2042  pz   -91.44
2043  pz    91.44
2044  pz   -92.71
2045  pz    92.71
c
c    Inner Shell Region of the Beam Port Surfaces
c
3000  px    70
3001  px    80
3002  px    90
c
3003  px   110
3004  px   120
3005  px   130
3006  px   140
3007  px   150
3008  px   160
3009  px   172.87
3010  px   178.87
3011  px   183.95
3012  px   195
3013  px   210
3014  px   220
3015  px   235
c
3016  px   252.73
3017  px   275
3018  px   300
c
c    Filter Surfaces
c
4000  kx   259.78     0.3819  -1
4001  kx   269.44     0.3819  -1
c
4002  py  -60.96
4003  py   60.96
c
4004  pz  -60.96
4005  pz   60.96
c
4006  py  -70.485
4007  py   70.485
c
4008  pz  -70.485
4009  pz   70.485
c
4010  py  -86.56
4011  py   86.56
c
4012  pz  -86.56
4013  pz   86.56
c
c    *********************** Tally Segment Surface ******************
c
5000  cx   7.5

c    ***************************** Mode Card *****************************
c
c     mode n p
c
c     *********************************************************************
c     ******************** SURFACE SOURCE READ CARDS **********************
c     *********************************************************************
c
```

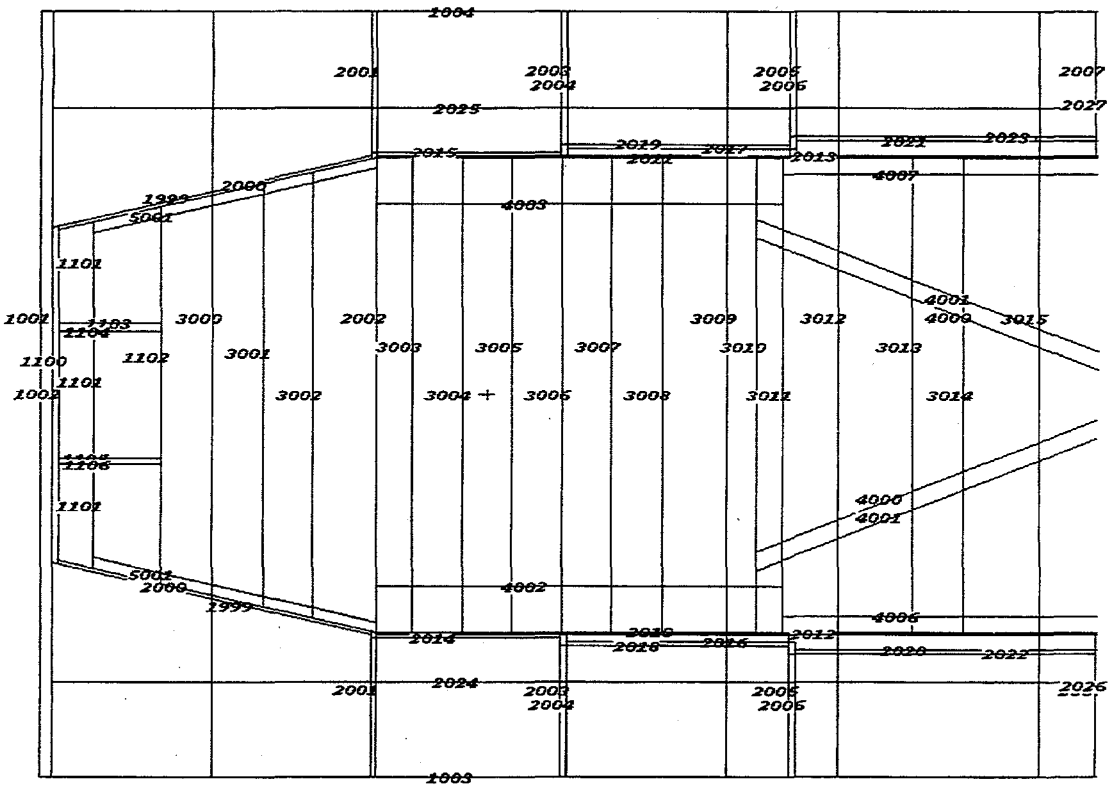
```
ssr    old=1002 new=1002
nps    1800000
c
c     ********************** MATERIAL CARDS *************************
c
c
c      Water
m1       1001.50c   0.667
         8016.50c   0.333
c
c      Aluminum
m2      13027.50c  1.0
c
c      304 Stainles Steel (WSU)
m3      26000.55c  0.730
        24000.50c  0.191
        28000.50c  0.075
         6012.50c  0.004
c
c      Graphite (Carbon)
m4       6012.50c  1.0
c
c      Boral (from ARH-600, 35% B4C 65% Al)
m5       5010.50c  0.090
         5011.56c  0.364
         6012.50c  0.114
        13027.50c  0.432
c
c      Standard Fuel Meat
m6      92235.50c  0.0027
        92238.50c  0.0106
         1001.50c  0.6129
        40000.50c  0.3738
c
c      FLIP Fuel Meat
m7      92235.50c  0.0098
        92238.50c  0.0041
         1001.50c  0.6016
        40000.50c  0.3826
        68166.81c  0.0011
        68167.81c  0.0008
c
c      Top of Fuel Region (homogenized)
m8      26000.55c  0.1364
        24000.50c  0.0357
        28000.50c  0.0141
         6012.50c  0.0007
        13027.50c  0.0322
         1001.50c  0.5207
         8016.50c  0.2602
c
c      Bottom of Fuel Region (homogenized)
m9      26000.55c  0.0274
        24000.50c  0.0071
        28000.50c  0.0028
         6012.50c  0.0001
        13027.50c  0.3041
         1001.50c  0.4390
         8016.50c  0.2195
c
c      Boron Carbide (Transient Fuel Rod)
m10      5010.50c  0.1583
         5011.56c  0.6417
         6012.50c  0.2000
c
c      Lead
```

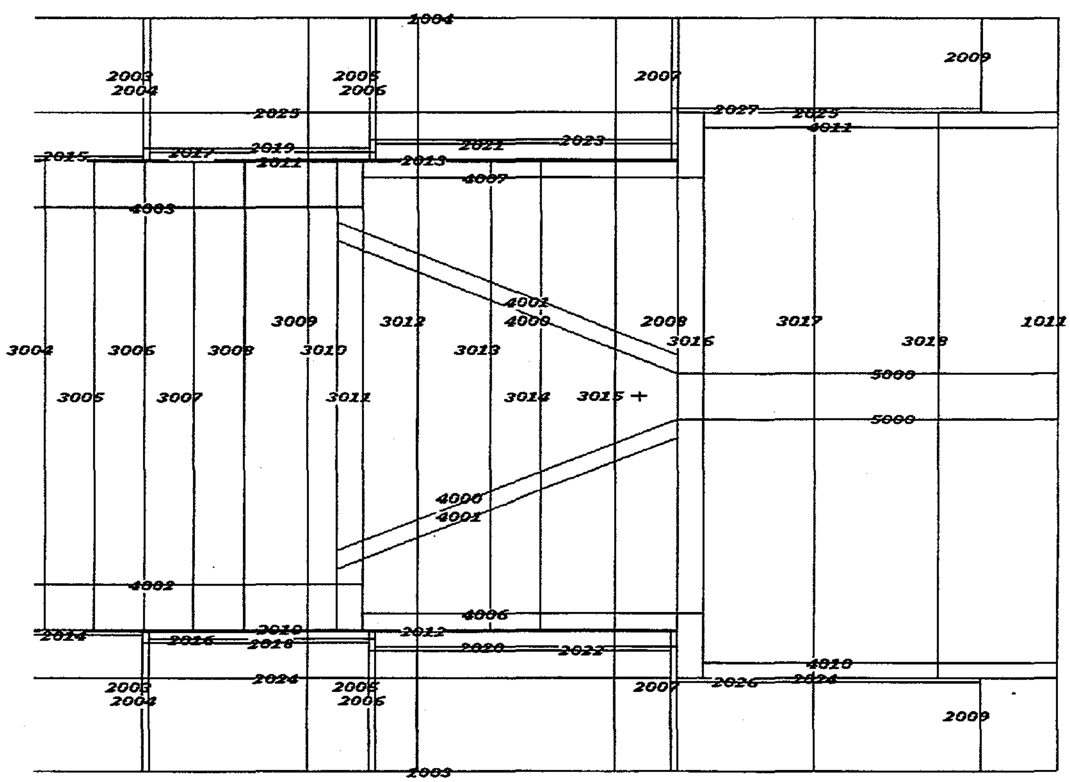
```
m11     82000.50c  1.0
c
c      Ordinary Concrete
m12      1001.50c    0.18667
         8016.50c    0.52127
        26000.55c    0.00247
         6000.50c    0.04788
        14000.50c    0.07579
        12000.50c    0.00738
        13027.50c    0.00924
        20000.50c    0.14549
        11023.50c    0.00381
c
c      Heavy Concrete
m13      1001.50c    0.10078
         8016.50c    0.55034
        25055.50c    0.00025
        26000.55c    0.19460
        14000.50c    0.01960
        12000.50c    0.01714
        16032.50c    0.00114
        20000.50c    0.03238
        24000.50c    0.00023
        15031.50c    0.00013
        22000.50c    0.08318
        23000.50c    0.00023
c
c      Al/Teflon
m14     13027.50c    0.5185
         3006.50c    0.0011
         3007.55c    0.0137
         6012.50c    0.1555
         9019.50c    0.3111
c
c      Aluminum Oxide (Al2O3)
m15     13027.50c  -0.5292
         8016.50c  -0.4708
c
c      Li(nat)-Poly
m17      1001.50c    0.5262
         8016.50c    0.1007
         6012.50c    0.2968
         3006.50c    0.0725
         3007.55c    0.0038
c
c      Bismuth
m18     83209.50c    1.0
c
c     *********************** TALLY SPECIFICATION CARDS *********************
c
c      Neutron Flux Over a 7.5cm(radius) Disk Along the Beam's Axial Centerline
f2:n     1002 1100 1101 1102 3000 3001 3002 2002 3003 3004 3005 3006 3007 3008 &
         3009 3010 3011 3012 3013 3014 3015 2008
fm2:n    7.53e16
fs2     -5000
sd2      (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)
fq2      f e
e2       4.14e-7  0.01  20
c
c      Neutron Current Over a 7.5cm(radius) Disk Along the Beam's Axial Centerline
f1:n     1002 1100 1101 1102 3000 3001 3002 2002 3003 3004 3005 3006 3007 3008 &
         3009 3010 3011 3012 3013 3014 3015 2008
fm1:n    7.53e16
```

```
fs1    -5000
sd1      (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
         (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)
fq1      f e
e1       4.14e-7  0.01  20
c
c     Neutron Current Over the Al/Teflon Filter Inlet and Outlet Face (121.92x121
f11:n    2002 3009
fm11:n  7.53e16
fs11     -4002 4003 -4004 4005
sd11      (1 1 1 1 1)  (1 1 1 1 1)
e11      4.14e-7  0.01  20
c
c     Neutron Dose rates at the Beam Aperature Exit (cGy/min)
f22:n  2008
fm22:n 7.53e16
fs22  -5000
sd22    (176.71 1)
fq22    f e
e22     4.14e-7  0.01  20
de22 .10000E-10     .10000E-06     .41399E-06     .87642E-06       .18554E-05
     .50435E-05     .10677E-04     .37267E-04     .10130E-03       .21445E-03
     .45400E-03     .15846E-02     .33546E-02     .71017E-02       .15034E-01
     .21875E-01     .24176E-01     .26058E-01     .31828E-01       .40868E-01
     .67379E-01     .11109E+00     .18316E+00     .29720E+00       .36883E+00
     .49787E+00     .60810E+00     .74274E+00     .82085E+00       .10026E+01
     .13534E+01     .16530E+01     .19205E+01     .22313E+01       .23457E+01
     .23653E+01     .24660E+01     .27253E+01     .30119E+01       .36788E+01
     .49659E+01     .60653E+01     .74682E+01     .86071E+01       .10000E+02
     .12214E+02     .14191E+02     .17333E+02
c
df22 .1E-20         .1E-20         .1E-20         .35220E-12       .80570E-12
     .19660E-11     .46200E-11     .13090E-10     .39370E-10       .92580E-10
     .19550E-09     .55320E-09     .13820E-08     .29910E-08       .60670E-08
     .99720E-08     .12200E-07     .13230E-07     .14940E-07       .18060E-07
     .24380E-07     .34870E-07     .47760E-07     .63230E-07       .75370E-07
     .85630E-07     .96160E-07     .10530E-06     .11350E-06       .12100E-06
     .13730E-06     .15330E-06     .16570E-06     .17750E-06       .18470E-06
     .18700E-06     .18910E-06     .19470E-06     .20240E-06       .21340E-06
     .23410E-06     .25160E-06     .26400E-06     .27390E-06       .28080E-06
     .28700E-06     .29200E-06     .29390E-06
c
c     Fine Energy Breakdown of Neutron Flux at Beam Exit Surface
c   f12:n  2008
c   fs12  -5000
c   sd12    (176.71 1)
c   fq12    e f
c   e12     1e-7  2e-7  3e-7  4e-7  5e-7  6e-7  7e-7  8e-7  9e-7 &
c        1e-6  2e-6  3e-6  4e-6  5e-6  6e-6  7e-6  8e-6  9e-6 &
c        1e-5  2e-5  3e-5  4e-5  5e-5  6e-5  7e-5  8e-5  9e-5 &
c        1e-4  2e-4  3e-4  4e-4  5e-4  6e-4  7e-4  8e-4  9e-4 &
c        1e-3  2e-3  3e-3  4e-3  5e-3  6e-3  7e-3  8e-3  9e-3 &
c        1e-2  2e-2  3e-2  4e-2  5e-2  6e-2  7e-2  8e-2  9e-2 &
c        1e-1  2e-1  3e-1  4e-1  5e-1  6e-1  7e-1  8e-1  9e-1 &
c        1     2     3     4     5     6     7     8     9    &
c        1e+1  2e+1  3e+1  4e+1  5e+1  6e+1  7e+1  8e+1  9e+1 &
c
c       Gamma Dose Rate (rem/hr) at Water Plug Surface
c  f62:p    2008
c  fs62    -5000
c  fm62     7.53e16
c  sd62     (176.71  1)
c       Flux-to-Dose Conversion Factors for Photons
c  de62     .01  .015  .02  .03  .04  .05  .06  .08  .1  .15  .2  .3  .4  &
```

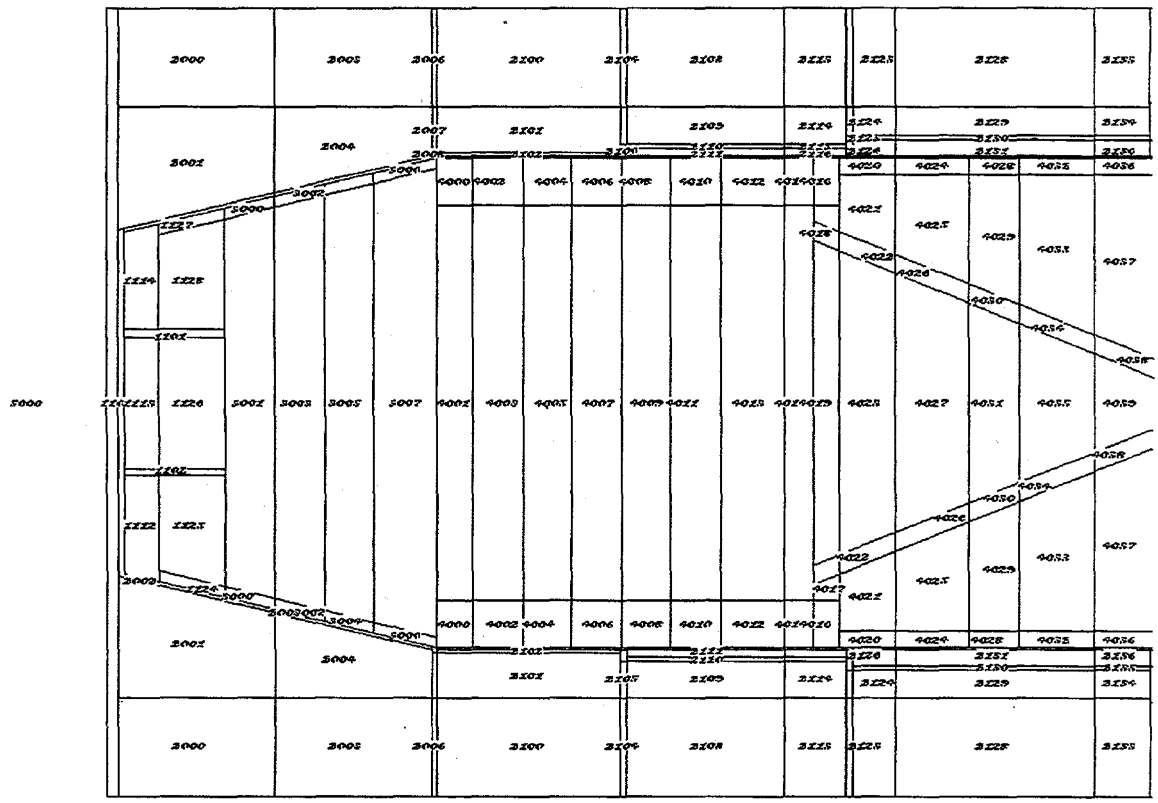
```
c         .5   .6   .8  1.0  1.5  2.0  3.0  4.0  5.0  6.0  8.0  10.0
c  df62     2.78e-6  1.11e-6  5.88e-7  2.56e-7  1.56e-7  1.20e-7  1.11e-7 &
c         1.20e-7  1.47e-7  2.38e-7  3.45e-7  5.56e-7  7.69e-7  9.09e-7 &
c         1.14e-6  1.47e-6  1.79e-6  2.44e-6  3.03e-6  4.00e-6  4.76e-6 &
c         5.56e-6  6.25e-6  7.69e-6  9.09e-6
c  fq62     f e
```

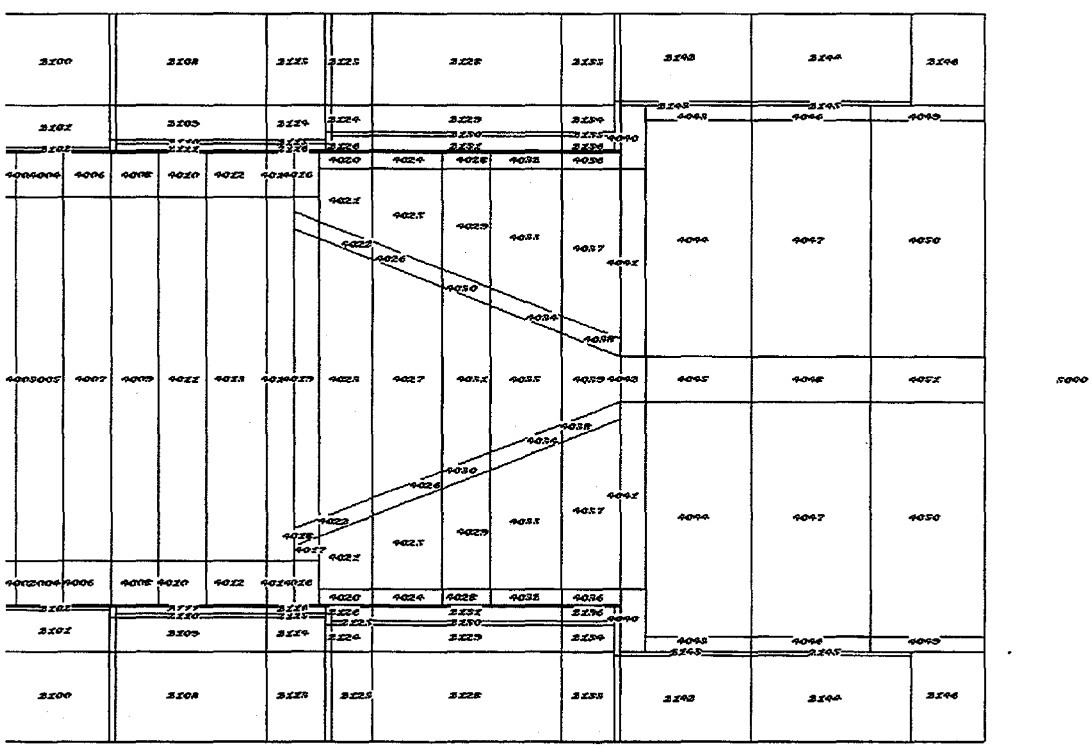
BSPT Model - Surface Diagram





BSPT Model - Cell Diagram





Appendix C

Combined Full Beam Model (CFB Model) Default Input File

This appendix includes the BSPT Model default input deck for the CFB Model. This Model may be useful as a check for the final beam design. Also, it may be needed to generate a Surface Source at the beam exit for use in analyzing the design of a treatment room facility.

```
MCNP4A - Washington State University Reactor Facility Beam Model
c        CELL CARDS
c
c     ***********************************************************
c     ************* Main Core Grid Cells **********************
c     ***********************************************************
c        Fill Each Main Grid Cell With the Appropriate Element:
c
c             11,21,31 - Standard Fuel Element
c             12,22,32 - FLIP Fuel Element
c             13,23,33 - Reflector Block
c             14,24,34 - Rotator Tube Element
c             15,25,35 - Transient Rod Element
c
c    ************** Region 1 - Use 11,12,13,14,15 **************
c       Row 1
12  0   2 -3 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
13  0   3 -4 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
14  0   4 -5 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
15  0   5 -6 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
16  0   6 -7 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
17  0   7 -8 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
18  0   8 -9 -11 12 -21 22 imp:n=1    imp:p=1    fill=13
c       Row 2
21  1   -1.0  1 -2 -12 121 -21 22 imp:n=1   imp:p=1  fill=
22  0   2 -3 -12 121 -21 22 imp:n=1   imp:p=1  fill=14
23  0   3 -4 -12 121 -21 22 imp:n=1   imp:p=1  fill=11
24  0   4 -5 -12 121 -21 22 imp:n=1   imp:p=1  fill=11
25  0   5 -6 -12 121 -21 22 imp:n=1   imp:p=1  fill=13
26  0   6 -7 -12 121 -21 22 imp:n=1   imp:p=1  fill=13
27  0   7 -8 -12 121 -21 22 imp:n=1   imp:p=1  fill=11
28  0   8 -9 -12 121 -21 22 imp:n=1   imp:p=1  fill=11
29  0   9 -10 -12 121 -21 22 imp:n=1   imp:p=1 fill=11
c
c    ************** Region 2 - Use 21,22,23,24,25 ***************
c       Row 3
31  1   -1.0   1 -2 -131 13 -21 22 imp:n=1   imp:p=1  fill=
32  0   2 -3   -131 13 -21 22 imp:n=1   imp:p=1  fill=24
33  0   3 -4   -131 13 -21 22 imp:n=1   imp:p=1  fill=21
34  0   4 -5   -131 13 -21 22 imp:n=1   imp:p=1  fill=22
35  0   5 -6   -131 13 -21 22 imp:n=1   imp:p=1  fill=22
36  0   6 -7   -131 13 -21 22 imp:n=1   imp:p=1  fill=22
37  0   7 -8   -131 13 -21 22 imp:n=1   imp:p=1  fill=22
38  0   8 -9   -131 13 -21 22 imp:n=1   imp:p=1  fill=21
39  0   9 -10 -131 13 -21 22 imp:n=1   imp:p=1  fill=21
c       Row 4
41  1   -1.0  1 -2   -13 14 -21 22 imp:n=1   imp:p 1  fill=
42  0   2 -3   -13 14 -21 22 imp:n=1   imp:p 1  fill=24
43  0   3 -4   -13 14 -21 22 imp:n=1   imp:p 1  fill=21
44  0   4 -5   -13 14 -21 22 imp:n=1   imp:p 1  fill=22
45  0   5 -6   -13 14 -21 22 imp:n=1   imp:p 1  fill=22
46  0   6 -7   -13 14 -21 22 imp:n=1   imp:p 1  fill=25
47  0   7 -8   -13 14 -21 22 imp:n=1   imp:p 1  fill=22
48  0   8 -9   -13 14 -21 22 imp:n=1   imp:p 1  fill=22
49  0   9 -10 -13 14 -21 22 imp:n=1   imp:p 1  fill=21
c       Row 5
51  1   -1.0  1 -2   -14 141 -21 22 imp:n=1   imp:p=1  fill=
52  0   2 -3   -14 141 -21 22 imp:n=1   imp:p=1  fill=24
53  0   3 -4   -14 141 -21 22 imp:n=1   imp:p=1  fill=21
54  0   4 -5   -14 141 -21 22 imp:n=1   imp:p=1  fill=22
55  0   5 -6   -14 141 -21 22 imp:n=1   imp:p=1  fill=22
56  0   6 -7   -14 141 -21 22 imp:n=1   imp:p=1  fill=22
57  0   7 -8   -14 141 -21 22 imp:n=1   imp:p=1  fill=22
58  0   8 -9   -14 141 -21 22 imp:n=1   imp:p=1  fill=21
59  0   9 -10 -14 141 -21 22 imp:n=1   imp:p=1  fill=21
c
```

```
c    ************ Region 3- Use 31,32,33,34,35 ****************
c         Row 6
61   0   1 -2   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
62   0   2 -3   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
63   0   3 -4   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
64   0   4 -5   -151 15 -21 22 imp:n=1    imp:p=1   fill=31
65   0   5 -6   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
66   0   6 -7   -151 15 -21 22 imp:n=1    imp:p=1   fill=33
67   0   7 -8   -151 15 -21 22 imp:n=1    imp:p=1   fill=31
68   0   8 -9   -151 15 -21 22 imp:n=1    imp:p=1   fill=31
69   0   9 -10 -151 15 -21 22 imp:n=1    imp:p=1   fill=31
c         Row 7
72   0   2 -3 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
73   0   3 -4 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
74   0   4 -5 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
75   0   5 -6 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
76   0   6 -7 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
77   0   7 -8 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
78   0   8 -9 -15 16 -21 22 imp:n=1    imp:p=1   fill=33
c
c     ****************** Corner Grid Elements *****************
c
c          Row 1
11    2    0.06020   (31 -2 -33 12 -21 22) (-927:928:931:-932) imp:n=1 imp:p=1
711  1   -1.0   927 -928 -931 932 -21 22                       imp:n=1 imp:p=1
c
19    2    0.06020   (9 -32 -33 12 -21 22) (-929:930:931:-932) imp:n=1 imp:p=1
719  1   -1.0   929 -930 -931 932 -21 22                       imp:n=1 imp:p=1
c          Row 7
71    2    0.06020   (31 -2 -15 34 -21 22) (-927:928:933:-934) imp:n=1 imp:p=1
771  1   -1.0   927 -928 -933 934 -21 22                       imp:n=1 imp:p=1
c
79    2    0.06020   (9 -32 -15 34 -21 22) (-929:930:933:-934) imp:n=1 imp:p=1
779  1   -1.0   929 -930 -933 934 -21 22                       imp:n=1 imp:p=1
c
c     ****************** Control Region Elements ***************
c
c          Guides
100   2 0.06020     1 -101 -121 131 -21 22 imp:n=1   imp:p=1
101   2 0.06020   101 -102 -121 111 -21 22 imp:n=1   imp:p=1
102   2 0.06020   101 -102 -112 131 -21 22 imp:n=1   imp:p=1
103   2 0.06020   102 -103 -121 131 -21 22 imp:n=1   imp:p=1
104   2 0.06020   103 -104 -121 111 -21 22 imp:n=1   imp:p=1
105   2 0.06020   103 -104 -112 131 -21 22 imp:n=1   imp:p=1
106   2 0.06020   104 -10  -121 131 -21 22 imp:n=1   imp:p=1
c
107   2 0.06020     1 -101 -141 151 -21 22 imp:n=1   imp:p=1
108   2 0.06020   101 -102 -141 113 -21 22 imp:n=1   imp:p=1
109   2 0.06020   101 -102 -114 151 -21 22 imp:n=1   imp:p=1
110   2 0.06020   102 -103 -141 151 -21 22 imp:n=1   imp:p=1
111   2 0.06020   103 -104 -141 113 -21 22 imp:n=1   imp:p=1
112   2 0.06020   103 -104 -114 151 -21 22 imp:n=1   imp:p=1
113   2 0.06020   104 -10  -141 151 -21 22 imp:n=1   imp:p=1
c          Control Blades - Upper Region
201   5 0.08881   101 -102 -111 112 -21 201  imp:n=1   imp:p=1
202   5 0.08881   103 -104 -111 112 -21 202  imp:n=1   imp:p=1
203   3 0.08647   101 -102 -113 114 -21 203  imp:n=1   imp:p=1
204   5 0.08881   103 -104 -113 114 -21 204  imp:n=1   imp:p=1
c          Control Blades - Lower Water Gap Region
211   1 -1.0   101 -102 -111 112 -201 22  imp:n=1  imp:p=1
212   1 -1.0   103 -104 -111 112 -202 22  imp:n=1  imp:p=1
213   1 -1.0   101 -102 -113 114 -203 22  imp:n=1  imp:p=1
214   1 -1.0   103 -104 -113 114 -204 22  imp:n=1  imp:p=1
c
c     ************** Core Grid Lattices ********************
c
```

```
c        Standard Element Lattices - Region 1,2,3
801  0   900 -901 902 -903 imp:n=1 imp:p=1 lat=1 u=21 fill=1
802  like 801 but   trcl=( 0  2.54  0)           u=11
803  like 801 but   trcl=( 0 -2.54  0)           u=31
c
c        FLIP Element Lattices - Region 1,2,3
804  like 801 but                                u=22 fill=2
805  like 804 but   trcl=( 0  2.54  0)           u=12
806  like 804 but   trcl=( 0 -2.54  0)           u=32
c
c        Graphite Element Lattices - Region 1,2,3
807  like 801 but                                u=23 fill=3
808  like 807 but   trcl=( 0  2.54  0)           u=13
809  like 807 but   trcl=( 0 -2.54  0)           u=33
c
c        Rotator Tube Lattices - Region 1,2,3
810  like 801 but                                u=24 fill=4
811  like 810 but   trcl=( 0  2.54  0)           u=14
812  like 810 but   trcl=( 0 -2.54  0)           u=34
c
c        Transient Rod Element Lattices - Region 1,2,3
813  like 801 but                                u=25 fill=5
814  like 813 but   trcl=( 0  2.54  0)           u=15
815  like 814 but   trcl=( 0 -2.54  0)           u=35
c
c      ************* Universe Element Cells ****************
c
c        Standard Element
c
901  6  0.09344  -909 -905 +906      imp:n=1 imp:p=1 u=1
902  4  -1.6     -909  905 -904      imp:n=1 imp:p=1 u=1
903  4  -1.6     -909 -906 +907      imp:n=1 imp:p=1 u=1
904  8  0.09532  -910  904           imp:n=1 imp:p=1 u=1
905  3  0.08647  -910 -907  908      imp:n=1 imp:p=1 u=1
906  9  0.08293  -910 -908           imp:n=1 imp:p=1 u=1
907  3  0.08647   909 -910 -904 907  imp:n=1 imp:p=1 u=1
c
908  6  0.09344  -911 -905 +906      imp:n=1 imp:p=1 u=1
909  4  -1.6     -911  905 -904      imp:n=1 imp:p=1 u=1
910  4  -1.6     -911 -906 +907      imp:n=1 imp:p=1 u=1
911  8  0.09532  -912  904           imp:n=1 imp:p=1 u=1
912  3  0.08647  -912 -907  908      imp:n=1 imp:p=1 u=1
913  9  0.08293  -912 -908           imp:n=1 imp:p=1 u=1
914  3  0.08647   911 -912 -904 907  imp:n=1 imp:p=1 u=1
c
915  6  0.09344  -913 -905 +906      imp:n=1 imp:p=1 u=1
916  4  -1.6     -913  905 -904      imp:n=1 imp:p=1 u=1
917  4  -1.6     -913 -906 +907      imp:n=1 imp:p=1 u=1
918  8  0.09532  -914  904           imp:n=1 imp:p=1 u=1
919  3  0.08647  -914 -907  908      imp:n=1 imp:p=1 u=1
920  9  0.08293  -914 -908           imp:n=1 imp:p=1 u=1
921  3  0.08647   913 -914 -904 907  imp:n=1 imp:p=1 u=1
c
922  6  0.09344  -915 -905 +906      imp:n=1 imp:p=1 u=1
923  4  -1.6     -915  905 -904      imp:n=1 imp:p=1 u=1
924  4  -1.6     -915 -906 +907      imp:n=1 imp:p=1 u=1
925  8  0.09532  -916  904           imp:n=1 imp:p=1 u=1
926  3  0.08647  -916 -907  908      imp:n=1 imp:p=1 u=1
927  9  0.08293  -916 -908           imp:n=1 imp:p=1 u=1
928  3  0.08647   915 -916 -904 907  imp:n=1 imp:p=1 u=1
c
929  1  -1.0      910 912 914 916    imp:n=1 imp:p=1 u=1
c
c        FLIP Element
c
930  7  0.09016  -909 -905 +906      imp:n=1 imp:p=1 u=2
```

```
931  4  -1.6      -909  905 -904      imp:n=1 imp:p=1 u=2
932  4  -1.6      -909 -906 +907      imp:n=1 imp:p=1 u=2
933  8  0.09532   -910  904           imp:n=1 imp:p=1 u=2
934  3  0.08647   -910 -907  908      imp:n=1 imp:p=1 u=2
935  9  0.08293   -910 -908           imp:n=1 imp:p=1 u=2
936  3  0.08647    909 -910 -904 907  imp:n=1 imp:p=1 u=2
c
937  7  0.09016   -911 -905 +906      imp:n=1 imp:p=1 u=2
938  4  -1.6      -911  905 -904      imp:n=1 imp:p=1 u=2
939  4  -1.6      -911 -906 +907      imp:n=1 imp:p=1 u=2
940  8  0.09532   -912  904           imp:n=1 imp:p=1 u=2
941  3  0.08647   -912 -907 908       imp:n=1 imp:p=1 u=2
942  9  0.08293   -912 -908           imp:n=1 imp:p=1 u=2
943  3  0.08647    911 -912 -904 907  imp:n=1 imp:p=1 u=2
c
944  7  0.09016   -913 -905 +906      imp:n=1 imp:p=1 u=2
945  4  -1.6      -913  905 -904      imp:n=1 imp:p=1 u=2
946  4  -1.6      -913 -906 +907      imp:n=1 imp:p=1 u=2
947  8  0.09532   -914  904           imp:n=1 imp:p=1 u=2
948  3  0.08647   -914 -907 908       imp:n=1 imp:p=1 u=2
949  9  0.08293   -914 -908           imp:n=1 imp:p=1 u=2
950  3  0.08647    913 -914 -904 907  imp:n=1 imp:p=1 u=2
c
951  7  0.09016   -915 -905 +906      imp:n=1 imp:p=1 u=2
952  4  -1.6      -915  905 -904      imp:n=1 imp:p=1 u=2
953  4  -1.6      -915 -906 +907      imp:n=1 imp:p=1 u=2
954  8  0.09532   -916  904           imp:n=1 imp:p=1 u=2
955  3  0.08647   -916 -907 908       imp:n=1 imp:p=1 u=2
956  9  0.08293   -916 -908           imp:n=1 imp:p=1 u=2
957  3  0.08647    915 -916 -904 907  imp:n=1 imp:p=1 u=2
c
958  1  -1.0       910 912 914 916    imp:n=1 imp:p=1 u=2
c
c       Graphite Reflector Element
c
959  4  -1.6        (917 -918 919 -920) -904 908    imp:n=1 imp:p=1 u=3
960  2   0.06020   (-917:918:-919:920) -904 908    imp:n=1 imp:p=1 u=3
961  8   0.09532     904                            imp:n=1 imp:p=1 u=3
962  9   0.08293    -908                            imp:n=1 imp:p=1 u=3
c
c       Rotator Tube Element
c
963  2  0.06020    -924 923 921         imp:n=1 imp:p=1 u=4
964  1  -1.0       -923 921             imp:n=1 imp:p=1 u=4
965  2  0.06020    -924 -921 922        imp:n=1 imp:p=1 u=4
966  2  0.06020    -926 925 -922        imp:n=1 imp:p=1 u=4
967  1  -1.0       -925 -922            imp:n=1 imp:p=1 u=4
c
968  1  -1.0        926 -922            imp:n=1 imp:p=1 u=4
969  1  -1.0        924  922            imp:n=1 imp:p=1 u=4
c
c       Transient Rod Element
c
970  2  0.04816   -936  935  907      imp:n=1 imp:p=1 u=5
971  10 0.13848   -935  205           imp:n=1 imp:p=1 u=5
972  1  -1.0      -935 -205  907      imp:n=1 imp:p=1 u=5
973  9  0.08293   -936 -907           imp:n=1 imp:p=1 u=5
c
974  7  0.09016   -911 -905 +906      imp:n=1 imp:p=1 u=5
975  4  -1.6      -911  905 -904      imp:n=1 imp:p=1 u=5
976  4  -1.6      -911 -906 +907      imp:n=1 imp:p=1 u=5
977  8  0.09532   -912  904           imp:n=1 imp:p=1 u=5
978  3  0.08647   -912 -907 908       imp:n=1 imp:p=1 u=5
979  9  0.08293   -912 -908           imp:n=1 imp:p=1 u=5
980  3  0.08647    911 -912 -904 907  imp:n=1 imp:p=1 u=5
c
```

```
981  7  0.09016   -913 -905 +906      imp:n=1 imp:p=1 u=5
982  4  -1.6      -913  905 -904      imp:n=1 imp:p=1 u=5
983  4  -1.6      -913 -906 +907      imp:n=1 imp:p=1 u=5
984  8  0.09532   -914  904           imp:n=1 imp:p=1 u=5
985  3  0.08647   -914 -907 908       imp:n=1 imp:p=1 u=5
986  9  0.08293   -914 -908           imp:n=1 imp:p=1 u=5
987  3  0.08647    913 -914 -904 907  imp:n=1 imp:p=1 u=5
c
988  7  0.09016   -909 -905 +906      imp:n=1 imp:p=1 u=5
989  4  -1.6      -909  905 -904      imp:n=1 imp:p=1 u=5
990  4  -1.6      -909 -906 +907      imp:n=1 imp:p=1 u=5
991  8  0.09532   -910  904           imp:n=1 imp:p=1 u=5
992  3  0.08647   -910 -907 908       imp:n=1 imp:p=1 u=5
993  9  0.08293   -910 -908           imp:n=1 imp:p=1 u=5
994  3  0.08647    909 -910 -904 907  imp:n=1 imp:p=1 u=5
c
995  1  -1.0       936 912 914 910    imp:n=1 imp:p=1 u=5
c
c    *******************************************************
c    ***************** Beamport Cells **********************
c    *******************************************************
c
c    ************ Core Side Water Region ********************
c
1000  1 -1.0  31 -1 -12 15 -21 22  imp:n=1  imp:p=1
1001  1 -1.0  10 -32 -12 15 -21 22 imp:n=1  imp:p=1
c
1002  1 -1.0      2 -8 11 -33 -21 22  imp:n=1 imp:p=1
1003  1 -1.0      8 -9 11 -33 -21 22  imp:n=1 imp:p=1    $ Pb Box
c
1004  1 -1.0      2 -8 -16 34 -21 22  imp:n=1 imp:p=1
1005  1 -1.0      8 -9 -16 34 -21 22  imp:n=1 imp:p=1    $ Pb Box
c
c    ****************** Water Box Cells ********************
c
1006  1 -1.0  (-31:32:33:-34:21:-22) (1001 -8 1005 -1006 1009 -1010) &
      imp:n=1 imp:p=1
1007  1 -1.0  1001 -1002 1003 -1004 1007 -1008 (-1005:1006:-1009:1010) &
      imp:n=0.25 imp:p=0.25
1008  1 -1.0   (5002:-5003:21:-22) 8 -1002 1005 -1006 1009 -1010  &
      imp:n=1 imp:p=1
1009  1 -1.0   32 -1002 -33 34 -21 22  imp:n=1 imp:p=1
c
1010  1 -1.0   8 -1002 33 -5002 -21 22 imp:n=1 imp:p=1  $ Pb Box
1011  1 -1.0   8 -1002 -34 5003 -21 22 imp:n=1 imp:p=1  $ Pb Box
c
c    ********* Aluminum Cone Grid & Lead Thermal Shield ******
c     Aluminum Grid
1100  2 0.06020  1002 -1100 -1999                      imp:n=2 imp:p=2
c
1101  2 0.06020  1100 -1102 -2000 -1103 1104           imp:n=2 imp:p=2
1102  2 0.06020  1100 -1102 -2000 -1105 1106           imp:n=2 imp:p=2
c
1103  2 0.06020  1100 -1102 -1107 1108 -1106 -2000 imp:n=2 imp:p=2
1104  2 0.06020  1100 -1102 -1107 1108 -1104  1105 imp:n=2 imp:p=2
1105  2 0.06020  1100 -1102 -1107 1108  1103 -2000 imp:n=2 imp:p=2
c
1106  2 0.06020  1100 -1102 -1109 1110 -1106 -2000 imp:n=2 imp:p=2
1107  2 0.06020  1100 -1102 -1109 1110 -1104  1105 imp:n=2 imp:p=2
1108  2 0.06020  1100 -1102 -1109 1110  1103 -2000 imp:n=2 imp:p=2
c     Lead Thermal Shield
1109  11 0.03298 1100 -1101 -1106 1107 -2000       imp:n=2 imp:p=2
1110  11 0.03298 1100 -1101 -1104 1105  1107 -2000 imp:n=2 imp:p=2
1111  11 0.03298 1100 -1101  1103 1107 -2000       imp:n=2 imp:p=2
c
1112  11 0.03298 1100 -1101 -1108 1109 -1106 -2000 imp:n=2 imp:p=2
```

```
1113  11 0.03298 1100 -1101 -1108 1109 -1104  1105 imp:n=2 imp:p=2
1114  11 0.03298 1100 -1101 -1108 1109  1103 -2000 imp:n=2 imp:p=2
c
1115  11 0.03298 1100 -1101 -1106 -1110 -2000      imp:n=2 imp:p=2
1116  11 0.03298 1100 -1101 -1104 1105 -1110 -2000 imp:n=2 imp:p=2
1117  11 0.03298 1100 -1101  1103 -1110 -2000      imp:n=2 imp:p=2
c     Void Region
1118  0            1101 -1102 -1106 1107 -2000  5001      imp:n=2 imp:p=2 $Rf
1119  0            1101 -1102 -1106 1107 -5001            imp:n=2 imp:p=2
1120  0            1101 -1102 -1104 1105  1107 -2000 5001 imp:n=2 imp:p=2 $Rf
1121  0            1101 -1102 -1104 1105  1107 -5001      imp:n=2 imp:p=2
1122  0            1101 -1102  1103 1107 -2000  5001      imp:n=2 imp:p=2 $Rf
1123  0            1101 -1102  1103 1107 -5001            imp:n=2 imp:p=2
c
1124  0            1101 -1102 -1108 1109 -1106 -2000 5001 imp:n=2 imp:p=2 $Rf
1125  0            1101 -1102 -1108 1109 -1106 -5001      imp:n=2 imp:p=2
1126  0            1101 -1102 -1108 1109 -1104  1105      imp:n=2 imp:p=2
1127  0            1101 -1102 -1108 1109  1103 -2000 5001 imp:n=2 imp:p=2 $Rf
1128  0            1101 -1102 -1108 1109  1103 -5001      imp:n=2 imp:p=2
c
1129  0  1101 -1102 -1106 -1110 -2000 5001      imp:n=2 imp:p=2 $Rf
1130  0            1101 -1102 -1106 -1110 -5001           imp:n=2 imp:p=2
1131  0  1101 -1102 -1104 1105 -1110 -2000 5001 imp:n=2 imp:p=2 $Rf
1132  0            1101 -1102 -1104 1105 -1110 -5001      imp:n=2 imp:p=2
1133  0  1101 -1102  1103 -1110 -2000 5001      imp:n=2 imp:p=2 $Rf
1134  0            1101 -1102  1103 -1110 -5001           imp:n=2 imp:p=2
c
c    ******************** Conical Region Cells ***************
c
2000  1 -1.0      1002 -3000 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=0.75 imp:p=0.75
2001  1 -1.0      1002 -3000 2024 -2025 2042 -2043 1999     imp:n=2 imp:p=2
2002  2 0.06020   1100 -3000 2000 -1999                     imp:n=2 imp:p=2
c
c
2003  1 -1.0      3000 -2001 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=0.75 imp:p=0.75
2004  1 -1.0      3000 -2001 2024 -2025 2042 -2043 1999     imp:n=3 imp:p=3
2005  2 0.06020   3000 -2001 2000 -1999                     imp:n=3 imp:p=3
c
c
2006  1 -1.0  2001 -2002 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=0.75 imp:p=0.75
2007  1 -1.0  2001 -2002 2024 -2025 2042 -2043 (-2014:2015:-2032:2033) &
     imp:n=3 imp:p=3
2008  2 0.06020  2001 -2002 2014 -2015 2032 -2033 2000      imp:n=3 imp:p=3
c
c    ****************** Boral Lined Region Cells *************
c
2100 12  0.07965  2002 -2003 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=3 imp:p=3
2101 12  0.07965  2002 -2003 2024 -2025 2042 -2043 (-2014:2015:-2032:2033) &
      imp:n=9 imp:p=9
2102 3   0.08647  2002 -2003 2014 -2015 2032 -2033 (-2012:2013:-2030:2031) &
      imp:n=9 imp:p=9
2103 5   0.08881  2002 -2003 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=9 imp:p=9
c
c
2104 12  0.07965  2003 -2004 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=3 imp:p=3
2105 12  0.07965  2003 -2004 2024 -2025 2042 -2043 (-2018:2019:-2036:2037) &
      imp:n=9 imp:p=9
2106 3   0.08647  2003 -2004 2018 -2019 2036 -2037 (-2012:2013:-2030:2031) &
      imp:n=9 imp:p=9
2107 5   0.08881  2003 -2004 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
```

```
      imp:n=9 imp:p=9
c
c
2108 12  0.07965  2004 -3009 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=9 imp:p=9
2109 12  0.07965  2004 -3009 2024 -2025 2042 -2043 (-2018:2019:-2036:2037) &
      imp:n=60 imp:p=60
2110 3   0.08647  2004 -3009 2018 -2019 2036 -2037 (-2016:2017:-2034:2035) &
      imp:n=60 imp:p=60
2111 11  0.03298  2004 -3009 2016 -2017 2034 -2035 (-2012:2013:-2030:2031) &
      imp:n=60 imp:p=60
2112 5   0.08881  2004 -3009 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=60 imp:p=60
c
2113 12  0.07965  3009 -2005 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=48 imp:p=48
2114 12  0.07965  3009 -2005 2024 -2025 2042 -2043 (-2018:2019:-2036:2037) &
      imp:n=192 imp:p=192
2115 3   0.08647  3009 -2005 2018 -2019 2036 -2037 (-2016:2017:-2034:2035) &
      imp:n=192 imp:p=192
2116 11  0.03298  3009 -2005 2016 -2017 2034 -2035 (-2012:2013:-2030:2031) &
      imp:n=192 imp:p=192
2117 5   0.08881  3009 -2005 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=192 imp:p=192
c
c
2118 13  0.08050  2005 -2006 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=48 imp:p=48
2119 13  0.08050  2005 -2006 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
      imp:n=192 imp:p=192
2120 3   0.08647  2005 -2006 2022 -2023 2040 -2041 (-2016:2017:-2034:2035) &
      imp:n=192 imp:p=192
2121 11  0.03298  2005 -2006 2016 -2017 2034 -2035 (-2012:2013:-2030:2031) &
      imp:n=192 imp:p=192
2122 5   0.08881  2005 -2006 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=192 imp:p=192
c
c
2123 13  0.08050  2006 -3012 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=48 imp:p=48
2124 13  0.08050  2006 -3012 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
      imp:n=192 imp:p=192
2125 3   0.08647  2006 -3012 2022 -2023 2040 -2041 (-2020:2021:-2038:2039) &
      imp:n=192 imp:p=192
2126 11  0.03298  2006 -3012 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
      imp:n=192 imp:p=192
2127 5   0.08881  2006 -3012 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=192 imp:p=192
c
2128 13  0.08050  3012 -3015 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=96 imp:p=96
2129 13  0.08050  3012 -3015 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
      imp:n=384 imp:p=384
2130 3   0.08647  3012 -3015 2022 -2023 2040 -2041 (-2020:2021:-2038:2039) &
      imp:n=384 imp:p=384
2131 11  0.03298  3012 -3015 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
      imp:n=384 imp:p=384
2132 5   0.08881  3012 -3015 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
      imp:n=384 imp:p=384
c
2133 13  0.08050  3015 -2007 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
      imp:n=96 imp:p=96
2134 13  0.08050  3015 -2007 2024 -2025 2042 -2043 (-2022:2023:-2040:2041) &
      imp:n=384 imp:p=384
2135 3   0.08647  3015 -2007 2022 -2023 2040 -2041 (-2020:2021:-2038:2039) &
      imp:n=384 imp:p=384
```

```
2136 11  0.03298  3015 -2007 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
     imp:n=384 imp:p=384
2137 5   0.08881  3015 -2007 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
     imp:n=384 imp:p=384
c
c
2138 13  0.08050  2007 -2008 1003 -1004 1007 -1008 (-2026:2027:-2044:2045) &
     imp:n=96 imp:p=96
2139 3   0.08647  2007 -2008 2026 -2027 2044 -2045 (-2020:2021:-2038:2039) &
     imp:n=384 imp:p=384
2140 11  0.03298  2007 -2008 2020 -2021 2038 -2039 (-2012:2013:-2030:2031) &
     imp:n=384 imp:p=384
2141 5   0.08881  2007 -2008 2012 -2013 2030 -2031 (-2010:2011:-2028:2029) &
     imp:n=384 imp:p=384
c
c    ********************** End Region Cells ****************************
c
2142 13  0.08050  2008 -3017 1003 -1004 1007 -1008 (-2026:2027:-2044:2045) &
     imp:n=96 imp:p=96
2143 3   0.08647  2008 -3017 2026 -2027 2044 -2045 (-2024:2025:-2042:2043) &
     imp:n=384 imp:p=384
c
2144 13  0.08050  3017 -2009 1003 -1004 1007 -1008 (-2026:2027:-2044:2045) &
     imp:n=96 imp:p=96
2145 3   0.08647  3017 -2009 2026 -2027 2044 -2045 (-2024:2025:-2042:2043) &
     imp:n=96 imp:p=96
c
2146 13  0.08050  2009 -1011 1003 -1004 1007 -1008 (-2024:2025:-2042:2043) &
     imp:n=24 imp:p=24
c
c    ******************* Inner Beam Cells ******************
c
3000  0           1102 -3000 -2000  5001                 imp:n=4 imp:p=4 $Rf
3001  0           1102 -3000 -5001                       imp:n=4 imp:p=4
c
3002  0           3000 -3001 -2000  5001                 imp:n=6 imp:p=6 $Rf
3003  0           3000 -3001 -5001                       imp:n=6 imp:p=6
c
3004  0           3001 -3002 -2000  5001                 imp:n=6 imp:p=6 $Rf
3005  0           3001 -3002 -5001                       imp:n=6 imp:p=6
c
3006   0          3002 -2002 -2000  5001                  imp:n=6 imp:p=6 $Rf
3007   0          3002 -2002 -5001                        imp:n=6 imp:p=6
c
c    Filter Region of Inner Beam
c
4000  15   -3.97     2002 -3003 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
      imp:n=6 imp:p=6
4001  14  0.06970    2002 -3003 4002 -4003 4004 -4005
      imp:n=12 imp:p=12
c
4002  15   -3.97     3003 -3004 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
      imp:n=12 imp:p=12
4003  14  0.06970    3003 -3004 4002 -4003 4004 -4005
      imp:n=24 imp:p=24
c
4004  15   -3.97     3004 -3005 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
      imp:n=24 imp:p=24
4005  14  0.06970    3004 -3005 4002 -4003 4004 -4005
      imp:n=48 imp:p=48
c
4006  15   -3.97     3005 -3006 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
      imp:n=48 imp:p=48
4007  14  0.06970    3005 -3006 4002 -4003 4004 -4005
      imp:n=96 imp:p=96
c
```

```
4008   15    -3.97       3006 -3007 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
        imp:n=96 imp:p=96
4009   14  0.06970       3006 -3007 4002 -4003 4004 -4005
        imp:n=192 imp:p=192
c
4010   15    -3.97       3007 -3008 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
        imp:n=192 imp:p=192
4011   14  0.06970       3007 -3008 4002 -4003 4004 -4005
        imp:n=384 imp:p=384
c
4012   15    -3.97       3008 -3009 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
        imp:n=384 imp:p=384
4013   14  0.06970       3008 -3009 4002 -4003 4004 -4005
        imp:n=768 imp:p=768
c
4014   11  0.03298       3009 -3010 2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
        imp:n=768 imp:p=768
4015   11  0.03298       3009 -3010 4002 -4003 4004 -4005
        imp:n=1536 imp:p=1536
c
c
c
4016   17   0.10351    3010 -3011  2010 -2011 2028 -2029 (-4002:4003:-4004:4005) &
               imp:n=768 imp:p=768
4017   17   0.10351    3010 -3011  4002 -4003 4004 -4005 4001                      &
               imp:n=768 imp:p=768
4018   17   0.10351    3010 -3011  4000 -4001          imp:n=768 imp:p=768
4019   0               3010 -3011 -4000                imp:n=1536 imp:p=1536
c
4020   17   0.10351    3011 -3012  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                             imp:n=192 imp:p=192
4021   0              3011 -3012  4006 -4007 4008 -4009 4001 imp:n=384 imp:p=384
4022   17   0.10351    3011 -3012  4000 -4001                  imp:n=768 imp:p=768
4023   0               3011 -3012 -4000                      imp:n=1536 imp:p=1536
c
4024   17   0.10351    3012 -3013  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                             imp:n=384 imp:p=384
4025   0              3012 -3013  4006 -4007 4008 -4009 4001 imp:n=576 imp:p=576
4026   17   0.10351    3012 -3013  4000 -4001                  imp:n=1152 imp:p=1152
4027   0               3012 -3013 -4000                      imp:n=2304 imp:p=2304
c
4028   17   0.10351    3013 -3014  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                             imp:n=384 imp:p=384
4029   0              3013 -3014  4006 -4007 4008 -4009 4001 imp:n=768 imp:p=768
4030   17   0.10351    3013 -3014  4000 -4001                  imp:n=1536 imp:p=1536
4031   0               3013 -3014 -4000                      imp:n=3072 imp:p=3072
c
4032   17   0.10351    3014 -3015  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                             imp:n=384 imp:p=384
4033   0              3014 -3015  4006 -4007 4008 -4009 4001 imp:n=1152 imp:p=1152
4034   17   0.10351    3014 -3015  4000 -4001                  imp:n=2304 imp:p=2304
4035   0               3014 -3015 -4000                      imp:n=4608 imp:p=4608
c
4036   17   0.10351    3015 -2008  2010 -2011 2028 -2029 (-4006:4007:-4008:4009) &
                                                             imp:n=384 imp:p=384
4037   0              3015 -2008  4006 -4007 4008 -4009 4001 imp:n=1536 imp:p=1536
4038   17   0.10351    3015 -2008  4000 -4001                  imp:n=3072 imp:p=3072
4039   0               3015 -2008 -4000                      imp:n=6144 imp:p=6144
c
c      End Region
c
4040   17 0.10351   2008 -3016  2024 -2025 2042 -2043 (-4006:4007:-4008:4009)    &
                                                             imp:n=384 imp:p=384
4041   0            2008 -3016  4006 -4007 4008 -4009 5000 imp:n=1536 imp:p=1536
4042   0            2008 -3016 -5000                       imp:n=6144 imp:p=6144
c
```

```
4043  17  0.10351 3016 -3017  2024 -2025 2042 -2043 (-4010:4011:-4012:4013)    &
                                                      imp:n=384 imp:p=384
4044  0           3016 -3017  4010 -4011 4012 -4013 5000 imp:n=1536 imp:p=1536
4045  0           3016 -3017 -5000                       imp:n=6144 imp:p=6144
c
4046  17  0.10351 3017 -3018  2024 -2025 2042 -2043 (-4010:4011:-4012:4013)    &
                                                      imp:n=96 imp:p=96
4047  0           3017 -3018  4010 -4011 4012 -4013 5000 imp:n=384 imp:p=384
4048  0           3017 -3018 -5000                       imp:n=1536 imp:p=1536
c
4049  17  0.10351 3018 -1011  2024 -2025 2042 -2043 (-4010:4011:-4012:4013)    &
                                                      imp:n=24 imp:p=24
4050  0           3018 -1011  4010 -4011 4012 -4013 5000 imp:n=96 imp:p=96
4051  0           3018 -1011 -5000                       imp:n=384 imp:p=384
c
c    ************** Outside World Void Region ************
c
5000 0          -1001:1011:-1003:1004:-1007:1008   imp:n=0 imp:p=0
c

c    *******************************************************
c    **************** Core Surface Cards *****************
c    *******************************************************
c
c        Core Grid Definition Surfaces (X-Axis)
c
c        Main Grid
1    px  -34.29
2    px  -26.67
3    px  -19.05
4    px  -11.43
5    px   -3.81
6    px    3.81
7    px   11.43
8    px   19.05
9    px   26.67
10   px   34.29
c        Corner Elements
31   px  -36.83
32   px   36.83
c        Control Plates
101  px  -28.311
102  px   -1.26
103  px    1.26
104  px   28.311
c
c        Core Definition Surfaces (Y-Axis)
c
c        Main Grid
11   py   29.21
12   py   21.59
121  py   13.97
131  py   11.43
13   py    3.81
14   py   -3.81
141  py  -11.43
151  py  -13.97
15   py  -21.59
16   py  -29.21
c        Corner Elements
33   py   31.75
34   py  -31.75
c        Control Plates
111  py   13.716
112  py   11.684
113  py  -11.684
```

```
114   py  -13.716
c
c         Core Definition Surfaces (Z-Axis)
c
c         Main Grid
21    pz   42.365
22    pz  -48.715
c         Control Plates
201   pz   15.0          $ This surface controls the height of Plate 1 (Boral)
202   pz   15.0          $ This surface controls the height of Plate 2 (Boral)
203   pz   15.0          $ This surface controls the height of Plate 3 (SS)
204   pz   15.0          $ This surface controls the height of Plate 4 (Boral)
205   pz   15.0          $ This surface controls the Transient Rod height (B4C)
c
c         Element Universe Surface Cards
c
c         Standard and FLIP Elements
c
900   px  -3.8101
901   px   3.8101
c
902   py  -3.8101
903   py   3.8101
c
904   pz   27.76
905   pz   19.05
906   pz  -19.05
907   pz  -27.76
908   pz  -32.84
c
909   c/z  -1.905  1.905  1.74
910   c/z  -1.905  1.905  1.791
c
911   c/z   1.905  1.905  1.74
912   c/z   1.905  1.905  1.791
c
913   c/z  -1.905 -1.905  1.74
914   c/z  -1.905 -1.905  1.791
c
915   c/z   1.905 -1.905  1.74
916   c/z   1.905 -1.905  1.791
c
c          Graphite Reflector Elements
c
917   px   -3.65125
918   px    3.65125
c
919   py   -3.65125
920   py    3.65125
c
c          Rotator Tube Elements
c
921   pz   -36.015
922   pz   -38.555
c
923   cz    3.683
924   cz    3.810
925   cz    2.540
926   cz    3.250
c
c          Corner Grid Elements
c
927   px   -35.125
928   px   -28.375
929   px    28.375
930   px    35.125
```

```
c
931  py    30.045
932  py    23.295
933  py   -23.295
934  py   -30.045
c
c         Transient Rod Elements
c
935  c/z   1.905  -1.905  1.7526
936  c/z   1.905  -1.905  1.8796
c
c    ********************** Lead Box and Relector Surfaces *********
c
5002  py   52.15
5003  py  -52.15
c
c    *************************************************************
c    ******************* Beam Port Surface Cards ******************
c    *************************************************************
c
c    Water Box Definition Surfaces
c
1001  px  -51.83
1002  px   38.1
c
1003  py  -121.92
1004  py   121.92
1005  py   -62.00
1006  py    62.00
c
1007  pz   -121.92
1008  pz    121.92
1009  pz    -62.00
1010  pz     62.00
c
1011  px    323.85
c
c    Conical Region Surfaces
c
1999  kx  -109.906  0.13069  1
2000  kx  -106.156  0.13069  1
5001  kx   -97.3    0.13069  1
c
2001  px   101.60
2002  px   102.87
c
c    Aluminum Face Grid
1100  px     39.37
1101  px     46.355
1102  px     59.69
c
1103  py     22.86
1104  py     20.32
1105  py    -20.32
1106  py    -22.32
c
1107  pz     22.86
1108  pz     20.32
1109  pz    -20.32
1110  pz    -22.86
c
c    Leaded Region Surfaces
c
2003  px   139.70
2004  px   140.97
2005  px   185.42
```

```
2006   px    186.69
2007   px    246.38
2008   px    247.65
2009   px    308.61
c
2010   py    -75.565
2011   py     75.565
2012   py    -76.2
2013   py     76.2
2014   py    -77.47
2015   py     77.47
2016   py    -78.74
2017   py     78.74
2018   py    -80.01
2019   py     80.01
2020   py    -81.28
2021   py     81.28
2022   py    -82.55
2023   py     82.55
2024   py    -91.44
2025   py     91.44
2026   py    -92.71
2027   py     92.71
c
2028   pz    -75.565
2029   pz     75.565
2030   pz    -76.2
2031   pz     76.2
2032   pz    -77.47
2033   pz     77.47
2034   pz    -78.54
2035   pz     78.54
2036   pz    -80.01
2037   pz     80.01
2038   pz    -81.28
2039   pz     81.28
2040   pz    -82.55
2041   pz     82.55
2042   pz    -91.44
2043   pz     91.44
2044   pz    -92.71
2045   pz     92.71
c
c    Inner Shell Region of the Beam Port Surfaces
c
3000   px     70
3001   px     80
3002   px     90
c
3003   px    110
3004   px    120
3005   px    130
3006   px    140
3007   px    150
3008   px    160
3009   px    172.87
3010   px    178.87
3011   px    183.95
3012   px    195
3013   px    210
3014   px    220
3015   px    235
c
3016   px    252.73
3017   px    275
3018   px    300
```

```
c
c    Filter Surfaces
c
4000  kx   259.78      0.3819  -1
4001  kx   269.44      0.3819  -1
c
4002  py  -60.96
4003  py   60.96
c
4004  pz  -60.96
4005  pz   60.96
c
4006  py  -70.485
4007  py   70.485
c
4008  pz  -70.485
4009  pz   70.485
c
4010  py  -86.56
4011  py   86.56
c
4012  pz  -86.56
4013  pz   86.56
c
c    *********************** Tally Segment Surface *****************
c
5000  cx   7.5

c    ****************************************************************
c    ********************** CRITICALITY DATA CARDS *****************
c    ****************************************************************
kcode 2500  1.1  5  100
c  ksrc  -17.145  19.685  0      -9.525  15.875  0      13.335  19.685  0
c      20.955  15.875  0      32.385  19.685  0     -17.145   9.525  0
c      -9.525   5.715  0      -1.905   9.525  0       5.715   5.715  0
c      13.335   9.525  0      20.955   5.715  0      28.575   9.525  0
c     -17.145  -1.905  0      -9.525   1.905  0      -1.905  -1.905  0
c       5.715   1.905  0      13.335  -1.905  0      20.955   1.905  0
c      28.575  -1.905  0     -17.145  -9.525  0      -9.525  -5.715  0
c      -1.905  -9.525  0       5.715  -5.715  0      13.335  -9.525  0
c      20.955  -5.715  0      32.385  -9.525  0      -9.525 -19.685  0
c      17.145 -19.685  0      32.385 -19.685  0
c
c     -17.145  19.685  12      -9.525  15.875  12      13.335  19.685  12
c      20.955  15.875  12      32.385  19.685  12     -17.145   9.525  12
c      -9.525   5.715  12      -1.905   9.525  12       5.715   5.715  12
c      13.335   9.525  12      20.955   5.715  12      28.575   9.525  12
c     -17.145  -1.905  12      -9.525   1.905  12      -1.905  -1.905  12
c       5.715   1.905  12      13.335  -1.905  12      20.955   1.905  12
c     28.575  -1.905  12     -17.145  -9.525  12     -9.525  -5.715  12
c      -1.905  -9.525  12       5.715  -5.715  12      13.335  -9.525  12
c      20.955  -5.715  12      32.385  -9.525  12      -9.525 -19.685  12
c      17.145 -19.685  12      32.385 -19.685  12
c
c     -17.145  19.685  -12      -9.525  15.875  -12      13.335  19.685  -12
c      20.955  15.875  -12      32.385  19.685  -12     -17.145   9.525  -12
c      -9.525   5.715  -12      -1.905   9.525  -12       5.715   5.715  -12
c      13.335   9.525  -12      20.955   5.715  -12      28.575   9.525  -12
c     -17.145  -1.905  -12      -9.525   1.905  -12      -1.905  -1.905  -12
c       5.715   1.905  -12      13.335  -1.905  -12      20.955   1.905  -12
c      28.575  -1.905  -12     -17.145  -9.525  -12      -9.525  -5.715  -12
c      -1.905  -9.525  -12       5.715  -5.715  -12      13.335  -9.525  -12
c      20.955  -5.715  -12      32.385  -9.525  -12      -9.525 -19.685  -12
c      17.145 -19.685  -12      32.385 -19.685  -12
c
c    **************************** Mode Card *********************
```

```
c
c     mode n p
c
c    ********************** Surface Source Write Card ***************
c    ssw  2008
c
c    ********************** Print Dump Control Card *****************
prdmp j 100 j 2
c
c    ********************** MATERIAL CARDS **************************
c
c
c     Water
m1        1001.50c    0.667
          8016.50c    0.333
mt1       lwtr.07t
c
c     Aluminum
m2       13027.50c  1.0
c
c     304 Stainles Steel (WSU)
m3       26000.55c  0.730
         24000.50c  0.191
         28000.50c  0.075
          6012.50c  0.004
c
c     Graphite (Carbon)
m4        6012.50c  1.0
mt4       grph.01t
c
c     Boral (from ARH-600, 35% B4C 65% Al)
m5        5010.50c  0.090
          5011.56c  0.364
          6012.50c  0.114
         13027.50c  0.432
c
c     Standard Fuel Meat
m6       92235.53c  0.0027
         92238.53c  0.0106
          1001.53c  0.6129
         40000.53c  0.3738
mt6       h/zr.01t
          zr/h.01t
c
c     FLIP Fuel Meat
m7       92235.53c  0.0098
         92238.53c  0.0041
          1001.53c  0.6016
         40000.53c  0.3826
         68166.81c  0.0011
         68167.81c  0.0008
mt7       h/zr.01t
          zr/h.01t
c
c     Top of Fuel Region (homogenized)
m8       26000.55c  0.1364
         24000.50c  0.0357
         28000.50c  0.0141
          6012.50c  0.0007
         13027.50c  0.0322
          1001.50c  0.5207
          8016.50c  0.2602
mt8       lwtr.07t
c
c     Bottom of Fuel Region (homogenized)
m9       26000.55c  0.0274
```

```
          24000.50c  0.0071
          28000.50c  0.0028
           6012.50c  0.0001
          13027.50c  0.3041
           1001.50c  0.4390
           8016.50c  0.2195
mt9        lwtr.07t
c
c       Boron Carbide (Transient Fuel Rod)
m10        5010.50c  0.1583
           5011.56c  0.6417
           6012.50c  0.2000
c
c       Lead
m11       82000.50c  1.0
c
c       Ordinary Concrete
m12       1001.50c   0.18667
          8016.50c   0.52127
         26000.55c   0.00247
          6000.50c   0.04788
         14000.50c   0.07579
         12000.50c   0.00738
         13027.50c   0.00924
         20000.50c   0.14549
         11023.50c   0.00381
c
c       Heavy Concrete
m13       1001.50c   0.10078
          8016.50c   0.55034
         25055.50c   0.00025
         26000.55c   0.19460
         14000.50c   0.01960
         12000.50c   0.01714
         16032.50c   0.00114
         20000.50c   0.03238
         24000.50c   0.00023
         15031.50c   0.00013
         22000.50c   0.08318
         23000.50c   0.00023
c
c       Al/Teflon
m14      13027.50c   0.5185
          6012.50c   0.1555
          9019.50c   0.3111
          3006.50c   0.0011
          3007.55c   0.0137
c
c       Aluminum Oxide (Al2O3)
m15      13027.50c  -0.5292
          8016.50c  -0.4708
c
c       Li(nat)-Poly
m17       1001.50c   0.5262
          8016.50c   0.1007
          6012.50c   0.2968
          3006.50c   0.0725
          3007.55c   0.0038
c
c       Bismuth
m18      83209.50c   1.0
c
c     ********************** TALLY SPECIFICATION CARDS *********************
c
c
c       Neutron Flux Over a 7.5cm(radius) Disk Along the Beam's Axial Centerline
f2:n      1002 1100 1101 1102 3000 3001 3002 2002 3003 3004 3005 3006 3007 3008 &
```

```
        3009 3010 3011 3012 3013 3014 3015 2008
fm2:n   7.53e16
fs2    -5000
sd2     (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
        (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
        (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
        (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)
fq2     f e
e2      4.14e-7  0.01  20
c
c      Neutron Current Over a 7.5cm(radius) Disk Along the Beam's Axial Centerline
f1:n    1002 1100 1101 1102 3000 3001 3002 2002 3003 3004 3005 3006 3007 3008 &
        3009 3010 3011 3012 3013 3014 3015 2008
fm1:n   7.53e16
fs1    -5000
sd1     (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
        (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
        (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1) &
        (176.71 1)  (176.71 1)  (176.71 1)  (176.71 1)
fq1     f e
e1      4.14e-7  0.01  20
c
c      Neutron Dose rates at the Beam Aperature Exit (cGy/min)
f22:n   2008
fm22:n 7.53e16
fs22   -5000
sd22    (176.71 1)
fq22    f e
e22     4.14e-7  0.01  20
de22 .10000E-10    .10000E-06    .41399E-06    .87642E-06     .18554E-05
     .50435E-05    .10677E-04    .37267E-04    .10130E-03     .21445E-03
     .45400E-03    .15846E-02    .33546E-02    .71017E-02     .15034E-01
     .21875E-01    .24176E-01    .26058E-01    .31828E-01     .40868E-01
     .67379E-01    .11109E+00    .18316E+00    .29720E+00     .36883E+00
     .49787E+00    .60810E+00    .74274E+00    .82085E+00     .10026E+01
     .13534E+01    .16530E+01    .19205E+01    .22313E+01     .23457E+01
     .23653E+01    .24660E+01    .27253E+01    .30119E+01     .36788E+01
     .49659E+01    .60653E+01    .74682E+01    .86071E+01     .10000E+02
     .12214E+02    .14191E+02    .17333E+02
c
df22 .1E-20        .1E-20        .1E-20        .35220E-12     .80570E-12
     .19660E-11    .46200E-11    .13090E-10    .39370E-10     .92580E-10
     .19550E-09    .55320E-09    .13820E-08    .29910E-08     .60670E-08
     .99720E-08    .12200E-07    .13230E-07    .14940E-07     .18060E-07
     .24380E-07    .34870E-07    .47760E-07    .63230E-07     .75370E-07
     .85630E-07    .96160E-07    .10530E-06    .11350E-06     .12100E-06
     .13730E-06    .15330E-06    .16570E-06    .17750E-06     .18470E-06
     .18700E-06    .18910E-06    .19470E-06    .20240E-06     .21340E-06
     .23410E-06    .25160E-06    .26400E-06    .27390E-06     .28080E-06
     .28700E-06    .29200E-06    .29390E-06
c
c      Fine Energy Breakdown of Neutron Flux at Beam Exit Surface
c    f12:n   2008
c    fs12  -5000
c    sd12    (176.71 1)
c    fq12    e f
c    e12     1e-7  2e-7  3e-7  4e-7  5e-7  6e-7  7e-7  8e-7  9e-7 &
c       1e-6  2e-6  3e-6  4e-6  5e-6  6e-6  7e-6  8e-6  9e-6 &
c       1e-5  2e-5  3e-5  4e-5  5e-5  6e-5  7e-5  8e-5  9e-5 &
c       1e-4  2e-4  3e-4  4e-4  5e-4  6e-4  7e-4  8e-4  9e-4 &
c       1e-3  2e-3  3e-3  4e-3  5e-3  6e-3  7e-3  8e-3  9e-3 &
c       1e-2  2e-2  3e-2  4e-2  5e-2  6e-2  7e-2  8e-2  9e-2 &
c       1e-1  2e-1  3e-1  4e-1  5e-1  6e-1  7e-1  8e-1  9e-1 &
c       1     2     3     4     5     6     7     8     9    &
c       1e+1  2e+1  3e+1  4e+1  5e+1  6e+1  7e+1  8e+1  9e+1 &
c
```

```
c        Gamma Dose Rate (rem/hr) at Water Plug Surface
c   f62:p    2008
c   fs62    -5000
c   fm62     7.53e16
c   sd62     (176.71  1)
c        Flux-to-Dose Conversion Factors for Photons
c   de62     .01  .015  .02  .03  .04  .05  .06  .08  .1  .15  .2  .3  .4  &
c          .5  .6  .8  1.0  1.5  2.0  3.0  4.0  5.0  6.0  8.0  10.0
c   df62     2.78e-6  1.11e-6  5.88e-7  2.56e-7  1.56e-7  1.20e-7  1.11e-7 &
c          1.20e-7  1.47e-7  2.38e-7  3.45e-7  5.56e-7  7.69e-7  9.09e-7 &
c          1.14e-6  1.47e-6  1.79e-6  2.44e-6  3.03e-6  4.00e-6  4.76e-6 &
c          5.56e-6  6.25e-6  7.69e-6  9.09e-6
c   fq62     f e
c
c      ********************** Power Density Tallies ****************************
c
f17:n      12 13 14 15 16 17 18
fm17     13152
sd17     1 1 1 1 1 1 1
f27:n    21 22 23 24 25 26 27 28 29
fm27     13152
sd27     1 1 1 1 1 1 1 1 1
f37:n    31 32 33 34 35 36 37 38 39
fm37     13152
sd37      1 1 1 1 1 1 1 1 1
f47:n    41 42 43 44 45 46 47 48 49
fm47     13152
sd47      1 1 1 1 1 1 1 1 1
f57:n    51 52 53 54 55 56 57 58 59
fm57     13152
sd57      1 1 1 1 1 1 1 1 1
f67:n    61 62 63 64 65 66 67 68 69
fm67     13152
sd67     1 1 1 1 1 1 1 1 1
f77:n    72 73 74 75 76 77 78
fm77     13152
sd77     1 1 1 1 1 1 1
c
```