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SOFTWARE QUALIFICATION REPORT
for
MCNP4A
A General Monte Carlo N-Particle Transport Code

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Civilian Radioactive Waste Management System
Management and Operating Contractor

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1.0 INTRODUCTION

The Software Qualification Report (SQR) for the MCNP4A code package (Ref. 1) is to be revised for two reasons. The first is the addition of two new computer CPUs which differ from those used for revision 01 of the SQR and will operate with a more recent version of the operating system than the computers on which the original installation was qualified. The second is that the installation of MCNP4A will be installed in a new location which is located on the new computer platform. The new installation along with the new operating system requires that a full SQR revision be performed in order to ensure that MCNP4A performs properly on both the new and existing computers. Since the MCNP4A code, manuals, and installation procedures will not change, the only baseline element which is required to be updated is the SQR. Upon verification and validation of the MCNP4A code package installation on the newer CPU informally identified as "QUICHE", the original installation as documented by revisions 00 and 01 of the SQR will be removed from the HP 9000/700 workstation system named "OPUS".

1.1 Purpose

This Software Qualification Report (SQR) documents the verification and validation process for the installation of the MCNP4A code package. This process includes validation of the criticality safety and neutron/gamma shielding capabilities of the code. Since no modifications are needed for implementation by the Waste Package Development Department (WPDD) of the Las Vegas Office of Civilian Radioactive Waste Management System (OCRWMS) Management and Operating Contractor (M&O) this code is classified as acquired engineering software. This software package is needed to support current analyses for the waste package/engineered barrier system of the Mined Geologic Disposal System. If additional computer platforms are required in the future, validation will be documented in revisions/addenda to this SQR.

The MCNP4A code package was developed by Los Alamos National Laboratory (LANL). The MCNP4A code package was obtained from the Radiation Shielding Information Center (RSIC) at Oak Ridge National Laboratory, as code package CCC-200. Generally, MCNP4A performs three dimensional neutron or gamma transport calculations for complex systems. For the analysis required for the waste package/engineered barrier system, the primary use will be for criticality safety analyses for spent nuclear fuel and other fissile material systems. Also, shielding calculations for the neutron and gamma sources contained in the waste package will be performed to determine the internal and external effects of the radiation.

The sample installation test cases accompanying the code package exercise these neutron and gamma transport capabilities to ensure they are all functioning correctly. The sample cases will be used to verify correct installation and operation of the MCNP4A code package. Additional criticality benchmark test cases are provided to validate computations performed by the MCNP4A code package. This type of validation method using additional benchmark test cases is an established practice in the MCNP4A Software Quality Assurance Plan at LANL (Ref. 2). MCNP4A also provides the capability to transport electrons (beta particles) for shielding problems, but this capability is not required for waste package analyses.

In the current configuration, the MCNP4A code package installed on the QUICHE HP 9000/C160 series workstation uses nuclear cross sections based on the ENDF/B-V and ENDF/B-VI library as provided by RSIC in the MCNPDAT6 package (Ref. 3). Originally, the MCNP4A code package was qualified on a HP 9000/700 series workstation using only cross sections based on ENDF/B-V (Ref. 4). This cross section library was updated to use the most current cross section information contained in ENDF/B-VI in addition to ENDF/B-V. A second group of benchmark test cases was used to verify correct installation of the ENDF/B-VI cross section library (Ref. 2).

1.2 Software Description

A full description of the MCNP4A code package is provided in the MCNP user manual (Ref. 5). The following excerpts will provide a general description.

> "MCNP is a general-purpose Monte Carlo N-Particle code that can be used for neutron, photon, electron, or coupled neutron/photon/electron transport, including the capability to calculate eigenvalues for critical systems. The code treats arbitrary three-dimensional configurations of materials in geometric cells bounded by first-degree and second-degree surfaces and fourth-degree elliptical tori."

> "Pointwise cross-section data are used. For neutrons, all reactions given in a particular cross-section evaluation (such as ENDF/B-VI) are accounted for. Thermal neutrons are described by both the free gas and $S(\alpha,\beta)$ models."

> "Important standard features that make MCNP very versatile and easy to use include a powerful general source, criticality source, and surface source; both geometry and output tally plotters; a rich collection of variance reduction techniques; a flexible tally structure; and an extensive collection of cross-section data."

More detailed theoretical and operational information can be obtained in the MCNP4A user manual.

Chapter 1 provides an overview of the complete system, the theoretical basis of the code, and tips for efficient use of the code.

Chapter 2 describes the geometry and cross section features of the code, and also provides details of the implementation of the theoretical basis of the code. The criticality safety capability of the code (to calculate $k_{effective}$) is described as is the capability for shielding calculations.

Chapter 3 provides detailed descriptions of the input required to create a model for MCNP4A, including the geometric description capabilities and the material properties. Chapter 4 provides example problem input and descriptions, and Chapter 5 provides output for these samples.

1.2.1 MCNP4A Computational Methods

The MCNP4A code package uses the Monte Carlo methodology to perform transport calculations. The Monte Carlo numerical method simulates and records the behavior of individual particles within a system. This mathematical approach applies random selections of particle transport characteristics and interactions based on probabilities, cross sections and system geometry. The behavior of the simulated particles is extrapolated to describe the average behavior of all of the particles within the system. The Monte Carlo method as applied to neutrons in an MCNP criticality calculation is based upon following a number of individual neutrons through their various transport experiences such as scattering, fission, absorption, or leakage. The fission process is regarded as the birth event that separates generations of neutrons. A generation is the lifetime of a neutron from birth by fission to death by either escape, parasitic capture, or absorption leading to fission. The average behavior of the sample set of neutrons is used to describe the average behavior of the system with regard to the number of neutrons in successive generations (i.e. critical multiplication factor, k_{eff}).

MCNP 4A calculates three k_{eff} estimates for each cycle in a given problem.

1) the collision estimate,
2) the absorption estimate, and
3) the track length estimate.

A detailed description of the three k_{eff} estimates may be found in Chapter 2 of the MCNP user manual. According to statisticians at the Los Alamos National Laboratory, "the three-combined k_{eff} estimator is the best final estimate from an MCNP calculation. The confidence interval based on the three statistically combined k_{eff} estimate is the recommended result to use for all final k_{eff} confidence interval quotations because all of the available information has been used in the final result."

1.2.2 MCNP4A Cross Section Libraries

The MCNP4A code package as originally received from RSIC is qualified with an associated set of cross section libraries based primarily on ENDF/B-V nuclear data. Since delivery of the MCNP4A code package, LANL and RSIC developed and released a cross section update package using MCNPDAT6, an ENDF/B-VI based cross section library. This cross section update was implemented on the QUICHE HP 9000/C160 workstation as indicated in Software Change Request (SCR) # LSCR119. Elemental/isotopic cross sections either in improved form or not available at all under the ENDF/B-V cross section libraries will be made available by including the MCNPDAT6 library in the MCNP4A baseline.

The RSIC Package MCNPDAT6 includes an ENDF/B-VI based cross section library named ENDF60 and an extended photon library named MCPLIB02. The ENDF60 library contains neutron data files for 124 nuclides. The MCPLIB02 photon data library contains photon interaction data up to 100 GeV for elements having $Z \leq 94$.

Functional requirements for the MCNP4A code package are listed in section 1.3 and are unaffected by the ENDF/B-VI cross section library update. The cross section library installation procedure and validation of correct operation is provided in sections 2.3 and 3.3, respectively. Validation of ENDF/B-VI library cross sections is achieved by experimental benchmark test cases that exercise the MCNP4A cross section library.

The cross section library available to the MCNP4A code package installed on the GATEWAY2000 P5-90 PC is the ENDF/B-V library. A requirement for the use of the ENDF/B-VI cross section library on the PC has not been established at this time.

1.3 Functional Requirements

The MCNP4A code package has the capability to perform criticality and shielding calculations. Shielding calculations include neutron, gamma, electron, and (n,gamma) sources. MCNP4A accomplishes these calculations with a well established computer source code and cross section data libraries. The criticality capability and neutron and gamma shielding capabilities are installed and tested using developer supplied test cases and additional benchmark tests. The electron transport capabilities are installed but have not been tested. Upon requirement of additional capabilities, or version/revision changes, the SQR shall be revised to include the required test cases and the revised SQR will be submitted to the Software Configuration Manager (SCM) per QAP-SI-0.

1.3.1 General Requirements

The MCNP4A code package generates data to support waste package performance activities (WBS 1.2.2) related to criticality, shielding and structural. The system can perform the following analyses: 1) three dimensional criticality analyses; 2) three dimensional shielding analyses for neutron sources; 3) three dimensional shielding analyses for gamma sources; and 4) three dimensional shielding analyses for gamma sources produced by neutron interactions (coupled n-gamma problems). Examples of analyses that can be supported by the MCNP4A system are:

1) Evaluation of the criticality safety of various waste package designs within the range of acceptable fuel types, including plutonium materials

2) Evaluation of the neutron and gamma-ray fluence and dose rate on the waste container materials and environment

3) Evaluation of corrosion and structural effects of the waste package due to radiolytic production of corrosive chemicals

MCNP4A requires that the user provide data which describe the materials and geometry which define the desired problem. MCNP4A also provides a Graphical User Interface (GUI) that provides interactive plotting of geometry models.

The complete MCNP4A code package is obtained from RSIC. The code package is implemented as delivered from RSIC. However, if the need arises for modifications as indicated by the developer or additional computer platforms are required, this SQR shall be revised to include the required verification and validation information and test cases and the SQR shall be submitted to the Software Configuration Manager (SCM) per QAP-SI-0 requirements.

1.3.2 Input/Output Requirements

Input to MCNP4A is provided by keyboard text entry via a text input file identified on the command line. The desired outfile is also identified on the command line. Problems may be stopped, and later re-started through the use of a "CONTINUE" run which uses a problem history file named "runtpe" and a source distribution file "srctp". This feature is useful when the calculated results of a run are not statistically adequate, and continuing the problem run can improve the statistics to acceptable values. MCNP4A input/output requirements include:

- MCNP4A instructions regarding housekeeping functions such as print options

- Cross section library specifications
- Model geometry in three dimensions
- Material specifications for the regions in the geometrical model.

MCNP4A can use a variety of cross section libraries which are provided with the code. The library used for each isotope specified in the material specifications of the geometrical model is defined by an extension of the isotope identifier. Hence, isotope cross sections may be retrieved by MCNP4A from a single or several libraries at the user's discretion. A user may employ either ENDF/B-V or ENDF/B-VI cross section available libraries in the MCNP4A code package as required. Additional cross section libraries are maintained in subdirectories attached to the main MCNP directory on the QUICHE HP 9000/C160 workstation.

MCNP4A provides a hard copy listing in ASCII format of the output that contains a listing of the input file, the interpretation of the problem model, and the calculational results. In addition, binary data files containing the problem history and source distribution information are produced.

1.3.3 Hardware/Software Platform Requirements

The current package, MCNP4A , is distributed for implementation on a variety of computer platforms including the HP 9000/700 and the HP 9000/C160 computer. The HP version is a UNIX based system that is optimized for the 9000 series computers without software modifications. Additionally, the current MCNP4A package is implemented on a desktop computer platform with an MS-DOS operating system, version 5.10 or higher. No software modifications were required for installation of the MCNP4A code package. Installation options appropriate to the HP 9000/C160, HP 9000/700, and the desktop computer were used.

The MCNP4A software, as acquired, is configured for installation on a HP 9000/C160 or HP 9000/700 series UNIX workstation. There are no limitations on the number of users or CPU's on which the software can be installed for the Waste Package Development Department in Las Vegas, Nevada. Installation outside this department and/or another location is not allowed without prior approval from RSIC.

In the WPDD, the MCNP4A code package is installed on a hard disk drive located on the QUICHE HP 9000/C160 workstation. This disk drive is also mounted as part of a Network File Server (NFS) which allows any CPU connected to the NFS to access the hard disk. The network is composed of HP 9000/700 and HP 9000/C160 class machines which are using the HP-UX V9.07 and V10.2 UNIX based operating systems, respectively. In the verification and validation process, installation test cases and benchmark test cases are run using the NFS mount on the workstation QUICHE. However, both types of test problems are run on both the HP 9000/700 and the HP 9000/C160 CPUs to test the operating systems and workstation environments for satisfactory operation. Future additions of HP 9000/700 or HP 9000/C160 class machines shall not require a re-qualification effort if they use one of the above listed operating systems. If a computer is added to the network that does not conform to the specified requirements the following shall be completed: (1) the test cases shall be performed on the new machine, (2) this SQR shall be revised to include the additional computer specifications and test case results, and (3) the new SQR shall be provided to the SCM to be included in the software baseline package as specified in the M&O procedure QAP-SI-0.

1.3.4 Computational Methods/Algorithm Requirements

The software will at a minimum be required to perform the following tasks, as necessary, and have the appropriate computational algorithms included in the source code:

- Determine the system k_{eff} for complex geometries using Monte Carlo methods
- Provide appropriate cross section libraries
- Perform three dimensional neutron and gamma-ray shielding calculations

The MCNP4A package meets these requirements and is commonly used for problems similar to Waste Package problems.

1.3.5 Other Requirements

There are no additional user requirements or code requirements (internal, external, or user) because the inputs are all provided by an analyst and the MCNP4A system does not interface with other codes. The user is responsible for independently collecting any materials or geometry information the MCNP4A code package may require. For configuration control, the users shall have only a read/execute privilege to the code. There are no hardware requirements beyond those stated in Section 1.3.3 above.

1.4 Description Of Validation

Correct installation of the MCNP4A code package is first verified by running the installation test cases which are based on specific criticality safety, and neutron and gamma shielding problems provided with the software by the developer. The acceptance criteria for qualification of the MCNP4A code package requires agreement of numerical results within the statistical accuracy of the calculations. Test case results should not deviate significantly from the vender supplied results for the same test case. Deviate significantly for this situation means that numerical results do not agree to within the fifth significant figure for deterministic calculations. For statistical calculations, results should agree within the statistical uncertainty of the cases. Differences larger than this specified criteria must be documented. After verification of correct installation, validation testing is implemented by running benchmark test cases from published sources to insure that the MCNP4A code provides correct answers for problems of the type required for the WPDD program.

The input and significant results of the MCNP4A verification test cases and validation benchmark cases are provided in this SQR. Complete results of the computer calculations are not presented here due to the large volume of data printed in the computer outputs but not relevant to the validation effort. The complete results of the computer calculations are available on electronic media, MI: 30006-M03-002.

Validation of the ENDF/B-VI based cross section library is performed by benchmark test case comparisons. During development, LANL performed extensive testing and validation of the MCNPDAT6 cross section package as documented in reference 3. The results based on the ENDF60 library were compared with the results of a number of other data libraries for infinite medium simulations of all nuclides (Ref.10). Additional testing by LANL included a number of experimental benchmarks consisting of pulsed sphere experiments (Ref. 11) and iron benchmark analyses (Ref. 12). Thus, benchmark test cases of this type are suitable for confirming correct installation of the ENDF/B-VI cross section library for use with the MCNP4A code package.

1.5 Additional Documentation And References

Additional software documents and references for installation and qualification activities of the MCNP4A software package are listed below:

1. "MCNP4A, A General Monte Carlo N-Particle Transport Code System", LA-12625-M, Prepared by the Radiation Transport Group, X-6, Los Alamos National Laboratory, January 1995.
2. "MCNP Software Quality Assurance Plan", LA-13138, Los Alamos National Laboratory April 1996.
3. "MCNPDAT6, MCNP4A Standard Neutron Cross Sections (Based on ENDF/B-VI), Photon Interaction, and Electron Data Libraries," DLC-181, Radiation Shielding Information Center Data Library Collection, Oak Ridge National Laboratory, December 1994.
4. "Software Qualification Report for MCNP4A, A General Monte Carlo N-Particle Transport Code," CSCI: 30006 V4A, DI: 30006-2003 Rev. 01, CRWMS M&O.
5. Briesmeister, J. F. Ed., "MCNP - A Monte Carlo N-Particle Transport Code, Version 4A," LA-

12625-M, Los Alamos National Laboratory (LANL), November 1993.
6. "Critical Separation Between Subcritical Clusters of 2.35 Wt% and 4.31 Wt% ^{235}U Enriched UO_2 Rods In Water With Fixed Neutron Poisons", PNL-2438, Battelle Pacific Northwest Laboratories, October 1977.
7. "Reference Problem Set to Benchmark Analysis Methods for Burnup Credit Applications (Draft)", ORNL/TM-12295, Computing Applications Division ORNL, November 1993.
8. Whalen, Daniel J., David A. Cardon, Jennifer L. Uhle, and John S. Hendricks, "MCNP: Neutron Benchmark Problems," LA-12212, LANL, November 1991.
9. Wagner, John C., James E. Sisolak, and Gregg W. McKinney, "MCNP: Criticality Safety Benchmark Problems," LA-12415, LANL, October 1992.
10. Court, John D., John S. Hendricks, and Stephanie C. Frankle, "MCNP ENDF/B-VI Validation: Infinite Media Comparisons of ENDF/B-VI and ENDF/B-V," LA-12887, LANL, December 1994.
11. Court, John D., Ronald C. Brockhoff, and John S. Hendricks, "Lawrence Livermore Pulsed Sphere Benchmark Analysis of MCNP ENDF/B-VI," LA-12885, LANL, December 1994.
12. Court, John D., and John S. Hendricks, "Benchmark Analysis of MCNP ENDF/B-VI Iron," LA-12884, LANL, December 1994.

No additional documentation other than listed above is required to qualify the MCNP4A code package for use on the HP 9000 series workstations and the GATEWAY2000 P5-90 desktop computer. The above listing of documentation is also sufficient for the installation of the ENDF/B-VI cross section library in the MCNP4A baseline.

2.0 INSTALLATION

The MCNP4A code package, as received, was compiled on a HP 9000 series UNIX based workstation and a GATEWAY2000 P5-90 desktop personal computer . The installation procedures provide guidelines for installation on the HP 9000/C160 series workstation in the WPDD, and on the GATEWAY2000 PC platform in the Repository Design Department (RDD). Installation procedures are described in Attachment II.

2.1 MCNP4A Installation Procedure

The MCNP4A electronic software package was transmitted by RSIC to the WPDD on a DC 6150 tape cartridge (150MB). The instructions for removal of the code files from the tape is described in the cover letter accompanying the package (see Attachment I). The DOS formatted diskette contains a file named 'README' that provides instructions for installation of the package on the HP machine.

The MCNP4A code package, as originally received and qualified in revision 00 of this SQR, is coded and compiled on an HP 9000 based workstation. The code package is thus ready for installation on any of the HP 9000 series workstations, either the 700's or the C160's, in the WPDD. Additional information on the electronic format of the code package was provided in the cover letter accompanying the package (see Attachment I). The MCNP4A media was submitted to the SCM as part of the revision 00 SQR and the original MCNP4A baseline element. The installation media for this revision and instructions for revisions 01 and 02 of this SQR were obtained from the SCM in compliance with QAP-SI-3 Section 5.5.3 and are identical to the original baseline element since the MCNP4A software has not changed.

2.1.1 HP 9000/C160 Series UNIX Based Workstation

The MCNP4A code package was installed by T.L. Lotz and J.W. Davis of the WPDD following the instructions for removal from the media and installation. The code was installed on the WPDD HP9000/C160 Series Workstation (CRWMS M&O #110431), identified as QUICHE. The files were transferred from the tape cartridge, uncompressed, and then a 'tar' command was executed to extract the files. The extracted files were loaded to directory structure 'quiche:/opt/neut/'. The processes created directory 'mcnp' containing five subdirectories 'smplprbs', 'cmds', 'src', 'datalib', and 'output'. The information in the 'README.NOW' file on the DOS diskette was then followed to install the code using the files in the mcnp directory. Attachment II contains a copy of the README. file used for the installation.

The MCNP4A installation process is controlled by a script which makes the necessary platform-dependent adjustments. The compilation process resulted in the creation of two additional subdirectories in mcnp, exe and obj, containing the executable and object files generated by the compilation. In addition, directory 'smplprbs' contains the sample problem input files obtained with the package and the output files executed with the version installed on the HP. All files not necessary for the execution of the MCNP4A code package for typical problems have been removed from the workstation directory and archived in electronic media. A listing of all the MCNP4A executable and library files currently contained in the mcnp directory and its subdirectories is provided in Attachment III. These files have been placed under the control of the appropriate systems administrator to provide write protection on these files.

Based upon the review of the installation procedure provided with the code, a comparison with the files loaded onto the HP 9000/C160 workstation and the installation procedure, and the results of the verification cases described in the following section, the following is concluded: 1) the complete MCNP4A code system has been installed on the QUICHE HP 9000/C160 series workstation as directed by the supplier and is accessible to the other CPUs via a NFS; 2) tested on both the HP 9000/700 and the HP 9000/C160 workstations using the V9.07 and the V10.2 UNIX operating systems, respectively; 3) and that the MCNP4A code package is functioning correctly on these workstations.

2.1.2 GATEWAY2000 P5-90 PC

The PC version of the MCNP4A code package was obtained from RSIC on 29 3.5" floppy disks. MCNP4A is version 4A of the MCNP code created on 10/01/93. This version contains the ENDF/B-IV cross section data. The ENDF/B-V cross section data are provided in a separate package called DLC105C. The code installation procedure includes attachment of the DLC105C package to MCNP4A. The README.RSI file in MCNP4A supplied by RSIC was written in February 1994, and revised on April 21, 1994.

The PC version of the code was installed by S. Su of the RDD using the instructions provided in the code package. The code was installed on the RDD GATEWAY2000 P5-90 PC using the WINDOWS 3.11/MS-DOS 6.22 operating system (CRWMS M&O #700621).

Attachment II provides the complete installation procedure of the MCNP4A code package with the DLC105C ENDF/B-V cross section data files. The installation consists of three parts executed in sequence: system setup, compilation of the source code, and validation with test problems. All the files created in the installation process reside in the \mcnp directory. A listing of all the executable and library files in the \mcnp directory required for running actual criticality and shielding problems is provided in Attachment III. These files and directory contents are controlled per QAP-SI-3. All the MCNP4A source code shall be removed from the qualified PC platform.

The code verification process for the PC is described in section 2.2 below. Based upon the review of the installation procedure provided with the code, a comparison with the files loaded onto the PC and the installation procedure, and the results of the validation cases described in the following section, it is judged that MCNP4A has been installed on the GATEWAY2000 P5-90 PC as directed by the developer, and that the criticality safety and shielding capabilities are functioning correctly.

2.2 MCNP4A Installation Verification

As described in installation instructions provided with the MCNP4A code package, the developer supplied test cases for the criticality safety and neutron/gamma shielding will be used for the code verification. Since this sequence provides statistical results, the acceptance criteria stated in the section 1.4 requires agreement of numerical results within the statistical accuracy of the calculations. Differences larger than this criteria must be documented.

Twenty-five developer supplied test cases are included with the MCNP4A package. They are briefly described in Table 2.2-1 and electronic copies of both the input and output files are included in the code package. Listings of the individual installation test case input files are provided in sections

2.2.1 through 2.2.25. Since an electronic copy of the output is provided with the code package, verification of results is simplified by use of the 'diff' command on the UNIX operating system, and by the fc (file comparison) command on the PC MS-DOS operating system. This is a sophisticated system command that compares two files and lists those lines that must be changed in the files to bring them into agreement. A review of the list produced by this command will provide an accurate and complete validation of the MCNP4A code package based on the comparison of sample case results.

For the HP 9000 workstations, the sample problems exercise the capabilities of the MCNP4A code. The sample problems provide a considerable amount of output, even with conservative printout requests. Thus, the output listings for these cases will be archived on electronic media MI: 30006-M03-002. All significant differences noted in the 'diff' file will be included and discussed.

For the PC version, the sample problems also exercise the capabilities of the MCNP4A code. Comparison of the tally files produced from the test run with those supplied by the code developer shows that there are no differences encountered for all of the 25 sample problems tested.

TABLE 2.2-1
Description of the 25 MCNP4A Installation Test Cases

Problem	Particle	Description
1	Neutron	Point source in concentric spheres
2	Neutron	Volume source with DXTRAN and alternate equivalent tallies in concentric spheres
3	Neutron	Combination sphere and volume sources in a box
4	Photon	Point source in spheres with DXTRAN and bremsstrahlung
5	Neutron	Volume source in toroidal tokamak with degenerate tori
6	Neutron	Surface source with spheres and balls and interacting variance reduction features
7	Neutron	Volume source in box writing a surface source for problem 8
8	Neutron, Photon, Electron	Surface source from problem 7
9	Neutron	Criticality source in complicated box geometry with fission sites written to file for problem 25
10	Neutron, Photon	Volume source in toroidal geometry with bremsstrahlung
11	Neutron, Photon	Volume source with intertwined super pretzel toroidal geometry and $S(\alpha,\beta)$ thermal scattering and bremsstrahlung
12	Neutron	Point source in detailed oil-well logging benchmark geometry and weight window generator
13	Neutron	Surface source stochastic volume calculator with void geometry

TABLE I
Description of the 25 MCNP4A Test Problems
(Continued)

14	Neutron	Cylindrical volume source in repeated structure geometry
15	Neutron	Point source with discrete reaction cross sections in filled lattice and skewed lattice geometry
16	Neutron	Distributed sources in a lattice geometry
17	Neutron	Criticality (eigenvalue) source in a rectangular lattice
18	Neutron	Criticality (eigenvalue) source in a hexagonal lattice
19	*	Boltzmann-Fokker-Planck charged particles in slab geometry (electrons and photons masquerading as neutrons in multigroup version of problem 20)
20	Electron, Photon	Slab geometry (continuous-energy version of problem 19)
21	Photon	Surface source in conical geometry with bremsstrahlung and writing surface source for problem 22
22	Photon	Surface source from problem 21 with bremsstrahlung and problem 21 geometry
23	Photon, electron	Volume source for detector chip
24	Neutron	Criticality (eigenvalue) source in a rectangular reflecting lattice
25	Neutron	Fission volume source from problem 9 in problem 9 geometry

2.2.1 Installation Test Case 1 Input File Listing

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob1 -- simple neutron problem to test some basic operations of mcnp.
1   1 -2.25   -1  imp:n=1  $ graphite ball
2   2 -8.95  1 -2  imp:n=1  $ copper shell
3   0       2 -3  imp:n=1  $ void space
4   0       3    imp:n=0  $ zero-importance outside world

1   so 5
2   so 7.5
3   so 10

c  biased isotropic point source at (0,0,0)
sdef  erg d1   vec 0 1 0   dir d2   tme d5
sc5  equiprobable bin treatment for time distribution.
si5  -50 -10 3i 10 5m
sp5  -41 10
sb5  0 .1 .2 .3 1r .2 .1
sc1  flat energy spectrum from 1 to 14.1 mev.
si1   1 14.1
sp1   0 1
sc2  direction is biased toward the point detector.
sb2   -31 1.5
c
m2   29000.40 1
m1    6012.40c 1
awtab 6012. 11.8969
c  xs3  6012.50c 11.8969 rmccs 0 3 92853 23390 0 0 2.53e-08
phys:n  14.2 .01
c
fc1  current across the graphite-copper interface.
f1:n  1
e1    .1 .5 .8 2 4 12 14.1
c1    -.866 -.5 0 .5 .866 1
em1  1 5i 7
cm1  8 4i 13
tm5  14 8i 23
t5  -50 -10 3i 10 5m 4m 5m 1.e20
fq1   c e
fc5  flux at a point in the void just outside the copper shell.
f5:n  0 8 0 0
e5    .1 .5 .8 2 4 12 14.1
c
```

```
cut:n 1.e20 .05 .05 .01 .01
nps  5000
print -98
prdmp 2j -1
dbcn j 1000 512 513 2j 100 10000 5 $ non-multitask version.
c   dbcn 6j 100 10000 5 $ dbcn card for multitask version.
```

2.2.2 Installation Test Case 2

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob2 -- three different tallies of the same physical quantity.
1    1 -2.45   -1    $ boron ball with volume source
2    2 -2.7   1 -2 4  $ aluminum shell
3    2 -2.7   2 -3 4  $ aluminum shell
4    0        3      $ outside world
5    2 -2.7   5 -4   $ big aluminum ball to avoid dxtran/tally2 conflict
6    2 -2.7   -5     $ little aluminum ball for tally 4

1    so 5
2    so 7
3    so 10
4    sy 7  1.95
5    sy 7  .3

c   volume source in boron ball, biased in position.
c   the symmetry is sufficient for the bias to be a fair game.
sdef cel 1  x d1  y d2  z d3  erg d4
si1  -5 5
sp1   0 1
sc2  position is biased toward the dxtran and the ring detector.
si2  a -5 5
sp2  1 1
sb2  1 2
si3  -5 5
sp3   0 1
sc4  flat energy spectrum from .1 to 1 mev.
si4  .1 1
sp4   0 1
c
m1    5010.03d .196 5011.40c .804  $ natural boron
m2    13027.40c 1  $ aluminum-27
ctme 60
phys:n  1.2    $ cross sections above 1.2 mev will be expunged.
```

```
c
c   all tallies have the same energy bins.
e0  .01 .03 .1 .3 1
fc2  average flux on surface 2.
f2:n  2
f1:n 1
c1  -.8 8i 1 t
fq1  c e
tf1  1 7r
ft2  tmc -2 .05
t2  -2 9i 3 10 100
fq2  t e
ft1  frv 3 4 5   geb 1 2 0
fc4  average flux in cell 6.
f4:n  6
pd5  .3 1 4r
dd5  .003
fq5  u e
fu5  1 8i 10
ft5  inc
fc5  average flux at ring detector.
fy5:n 5 4.89 .7
dxc:n  1 .7 .9 0 1 1
dd1  .04 100
thtme -10 0 .5 1 2
#   tmp1  tmp2  tmp3  tmp4  tmp5
 1  1e-8  2e-8  3e-8  4e-8  5e-8
 2  2e-8  3e-8  5e-8  4e-8  3e-8
 3  1e-8  5e-8  4e-8  3e-8  2e-8
 4    0     0     0     0     0
 5  2e-8  1e-8  5e-8  3e-8  1e-8
 6  3e-8  2e-8  1e-8  2e-8  1e-8
c
dxt:n 0 7 0 1 1.9  $ dxtran around cell 6, inside cell 5.
imp:n 1 1 1 0 1 1
c
cut:n j .001      $ energy cutoff at .001 mev.
nps   5000        $ run 5000 histories.
print -98         $ print all possible output for easier debugging.
prdmp 2j -1       $ print mctal file.
ptrac buffer=2 file=asc event=src nps=1,200 cell=3
```

2.2.3 Installation Test Case 3

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob3 -- many features of the general source
3   1 -7 -10          $ source on surface of this cell
4   2 -.9 -90 #3 #8 #30  $ carbon between sources and tally
8   3 -3.7 -14 15 -16    $ tally here
30  4 -1.2 (-21 22 -23 24:-27) -25 26  $ volume source here
40  0 90              $ zero-importance outside world

10  sx -50 12
14  py 31
15  py 0
16  cy 15
21  py 30
22  py -16
23  px 30
24  px 25
25  pz 9
26  pz -9
27  c/z 25 30 4
90  sq 1 4 4 0 0 0 -6400 0 0 0

sc6  a surface source on sphere 10 and a cell source in cell 30.
sdef  sur d6  axs fsur d61  cel fsur d62  x fsur d63  y fsur d64
    z fsur d65  vec fsur d66  dir fsur d67  erg fsur d68
    ext fsur d69
c   biased sampling between the surface and cell sources
si6  1 10 0
sp6  .8 .2
sb6  .3 .7
c   axs for position bias on the surface
ds61  t 10 4 2 0
c   the name of the cell
ds62  1 0 30
c   sample x for the cell cover
ds63  s 0 73
si73  20 30
sp73  0 1
c   sample y for the cell cover
ds64  s 0 74
si74  -17 36
```

```
sp74  0 1
c    sample z for the cell cover
ds65  s 0 75
si75  -10 10
sp75  0 1
c    reference vector for directional biasing in the cell
ds66  t 0 -3 1 0
c    exponential biasing in the cell
ds67  s 0 77
sb77  -31 1.5
c    the surface and cell sources have different energy spectra
ds68  s 78 88
si78  a 7 10 13
sp78  0 1 0
sp88  -3
c    position biasing on the surface
ds69  s 79 0
si79  -1 .5 .9 1
sp79  c 0 1.5 1.9 2
sb79  c 0 .5 1.2 2
c    materials
m1    26000.40c 1
m2    6012.40c 1
m3    13027.40c 1
m4    1001.00c 2  8016.40c 1  92238.40c .015
drxs
c    tally
f4:n  8
e4    1 2 4 6 8 12 14
c    miscellaneous
imp:n   1 3r 0
cut:n   j .0001 .18 .09
nps     10000
prdmp 2j -1
print -98
nonu
f14:n 8
f24:n 8
fq14 u e
fq24 u e
ft14 scx 79
ft24 scd
fu24 6 73 74 75 77 78 79
```

2.2.4 Installation Test Case 4

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob4 -- photons
1  1 .02 -1   $ uranium hydride ball with point source
2  2 .1 -2 1 3 4 $ uranium-lithium shell
3  0       2  $ zero-importance outside world
4  2 .1 -3 5
5  2 .1 -4 6
6  2 .1 -5
7  2 .1 -6

1  so 10
2  so 20
3  s -10 2r 2.1
4  s 10 2r 1.1
5  s -10 2r 1.9
6  s 10 2r .9

mode p
imp:p 1 1 0 1 1 1m 1m
m1  92000 1  1000 3
m2  92000 1  3000 3
c  monoenergetic isotropic point source at (0,0,0)
sdef erg=3  cel=1
e0  .01 .1 1 5
f6:p 1 2 6 7  $ heating tally
f5x:p 12 15 1
f4:p 1 2 6 7  $ flux tally
fq4 e f
fq6 f e
fq5 e d
fq25 e d
fz25:p -12 15 -1  -7 7 2
dd 0 100 .01
dd5 -.1
nps 5000
print -90 -98 -20 -80
prdmp 2j -1
dxt:p -10 2r 1 2 10 2r 1 1 .01 .005
dxc:p 1 1 0 .9 .9 .1 .1
pd 1 1 0 .1 3r
dd2 0 100 .005 .4m
```

```
de25 .01 8i .1 8i 1 2
df25 lin .8 18i .99
phys:p .05
cut:p .1 .01 .5 .2 .8
cf4 4
cf6 5
```

2.2.5 Installation Test Case 5

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob5 -- toroidal tokamak
1  0      1 -16 -13 19    imp:n=1
2  0      1 16 -10 18     imp:n=1
3  1 .04688  1 5 -11 10   imp:n=1
4  2 .1125  1 9 -12 11 16  imp:n=1
5  3 .113  1 -7 -14 13    imp:n=1
6  4 .0933  1 -17 -15 14   imp:n=1
7  4 .0933  -3 15 -6 9     imp:n=4
8  0      7 8 -15 13 -3 -12 imp:n=1
9  1 .04688  -4 -8         imp:n=2
10  2 .1125  -3 4 -8       imp:n=4
11  0     -5 10 -13 8 -11  imp:n=1
12  0     3            imp:n=0
13  0     -1           imp:n=0
14  0     1 -3 12 2 16    imp:n=0
15  2 .1125  -3 12 9 -2 16  imp:n=4
16  0     1 -3 15 6 -16   imp:n=0
17  3 .113  17 -7 -15 14 1  imp:n=1
18  0     -3 15 -9 8      imp:n=1
19  0     -3 11 -9 8 16   imp:n=1
20  0     1 -18 16        imp:n=1
21  0     1 -19 -16       imp:n=1

*1  py 80    $ reflecting surface
2   ty 35 906.9126 105 643.48 244.7044 227.0383
3   py 930
4   py 830
5   k/y 35 -1056.4 105 .183726
6   ty 35 906.9126 105 643.48 244.7044 227.0383
7   k/y 35 1405. 105 .64
8   ty 35 906.9126 105 643.48 170. 151.9694
9   ty 35 906.9126 105 643.48 205.8074 187.49784
10  ty 35 80 105 605. 620. 505.
```

```
11   ty 35 80 105 605. 720. 605.
12   ty 35 80 105 605. 820. 705.
13   ty 35 80 105 2330. 1800. 1800.
14   ty 35 80 105 2330. 1820. 1820.
15   ty 35 80 105 2330. 1920. 1920.
16   c/y 35 105  639.6136
17   k/y 35 1373. 105 .64
18   ty 35 80 105 486.4769 593.5231 593.5231
19   ty 35 80 105 2330. 1785. 1785.
c   volume source uniform in cells 20 and 21
sdef erg d1  cel=d4  rad fcel d2  ext d3  axs=0 1 0  pos=35 80 105
si1  13.876 14.0123
sp1  0 1
ds2  s d5 d6
si3  0 580
si4  1 20 21
sp4  v
si5  639.6136 1080
si6  545 639.6136
c
m1   3007.40c .8878 5010 .1122
m2   6012.40c .9944
m3   6012.40c 1
m4   5010 .4707 6012.40c .1177
drxs 5010  $ just to test the drxs feature.
phys:n 14.1
c
f4:n 3 9
fq4  f
f1:n 3
fs1  -8 -9 t
fq1  s
c
cut:n 2j .001 .0005
nps  1000
print -98
prdmp 2j -1        $ write mctal file.
```

2.2.6 Installation Test Case 6

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob6 -- cutoffs, flagging, and variance reduction features
c   energy importance, exponential transform, forced collisions
1   1 .11 -1      $ carbon ball
2   2 .08 -2 1 5  $ copper polar caps
4   1 .05 -3 -4   $ carbon lens
3   1 .05 -3 2 4  $ carbon shell, minus lens
5   0    3.       $ zero-importance outside world
6   2 .08 1 -2 -5 $ copper belt

4   gq 1 1 1 .01 .02 .03 .025 -80.2 .015 578.
2   sy .1 7.5
3   sy .1 10
1   sy .1 5
5   gq 0 0 1 0 5r -9  $ 2 parallel planes

esplt:n 2 7 2 3  $ 2-for-1 splits at 7 and 3 mev
imp:n 1 3r 0 .5
wwp:n 5 3 5 1 .4
c   source on spherical surface with position and energy bias
sdef sur 1 ext d1 axs 0 1 0 erg=fdir=d2 dir=d4
si1  -1 .2 1
sp1  0 .6 .4
sb1  0 .4 .6
si4  a -1 0 .5 .8 .9 1
sp4  .5 4i 1
```

```
c   ds q and detector combo fail in mcnp4.2
ds2 q .1 11 .4 12 .7 13 1. 14
si11 h 1 5
sp11 d 0 1
si12 h 5 10
sp12 d 0 1
si13 h 10 14
sp13 d 0 1
si14 h 14 16
sp14 d 0 1
c
m1   6012.40c 1
m2   29000.40c 1
f1:n 1
e1   .183 .498 .821 1.353 3.679 12.0 13.5 14.2
c1   -.866 -.5 0 .5 .866 1 t
c   f5/f15 with different time bins are erroneously
c   master/slave in mcnp4.2
f5:n 5 5 5 1
f15:n 5 5 5 1
fq5 t d
fq15 t d
t15  2 3i 10
t5   2
fq1  c e
f2:n 2
e2   1 14.2
t2   5 10
f4:n 2
e4   1 14.2
t4   5 10
sf4  4
ext:n .2y .2y 0 0 0 $ exponential tranform in the y direction
fcl:n 0 0 0 .2 0 $ forced collisions in cell 3
cut:n 10 .02 .01
nps 5000
print
prdmp 2j -1
```

2.2.7 Installation Test Case 7

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob7 -- generate surface source for prob8
```

```
1   0  12              $ zero-importance outside world
2   0  -12 (7:1:-2)    $ empty space
3   5 -5.2  -7 -1 2 #4 #5  $ rusty box
4   6 -8.1  -5 -4 3    $ source cell:  uranium oxide
5   7 -2.7  -7 -6 5    $ aluminum stuffer

1   cx 15
2   px 0
3   px 10
4   cx 5
5   px 20
6   c/x 2.5 0 2.5
7   px 40
12  so 170

m5   26000.40c 1  8016.40c 1
m6   92235.40c 1  8016.40c 2
m7   13027.40c 1
drxs
imp:n  0 0 1 2r
ssw  7    $ write the surface source at surface 7
c
sdef erg d1  cel 4  axs 1 0 0  rad d3  ext d2  vec 1 0 0  dir d5
si1  a 1 2 4 7
sp1  0 2 1 0
sc2  the symmetry makes it a fair game.
si2  10 12 14 16 18 20
sp2  0 1 4r
sb2  0 1 2 3 4 5
si3  0 5
sp3  -21 1
si5  -1 -.5 0 .5 1
sp5  0 1 3r
sb5  0 1 2 3 4
c
f2:n  7
e0   .1 .5 1 2 10
f7:n  4
sd2  706.858  $ area of surface 7
cut:n  j .01
nps  10000
prdmp 2j -1
print -98
```

2.2.8 Installation Test Case 8

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
 mEssAgE: rssA=rssA08 &
  fAtAl.

prob8 -- use surface source from prob7
1   0  12
2   0  -12 #3 #6 #7
3   0  -71 -1 2
6   8 -1.2  -9 -11 8  $ cArbOn dIsk
7   9 -1.2  -10 -11 9  $ AnOthEr cArbOn dIsk

1   cx 15
2   px 0
71   x 40 0
8   px 100
9   px 110
10   px 120
11   x  0 20  -10 20
12   sO 170

m8   6012.40c .9 26000.40c .1
m9   6012.40c .6  1001.00c .2  29000.40c .2
pIkmt 6012 0   1001 -1
    26000 1 102001 1
ssr  nEw 71  psc 1
f4:n  7
E4   1 2 3 5 7 20
f14:p  7
E14  .1 1 10 100
f24:E  7
E24  .01 .1 1 10 100 1000
f6:n,p 7 6
fq6  E f
f26:p 6 7
fq26  E f
E26  .01 .1 1 5 10 20
*f8:p  6 7
fq8  f t
prdmp 2j -1
prInt -98

Imp:p,E,n .0 1 3r
mOdE E n p
wwg  24 2 0 1E8 0 0
wwgE:E .01 .1 1 100
wwgE:p .1 1 10 100
```

```
wwgE:n 1 20
Esplt:E .5 .01 .5 .1 .5 1
f5:n 115 0 0 .01
dd5 -1.E-8
f15:p 115 0 0 .01
dd15 0
nps 30000
phys:E 1000 0 0 1 1 1.2 .8 .1 .7
ptrac file=asc max=2000 type=p,e tally=14,24 value=3.e-7,2.e-9
```

2.2.9 Installation Test Case 9

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob9 -- kcode in complicated cells and sdef
1   1 -14.1  -1 2 3(-4:-16)5 -6(12:13:-14)(10:-9:-11:-7:6)15
2   2 -7.58  -10 9 11 7 -6 -1:2 -12 14 -6 -13 3
3   3 -.01   -17(1:-2:-5:6:-3:-15:16 4)
4   0 17

1   pz 10
2   pz -10
3   py -10
4   py 10
5   px -10
6   px 10
7   px -1
9   py -2
10  py 0
11  pz 5
12  pz -8
13  py -3
14  px 2
15  3 kx  1 .3 1 $ MCNP4.2 cone rotation bug (X-6:HGH-92-337)
16  2 kz 13 1 -1 $ MCNP4.2 cone rotation bug (X-6:HGH-92-337)
17  so 20

imp:n 1 1 1 0
tr3  0 0 0 0 -1 0 1 0 0 0 0 1
tr2  0 0 0 1 0 0 0 0 -1 0 1 0
kcode 1000 1 3 10
sdef  cel=1 x=d3 y=d2 z=d1
si1  -10 10
```

```
sp1  0 1
si3  -10 10
sp3  0 3
si2  -10 10
sp2  0 2
m1  92235.40c 1  $ test of getting 92235.51c instead
m2  29000.40c -1  $ test getting 29000.51c instead
m3  8016.40c 1  7014.40c 1
print -98
prdmp 2j -1
f7:n  1 2 3
vol  1 j 1
fq0  e f
f4:n  1 2 3
e0         .162524 .266043 .358425 .445672 .530293 .613680
     .696783 .780264 .864702 .950540 1.038286 1.128326 1.221111
     1.317206 1.417070 1.521302 1.630646 1.745929 1.868073 1.998282
     2.138046 2.289259 2.454356 2.636707 2.840830 3.073518 3.344965
     3.672134 4.086420 4.656234 5.588725 9.000000
ssw  cel 1
```

2.2.10 Installation Test Case 10

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob10 general test problem    /x6code/gtprob
1   1 -6.4   1 -2 -31 32 -33 34
2   0        10 -4 -12 #1
3   2 -1     4 -14 -12 5
4   3 -8.94  -5 6
5   0        -6
6   4 -2.25  7 -8 -12
7   2 -1     8 -9 -12
8   2 -1     9 -12
9   4 -2.25  11 -10 -12
10  2 -1     -11 -12
11  3 -8.94  12 -13
12  0        13
13  2 -1     14 -7 -12 5

1   px 0
2   px 10
4   px 11.9
5   tx 30 0 0 20 18 18
```

```
6   tx 30 0 0 20 15 15
7   px 50
8   px 70
9   px 90
10  px -20
11  px -50
12  cx 40
13  cx 45
14  px 30
20  cx 10
21  cx 25
31  py 5
32  py -5
33  pz 5
34  pz -5

mode  n p
m1   29000.40 1  8016.40 1
m2   1001.00 2  8016.40 1
m3   29000.40 1
m4   6012.40 1
imp:n  1 1 2 2 2 4 2 1 .5 .25 1 0 4
imp:p  1 1 2 2 2 4 2 1 .5 .25 1 0 4
sdef  erg=d1 vec=1 0 0 dir=d2 pos=5 0 0 rad=d3 cel=1
sp1  -3
sb2  -31 1.2
si3  8.67
f4:n  6
f14:p 6
fq   s e
fs   -20 -21
phys:n  j 1e-6
phys:p 1 0
nps  500
prdmp 2j -1
print 20 -70 50 -72 100 -30 -98
```

2.2.11 Installation Test Case 11

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob11 -- intertwined super pretzels with s(a,b), mode n p
1    1 -7.8  -1:-2:-3  $ pretzel of tori
2    2 -2.66  -4:-5:-6:-7:-8:-9:-10:-11  $ cage of ellipsoids
```

```
3   3 -9    -12 -13:-14:-15:-16:-17:-18:-19:-20:-21  $ toys
4   4 -.5   1 2 3 4 5 6 7 8 9 10 11(12:13)  $ space between
          14 15 16 17 18 19 20 21 -22
5   0      22     $ zero-importance outside world
6   0      -23 -24 -25 26  $ cookie-cutter cell

1   tx 0 0 0 10 2 2
2   ty 0 0 0 12 2 2.5
3   tz 0 0 0 10 3 4
4   sq .028 1 1 0 0 0 -1 0 15 5
5   sq 1 .00448 1 0 0 0 -1 -5 0 5
6   sq 1 1 .028 0 0 0 -1 -5 -15 0
7   sq 1 .00448 1 0 0 0 -1 -5 0 -5
8   sq .028 1 1 0 0 0 -1 0 15 -5
9   sq 1 .00448 1 0 0 0 -1 5 0 -5
10  sq 1 1 .028 0 0 0 -1 5 -15 0
11  sq 1 .00448 1 0 0 0 -1 5 0 5
12  sq .1 0 .05 0 1 0 -4 0 -11 17
13  sq .1 0 .07 0 -.3 0 -10 0 -1 16
14  sq .05 .2 1 0 0 0 -16 0 -6 -20
15  sq 1 .1 1 0 0 0 -4 0 14 -14
16  sq 1 1 .1 0 0 0 -4 0 14 -14
17  s 0 4.5 22.5 2
18  s 0 6.5 22.5 2
19  s 0 5.5 18 4
20  s 0 4.5 14 1
21  s 0 6.5 14 1
22  so 30
23  pz 9
24  c/y 1 .5 10
25  py -18.5
26  py -21.5

m1   92235.40c 1
m2   14000.40c 1 8016.40c 2
m3   29000.40c 1
m4   1001.00c 2 8016.40c 1
mt4  lwtr.01t
imp:n 1 1 1 1 0 0
mode n p
c   monodirectional source on plane with cookie cutter
sdef pos 0 -20 0 dir 1 vec .05 1 .1 rad d1 axs .05 1 .1
     ccc 6 erg d2
si1  0 12
si2  1e-8 .001
sp2  0 1
cut:n 1000 0 .2 .1
fq   f e
f4:n   1 2 3
sd4   (1) (1) (1)
```

```
fc4  volumes=1. so tally is volume-integrated flux
e4   1e-7 .001 20
f11:p  1 2 3 t
tmp1  4e-8 3r 0 0
nps  3000
print  -98 -85
prdmp 2j -1
```

2.2.12 Installation Test Case 12

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No differences whatsoever were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob12 ==>> porosity tool model
c ==========================================================
c ==========================================================
c ===>>> run       : prob12
c ===>>> tool      : generic porosity tool
c ===>>> source    : ambe
c ===>>> borehole  : 8" bh, fw
c ===>>> formation : 20 pu limestone, fw
c ===>>> casing    : none
c ===>>> detector  : he-3 at 4 atomospheres
c ===>>>             near : 1"odx3"  at 7.5" centerline from source
c ===>>>             far  : 2"odx10" at 20" centerline from source
c ===>>> shielding : none
c ===>>> sonde     : solid iron
c ===>>> weights   : xtrapt/diffusion
c ===>>>  generate weights using wep patch with factor of 2.0 to far det
c ===>>>     using a factor of 8.0; only use 50k particles
c ===>>> physics   : thermal cutin changed to -200
c ===>>>             s(a,b) added for water
c ==========================================================
c ==========================================================
c
c
c ==========================================================
c ===== zone cards
c ==========================================================
c ===== near detector
c ==========================================================
c
  1  1  -0.000502   -1   +13   -14              $ det_n
c
```

```
c  ==========================================================================
c  ===== far detector
c  ==========================================================================
c
 2  1  -0.000502   -2   +16   -19                    $ det_f
c
c  ==========================================================================
c  ===== source region
c  ==========================================================================
c
 3  2  -7.86       -3   +11   -12                    $ sourc
c
c  ==========================================================================
c  ===== iron sonde
c  ==========================================================================
c
 4  2  -7.86       -3   +10   -11                    $ sonde
 5  2  -7.86       -3   +12   -13                    $ sonde
 6  2  -7.86       +1   -3    +13   -14              $ sonde
 7  2  -7.86       -3   +14   -15                    $ sonde
 8  2  -7.86       -3   +15   -16                    $ sonde
 9  2  -7.86       +2   -3    +16   -17              $ sonde
10  2  -7.86       +2   -3    +17   -18              $ sonde
11  2  -7.86       +2   -3    +18   -19              $ sonde
12  2  -7.86       -3   +19   -20                    $ sonde
13  2  -7.86       -3   +20   -21                    $ sonde
14  2  -7.86       -3   +21   -22                    $ sonde
c
c  ==========================================================================
c  ===== borehole
c  ==========================================================================
c
15  3  -1.0        +3   -5    -4   +10   -11         $ bh
16  3  -1.0        +3   -5    -4   +11   -12         $ bh
17  3  -1.0        +3   -5    -4   +12   -13         $ bh
18  3  -1.0        +3   -5    -4   +13   -14         $ bh
19  3  -1.0        +3   -5    -4   +14   -15         $ bh
20  3  -1.0        +3   -5    -4   +15   -16         $ bh
21  3  -1.0        +3   -5    -4   +16   -17         $ bh
22  3  -1.0        +3   -5    -4   +17   -18         $ bh
23  3  -1.0        +3   -5    -4   +18   -19         $ bh
24  3  -1.0        +3   -5    -4   +19   -20         $ bh
25  3  -1.0        +3   -5    -4   +20   -21         $ bh
26  3  -1.0        +3   -5    -4   +21   -22         $ bh
27  3  -1.0        +3   -5    +4   +10   -11         $ bh
28  3  -1.0        +3   -5    +4   +11   -12         $ bh
29  3  -1.0        +3   -5    +4   +12   -13         $ bh
30  3  -1.0        +3   -5    +4   +13   -14         $ bh
31  3  -1.0        +3   -5    +4   +14   -15         $ bh
32  3  -1.0        +3   -5    +4   +15   -16         $ bh
```

```
33  3  -1.0      +3   -5   +4   +16  -17       $ bh
34  3  -1.0      +3   -5   +4   +17  -18       $ bh
35  3  -1.0      +3   -5   +4   +18  -19       $ bh
36  3  -1.0      +3   -5   +4   +19  -20       $ bh
37  3  -1.0      +3   -5   +4   +20  -21       $ bh
38  3  -1.0      +3   -5   +4   +21  -22       $ bh
c
c  ==================================================================
c  ==== formation region to radius=15 cm
c  ==================================================================
c
39  4  -2.3688   +5   -6   -23  -24  +10  -11  $ form
40  4  -2.3688   +5   -6   -23  -24  +11  -12  $ form
41  4  -2.3688   +5   -6   -23  -24  +12  -13  $ form
42  4  -2.3688   +5   -6   -23  -24  +13  -14  $ form
43  4  -2.3688   +5   -6   -23  -24  +14  -15  $ form
44  4  -2.3688   +5   -6   -23  -24  +15  -16  $ form
45  4  -2.3688   +5   -6   -23  -24  +16  -17  $ form
46  4  -2.3688   +5   -6   -23  -24  +17  -18  $ form
47  4  -2.3688   +5   -6   -23  -24  +18  -19  $ form
48  4  -2.3688   +5   -6   -23  -24  +19  -20  $ form
49  4  -2.3688   +5   -6   -23  -24  +20  -21  $ form
50  4  -2.3688   +5   -6   -23  -24  +21  -22  $ form
51  4  -2.3688   +5   -6   -23  +24  +10  -11  $ form
52  4  -2.3688   +5   -6   -23  +24  +11  -12  $ form
53  4  -2.3688   +5   -6   -23  +24  +12  -13  $ form
54  4  -2.3688   +5   -6   -23  +24  +13  -14  $ form
55  4  -2.3688   +5   -6   -23  +24  +14  -15  $ form
56  4  -2.3688   +5   -6   -23  +24  +15  -16  $ form
57  4  -2.3688   +5   -6   -23  +24  +16  -17  $ form
58  4  -2.3688   +5   -6   -23  +24  +17  -18  $ form
59  4  -2.3688   +5   -6   -23  +24  +18  -19  $ form
60  4  -2.3688   +5   -6   -23  +24  +19  -20  $ form
61  4  -2.3688   +5   -6   -23  +24  +20  -21  $ form
62  4  -2.3688   +5   -6   -23  +24  +21  -22  $ form
63  4  -2.3688   +5   -6   +23  -24  +10  -11  $ form
64  4  -2.3688   +5   -6   +23  -24  +11  -12  $ form
65  4  -2.3688   +5   -6   +23  -24  +12  -13  $ form
66  4  -2.3688   +5   -6   +23  -24  +13  -14  $ form
67  4  -2.3688   +5   -6   +23  -24  +14  -15  $ form
68  4  -2.3688   +5   -6   +23  -24  +15  -16  $ form
69  4  -2.3688   +5   -6   +23  -24  +16  -17  $ form
70  4  -2.3688   +5   -6   +23  -24  +17  -18  $ form
71  4  -2.3688   +5   -6   +23  -24  +18  -19  $ form
72  4  -2.3688   +5   -6   +23  -24  +19  -20  $ form
73  4  -2.3688   +5   -6   +23  -24  +20  -21  $ form
74  4  -2.3688   +5   -6   +23  -24  +21  -22  $ form
75  4  -2.3688   +5   -6   +23  +24  +10  -11  $ form
76  4  -2.3688   +5   -6   +23  +24  +11  -12  $ form
77  4  -2.3688   +5   -6   +23  +24  +12  -13  $ form
```

```
 78  4 -2.3688   +5   -6  +23  +24  +13  -14  $ form
 79  4 -2.3688   +5   -6  +23  +24  +14  -15  $ form
 80  4 -2.3688   +5   -6  +23  +24  +15  -16  $ form
 81  4 -2.3688   +5   -6  +23  +24  +16  -17  $ form
 82  4 -2.3688   +5   -6  +23  +24  +17  -18  $ form
 83  4 -2.3688   +5   -6  +23  +24  +18  -19  $ form
 84  4 -2.3688   +5   -6  +23  +24  +19  -20  $ form
 85  4 -2.3688   +5   -6  +23  +24  +20  -21  $ form
 86  4 -2.3688   +5   -6  +23  +24  +21  -22  $ form
c
c  =================================================================
c  ===== formation region to radius=25 cm
c  =================================================================
c
 87  4 -2.3688   +6   -7  -23  -24  +10  -11  $ form
 88  4 -2.3688   +6   -7  -23  -24  +11  -12  $ form
 89  4 -2.3688   +6   -7  -23  -24  +12  -13  $ form
 90  4 -2.3688   +6   -7  -23  -24  +13  -14  $ form
 91  4 -2.3688   +6   -7  -23  -24  +14  -15  $ form
 92  4 -2.3688   +6   -7  -23  -24  +15  -16  $ form
 93  4 -2.3688   +6   -7  -23  -24  +16  -17  $ form
 94  4 -2.3688   +6   -7  -23  -24  +17  -18  $ form
 95  4 -2.3688   +6   -7  -23  -24  +18  -19  $ form
 96  4 -2.3688   +6   -7  -23  -24  +19  -20  $ form
 97  4 -2.3688   +6   -7  -23  -24  +20  -21  $ form
 98  4 -2.3688   +6   -7  -23  -24  +21  -22  $ form
 99  4 -2.3688   +6   -7  -23  +24  +10  -11  $ form
100  4 -2.3688   +6   -7  -23  +24  +11  -12  $ form
101  4 -2.3688   +6   -7  -23  +24  +12  -13  $ form
102  4 -2.3688   +6   -7  -23  +24  +13  -14  $ form
103  4 -2.3688   +6   -7  -23  +24  +14  -15  $ form
104  4 -2.3688   +6   -7  -23  +24  +15  -16  $ form
105  4 -2.3688   +6   -7  -23  +24  +16  -17  $ form
106  4 -2.3688   +6   -7  -23  +24  +17  -18  $ form
107  4 -2.3688   +6   -7  -23  +24  +18  -19  $ form
108  4 -2.3688   +6   -7  -23  +24  +19  -20  $ form
109  4 -2.3688   +6   -7  -23  +24  +20  -21  $ form
110  4 -2.3688   +6   -7  -23  +24  +21  -22  $ form
111  4 -2.3688   +6   -7  +23  -24  +10  -11  $ form
112  4 -2.3688   +6   -7  +23  -24  +11  -12  $ form
113  4 -2.3688   +6   -7  +23  -24  +12  -13  $ form
114  4 -2.3688   +6   -7  +23  -24  +13  -14  $ form
115  4 -2.3688   +6   -7  +23  -24  +14  -15  $ form
116  4 -2.3688   +6   -7  +23  -24  +15  -16  $ form
117  4 -2.3688   +6   -7  +23  -24  +16  -17  $ form
118  4 -2.3688   +6   -7  +23  -24  +17  -18  $ form
119  4 -2.3688   +6   -7  +23  -24  +18  -19  $ form
120  4 -2.3688   +6   -7  +23  -24  +19  -20  $ form
```

```
121  4  -2.3688   +6  -7  +23  -24  +20  -21  $ form
122  4  -2.3688   +6  -7  +23  -24  +21  -22  $ form
123  4  -2.3688   +6  -7  +23  +24  +10  -11  $ form
124  4  -2.3688   +6  -7  +23  +24  +11  -12  $ form
125  4  -2.3688   +6  -7  +23  +24  +12  -13  $ form
126  4  -2.3688   +6  -7  +23  +24  +13  -14  $ form
127  4  -2.3688   +6  -7  +23  +24  +14  -15  $ form
128  4  -2.3688   +6  -7  +23  +24  +15  -16  $ form
129  4  -2.3688   +6  -7  +23  +24  +16  -17  $ form
130  4  -2.3688   +6  -7  +23  +24  +17  -18  $ form
131  4  -2.3688   +6  -7  +23  +24  +18  -19  $ form
132  4  -2.3688   +6  -7  +23  +24  +19  -20  $ form
133  4  -2.3688   +6  -7  +23  +24  +20  -21  $ form
134  4  -2.3688   +6  -7  +23  +24  +21  -22  $ form
c
c ==========================================================
c ===== formation region to radius=40 cm
c ==========================================================
c
135  4  -2.3688   +7  -8  -23  -24  +10  -11  $ form
136  4  -2.3688   +7  -8  -23  -24  +11  -12  $ form
137  4  -2.3688   +7  -8  -23  -24  +12  -13  $ form
138  4  -2.3688   +7  -8  -23  -24  +13  -14  $ form
139  4  -2.3688   +7  -8  -23  -24  +14  -15  $ form
140  4  -2.3688   +7  -8  -23  -24  +15  -16  $ form
141  4  -2.3688   +7  -8  -23  -24  +16  -17  $ form
142  4  -2.3688   +7  -8  -23  -24  +17  -18  $ form
143  4  -2.3688   +7  -8  -23  -24  +18  -19  $ form
144  4  -2.3688   +7  -8  -23  -24  +19  -20  $ form
145  4  -2.3688   +7  -8  -23  -24  +20  -21  $ form
146  4  -2.3688   +7  -8  -23  -24  +21  -22  $ form
147  4  -2.3688   +7  -8  -23  +24  +10  -11  $ form
148  4  -2.3688   +7  -8  -23  +24  +11  -12  $ form
149  4  -2.3688   +7  -8  -23  +24  +12  -13  $ form
150  4  -2.3688   +7  -8  -23  +24  +13  -14  $ form
151  4  -2.3688   +7  -8  -23  +24  +14  -15  $ form
152  4  -2.3688   +7  -8  -23  +24  +15  -16  $ form
153  4  -2.3688   +7  -8  -23  +24  +16  -17  $ form
154  4  -2.3688   +7  -8  -23  +24  +17  -18  $ form
155  4  -2.3688   +7  -8  -23  +24  +18  -19  $ form
156  4  -2.3688   +7  -8  -23  +24  +19  -20  $ form
157  4  -2.3688   +7  -8  -23  +24  +20  -21  $ form
158  4  -2.3688   +7  -8  -23  +24  +21  -22  $ form
159  4  -2.3688   +7  -8  +23  -24  +10  -11  $ form
160  4  -2.3688   +7  -8  +23  -24  +11  -12  $ form
161  4  -2.3688   +7  -8  +23  -24  +12  -13  $ form
162  4  -2.3688   +7  -8  +23  -24  +13  -14  $ form
163  4  -2.3688   +7  -8  +23  -24  +14  -15  $ form
164  4  -2.3688   +7  -8  +23  -24  +15  -16  $ form
165  4  -2.3688   +7  -8  +23  -24  +16  -17  $ form
```

```
166  4  -2.3688   +7  -8  +23  -24  +17  -18  $ form
167  4  -2.3688   +7  -8  +23  -24  +18  -19  $ form
168  4  -2.3688   +7  -8  +23  -24  +19  -20  $ form
169  4  -2.3688   +7  -8  +23  -24  +20  -21  $ form
170  4  -2.3688   +7  -8  +23  -24  +21  -22  $ form
171  4  -2.3688   +7  -8  +23  +24  +10  -11  $ form
172  4  -2.3688   +7  -8  +23  +24  +11  -12  $ form
173  4  -2.3688   +7  -8  +23  +24  +12  -13  $ form
174  4  -2.3688   +7  -8  +23  +24  +13  -14  $ form
175  4  -2.3688   +7  -8  +23  +24  +14  -15  $ form
176  4  -2.3688   +7  -8  +23  +24  +15  -16  $ form
177  4  -2.3688   +7  -8  +23  +24  +16  -17  $ form
178  4  -2.3688   +7  -8  +23  +24  +17  -18  $ form
179  4  -2.3688   +7  -8  +23  +24  +18  -19  $ form
180  4  -2.3688   +7  -8  +23  +24  +19  -20  $ form
181  4  -2.3688   +7  -8  +23  +24  +20  -21  $ form
182  4  -2.3688   +7  -8  +23  +24  +21  -22  $ form
c
c ==========================================================================
c ===== formation region to radius= 60 cm
c ==========================================================================
c
183  4  -2.3688   +8  -9  -23  -24  +10  -11  $ form
184  4  -2.3688   +8  -9  -23  -24  +11  -12  $ form
185  4  -2.3688   +8  -9  -23  -24  +12  -13  $ form
186  4  -2.3688   +8  -9  -23  -24  +13  -14  $ form
187  4  -2.3688   +8  -9  -23  -24  +14  -15  $ form
188  4  -2.3688   +8  -9  -23  -24  +15  -16  $ form
189  4  -2.3688   +8  -9  -23  -24  +16  -17  $ form
190  4  -2.3688   +8  -9  -23  -24  +17  -18  $ form
191  4  -2.3688   +8  -9  -23  -24  +18  -19  $ form
192  4  -2.3688   +8  -9  -23  -24  +19  -20  $ form
193  4  -2.3688   +8  -9  -23  -24  +20  -21  $ form
194  4  -2.3688   +8  -9  -23  -24  +21  -22  $ form
195  4  -2.3688   +8  -9  -23  +24  +10  -11  $ form
196  4  -2.3688   +8  -9  -23  +24  +11  -12  $ form
197  4  -2.3688   +8  -9  -23  +24  +12  -13  $ form
198  4  -2.3688   +8  -9  -23  +24  +13  -14  $ form
199  4  -2.3688   +8  -9  -23  +24  +14  -15  $ form
200  4  -2.3688   +8  -9  -23  +24  +15  -16  $ form
201  4  -2.3688   +8  -9  -23  +24  +16  -17  $ form
202  4  -2.3688   +8  -9  -23  +24  +17  -18  $ form
203  4  -2.3688   +8  -9  -23  +24  +18  -19  $ form
204  4  -2.3688   +8  -9  -23  +24  +19  -20  $ form
205  4  -2.3688   +8  -9  -23  +24  +20  -21  $ form
206  4  -2.3688   +8  -9  -23  +24  +21  -22  $ form
207  4  -2.3688   +8  -9  +23  -24  +10  -11  $ form
208  4  -2.3688   +8  -9  +23  -24  +11  -12  $ form
209  4  -2.3688   +8  -9  +23  -24  +12  -13  $ form
210  4  -2.3688   +8  -9  +23  -24  +13  -14  $ form
```

```
211  4  -2.3688   +8   -9  +23  -24  +14  -15  $ form
212  4  -2.3688   +8   -9  +23  -24  +15  -16  $ form
213  4  -2.3688   +8   -9  +23  -24  +16  -17  $ form
214  4  -2.3688   +8   -9  +23  -24  +17  -18  $ form
215  4  -2.3688   +8   -9  +23  -24  +18  -19  $ form
216  4  -2.3688   +8   -9  +23  -24  +19  -20  $ form
217  4  -2.3688   +8   -9  +23  -24  +20  -21  $ form
218  4  -2.3688   +8   -9  +23  -24  +21  -22  $ form
219  4  -2.3688   +8   -9  +23  +24  +10  -11  $ form
220  4  -2.3688   +8   -9  +23  +24  +11  -12  $ form
221  4  -2.3688   +8   -9  +23  +24  +12  -13  $ form
222  4  -2.3688   +8   -9  +23  +24  +13  -14  $ form
223  4  -2.3688   +8   -9  +23  +24  +14  -15  $ form
224  4  -2.3688   +8   -9  +23  +24  +15  -16  $ form
225  4  -2.3688   +8   -9  +23  +24  +16  -17  $ form
226  4  -2.3688   +8   -9  +23  +24  +17  -18  $ form
227  4  -2.3688   +8   -9  +23  +24  +18  -19  $ form
228  4  -2.3688   +8   -9  +23  +24  +19  -20  $ form
229  4  -2.3688   +8   -9  +23  +24  +20  -21  $ form
230  4  -2.3688   +8   -9  +23  +24  +21  -22  $ form
c
c  ======================================================================
c  ===== external void
c  ======================================================================
c
231   0        +9                          $ exter
         : -10                             $ exter
         : +22                             $ exter

c
c  ======================================================================
c  ===== surface cards
c  ======================================================================
c  ===== general symbols
c  ======================================================================
c  ======================================================================
c  ===== detectors
c  ======================================================================
c
  1 cy     1.27                            $ c_nea
  2 cy     2.54                            $ c_far
c
c  ======================================================================
c  ===== tool, borehole and formation cylinders
c  ======================================================================
c
  3 cy     3.81                            $ c_too
  4 cy     8.255                           $ c_hal
  5 c/y   -6.34    0.0    10.16            $ c_bh
  6 c/y   -6.34    0.0    15.0             $ c_for
```

```
 7 c/y   -6.34   0.0   25.0              $ c_for
 8 c/y   -6.34   0.0   40.0              $ c_for
 9 c/y   -6.34   0.0   60.0              $ c_for
c
 10 py   -38.1                           $ btm
 11 py   -5.0                            $ b_sou
 12 py    5.0                            $ t_sou
 13 py   15.24                           $ b_nea
 14 py   22.86                           $ t_nea
 15 py   30.0                            $ plane
 16 py   38.1                            $ b_far
 17 py   46.0                            $ plane
 18 py   54.0                            $ plane
 19 py   63.5                            $ t_far
 20 py   70.0                            $ plane
 21 py   82.5                            $ plane
 22 py   101.6                           $ top
c
c ================================================================
c ==== divide formation into 4 pieces
c ================================================================
c
 23 p    1.0    0.0    1.0    0.0         $ p1
 24 p    1.0    0.0   -1.0    0.0         $ p2

c
c ================================================================
c ==== data cards
c ================================================================
c

mode  n
print  110 157
drxs
nps   3000
c
c ================================================================
c ==== material #   1
c ================================================================
c  name    = helium-3
c  density =   0.000502 g/cc
c
  m1   2003.00c 1.00000
c
c ================================================================
c ==== material #   2
c ================================================================
c  name    = iron
c  density =   7.8600 g/cc
c
```

```
 m2  26000.40c 1.00000
c
c  =====================================================================
c  ==== material #   3
c  =====================================================================
c  name   = borehole fluid - fw
c  density =    1.0000 g/cc
c
 m3   1001.00c 0.66667    8016.40c 0.33333
c
c  =====================================================================
c  ==== material #   4
c  =====================================================================
c  name   = formation - 20 pu limestone, fw
c  density =   2.3688 g/cc
c
 m4   1001.00c 0.15675    6012.40c 0.15298    8016.40c 0.53730
c
c  =====================================================================
c  ==== material #   5
c  =====================================================================
c  name   = formation - 1 pu limestone, fw
c  density =   2.6939 g/cc
c
 m5   1001.00c 0.00818    6012.40c 0.19755    8016.40c 0.59673
c
c
c  =====================================================================
c  ===== s(a,b) treatment
c  =====================================================================
c
mt3  lwtr.01
mt4  lwtr.01
mt5  lwtr.01
c
c  =====================================================================
c  ===== neutron source => ambe neutron source
c  =====================================================================
c
c     sdir   0.0  1.0  0.0  0.6  0.5
 sdef    cel=3 wgt=1 erg=d1 dir=d2 vec= 0.0 1.0 0.0
 si1           .0026126 .0408000 .0673800 .0865170
      .1110900 .1227700 .1356900 .1499600 .1647300
      .1831600 .2024200 .2237100 .2427400 .2732400
      .3019700 .3337300 .3683300 .4076200 .4504900
      .4978700 .5502300 .6081000 .6720600 .7427400
      .8208500 .9071800 1.002600 1.108000 1.224600
      1.353400 1.495700 1.653000 1.826800 2.019000
      2.231300 2.466000 2.725300 3.011900 3.328700
      3.678800 4.065700 4.493300 4.965900 5.488100
```

```
    6.065300 6.703200 7.408200 8.187300 9.048400
    10.000000 11.052000
sp1  .000000  .005728  .003977  .002886  .003685
    .001752  .001938  .002141  .002366  .002615
    .002889  .003193  .003530  .003900  .004310
    .004764  .005265  .005819  .006431  .007107
    .007854  .008681  .009594  .010602  .011717
    .012950  .014313  .012208  .013505  .014918
    .016482  .016790  .016973  .020516  .022661
    .025052  .027678  .037100  .051803  .046116
    .046571  .051469  .063324  .068786  .051124
    .046359  .056039  .060159  .037157  .028095
    .019113
sp2  -31 0.5
c
c  ==================================================================
c  ===== tallies
c  ==================================================================
c
fq0   e f
c
c  ==================================================================
c  ===== tally 4, neutron flux in cells 1 (near) and 2 (far)
c  ==================================================================
f4:n  1 2
fc4   neutron flux*volume in cells 1 (near) and 2 (far)
e4    0.1e-6  0.41e-6 10.6e-6 101e-6 1.5e-3 26e-3 .49 2.7 12.2 17.3
em4   1 9r
c
c  ==================================================================
c  ===== tally 24, absorption rate in cells 1 (near)
c  ==================================================================
f24:n  1
fc24  neutron absorption rate in cells 1 (near)
e24   0.1e-6  0.41e-6 10.6e-6 101e-6 1.5e-3 26e-3 .49 2.7 12.2 17.3
em24  1 9r
fm24   1.0023e-04  1  103
c
c  ==================================================================
c  ===== tally 44, absorption rate in cells 2 (far)
c  ==================================================================
f44:n  2
fc44  neutron total reaction rate in cells 1 (near) and 2 (far)
e44   0.1e-6  0.41e-6 10.6e-6 101e-6 1.5e-3 26e-3 .49 2.7 12.2 17.3
em44  1 9r
fm44   1.0023e-04  1  103
c
c  ==================================================================
c  ===== tally 64, absorption rate in cells 1 (near) and 2 (far)
c  ==================================================================
```

```
f64:n 1 2
fc64 neutron elastic scattering rate in cells 1 (near) and 2 (far)
e64 0.1e-6 0.41e-6 10.6e-6 101e-6 1.5e-3 26e-3 .49 2.7 12.2 17.3
em64 1 9r
fm64 1.0023e-04 1 2
c
c =================================================================
c ===== cutoffs
c =================================================================
c
phys:n 14 14
cut:n 830000 0.0 -.1 -.05
thtme 0
prdmp 2j -1
ctme 3600
tmp1 0.0253e-6 230r
vol 1 230r
area 1 23r
c
c =================================================================
c ===== bias parameters
c =====     derived from xtrapt with full diffusion approximation
c =====     (these are parameters for deriving ww from xtrapt
c =====     adjoint fluxes).
c =================================================================
c ===== adjoint fluxes        : por5xu1.
c ===== normalization cell    :  3
c ===== normalization group   :  2
c ===== normalization weight  :  0.5
c ===== minimum weight allowed :  0.00001
c ===== maximum weight allowed :  1.0
c ===== analog weight value   : 100000.0
c =====
c ===== number of neutron windows :  5
c ===== number of photon  windows :  0
c ===== number of mcnp cells     :  231
c =================================================================
wwp:n 5 3 5
wwe:n 4.1399-7 1.013-4 2.6058-2 2.7253 17.333
wwn1:n 5.4376e-03 5.4376e-03 5.4376e+02 5.4376e+02 1.8431e-01
     1.3183e-02 1.2343e-01 5.4376e-03 5.4376e-03 5.4376e-03
     5.4376e-03 5.4376e-03 3.9857e-01 5.4376e+02 5.4376e+02
     2.7765e+02 7.5563e-01 6.5276e-02 1.8178e-01 7.0702e-03
     5.4376e-03 5.4376e-03 5.4376e-03 2.7976e-02 2.7976e-02
     6.9505e+01 5.4376e+02 7.8168e+01 1.2746e+00 3.1653e-01
     1.8776e-01 1.5314e-02 5.4376e-03 5.4376e-03 5.4376e-03
     2.9537e-02 2.9537e-02 1.0680e+01 5.4376e+02 7.8002e+01
     6.0885e+00 1.9371e+00 4.1142e-01 8.4630e-02 2.2850e-02
     2.2850e-02 2.2851e-02 1.0777e-01 1.0777e-01 6.4436e+00
     5.4376e+02 3.0382e+01 1.0628e+00 2.2054e-01 1.0523e-01
```

```
        1.0598e-02 5.4376e-03 5.4376e-03 5.4376e-03 2.0858e-02
        2.0858e-02 2.9028e+00 5.4376e+02 3.6225e+01 9.3802e-01
        2.2052e-01 1.0528e-01 1.0603e-02 5.4376e-03 5.4376e-03
        5.4376e-03 1.9844e-02 1.9844e-02 3.4659e+00 5.4376e+02
        5.6288e+01 4.8798e-01 5.6185e-02 8.8100e-02 5.4376e-03
        5.4376e-03 5.4376e-03 5.4376e-03 1.2737e-02 1.2737e-02
        6.3683e+00 5.4376e+02 7.7442e+01 1.1057e+01 2.2675e+00
        6.0164e-01 2.0593e-01 9.7778e-02 9.7778e-02 9.7799e-02
        2.8976e-01 2.8976e-01 5.1704e+00 4.0053e+02 1.0606e+01
        1.2840e+00 2.5166e-01 6.2879e-02 1.7525e-02 8.2302e-03
        8.2302e-03 8.2311e-03 2.9484e-02 2.9484e-02 7.1153e-01
        4.1813e+02 1.1420e+01 1.4398e+00 2.5168e-01 6.2878e-02
        1.7524e-02 9.8269e-03 9.8269e-03 9.8282e-03 3.3765e-02
        3.3765e-02 7.6667e-01 2.0561e+02 4.7561e+00 4.9360e-01
        1.0839e-01 2.6856e-02 6.5165e-03 5.4376e-03 5.4376e-03
        5.4376e-03 1.0606e-02 1.0606e-02 3.1804e-01 5.4376e+02
        5.4376e+02 5.2172e+01 6.3354e+00 6.3354e+00 1.7651e+00
        8.3526e-01 8.3526e-01 8.3583e-01 8.3583e-01 2.3211e+00
        3.0391e+01 1.4502e+02 1.4502e+02 3.5676e+00 5.3502e-01
        5.3502e-01 1.4243e-01 5.1731e-02 5.1731e-02 5.1760e-02
        5.1760e-02 1.5475e-01 2.1337e+00 2.2354e+02 2.2354e+02
        5.4783e+00 8.0092e-01 8.0092e-01 2.1635e-01 8.2825e-02
        8.2825e-02 8.2873e-02 8.2873e-02 2.4264e-01 3.2576e+00
        5.8205e+01 5.8205e+01 1.4125e+00 1.9358e-01 1.9358e-01
        4.8765e-02 1.8193e-02 1.8193e-02 1.8202e-02 1.8202e-02
        5.7382e-02 8.5697e-01 5.4376e+02 5.4376e+02 1.9501e+02
        4.3795e+01 4.3795e+01 1.8594e+01 1.1175e+01 1.1175e+01
        1.1188e+01 1.1188e+01 2.2115e+01 1.2401e+02 3.1569e+02
        3.1569e+02 1.7356e+01 3.1466e+00 3.1466e+00 1.3307e+00
        1.0193e+00 1.0193e+00 1.0204e+00 1.0204e+00 2.0302e+00
        1.1171e+01 3.1575e+02 3.1575e+02 1.7358e+01 4.0853e+00
        4.0853e+00 1.7341e+00 1.0194e+00 1.0194e+00 1.0205e+00
        1.0205e+00 2.0303e+00 1.1172e+01 8.3890e+01 8.3890e+01
        4.6086e+00 1.0557e+00 1.0557e+00 4.3674e-01 2.5267e-01
        2.5267e-01 2.5294e-01 2.5294e-01 5.1594e-01 2.9604e+00
       -1.0000e+00
wwn2:n 1.7757e-02 5.4350e-04 1.5880e+00 1.5880e+00 9.6258e-02
        1.9247e-02 1.1756e-02 1.9036e-03 4.5802e-04 4.2660e-04
        4.6101e-04 2.0273e-03 9.2488e-03 7.7646e-01 1.5880e+00
        1.5880e+00 3.2581e-01 5.6523e-02 8.4317e-02 6.3782e-03
        7.9420e-04 7.6414e-04 7.9513e-04 9.9312e-03 9.9312e-03
        1.3818e+00 1.5880e+00 1.5880e+00 1.5880e+00 3.2129e-01
        2.0132e-01 1.9183e-02 3.7223e-03 3.3823e-03 3.7288e-03
        4.2937e-02 4.2937e-02 1.5880e+00 1.5880e+00 1.5880e+00
        1.5880e+00 8.6552e-01 2.2900e-01 5.6212e-02 1.6773e-02
        1.6773e-02 1.6965e-02 6.0314e-02 6.0314e-02 1.5880e+00
        1.5880e+00 1.5880e+00 7.0903e-01 1.1152e-01 4.3747e-02
        9.0062e-03 2.5991e-03 2.5991e-03 2.6214e-03 2.1023e-02
        2.1023e-02 6.2600e-01 1.5880e+00 1.5880e+00 6.0060e-01
        1.1429e-01 4.4277e-02 9.2444e-03 2.1392e-03 2.1392e-03
```

```
     2.1579e-03 1.8356e-02 1.8356e-02 5.8795e-01 1.5880e+00
     1.5880e+00 2.5971e-01 4.7687e-02 1.9363e-02 4.1038e-03
     1.0309e-03 1.0309e-03 1.0374e-03 8.5303e-03 8.5303e-03
     3.0474e-01 1.5880e+00 1.5880e+00 1.5880e+00 1.3679e+00
     4.2220e-01 1.7796e-01 9.6109e-02 9.6109e-02 9.9062e-02
     3.0572e-01 3.0572e-01 1.5880e+00 1.5880e+00 1.5880e+00
     1.0978e+00 1.7900e-01 5.2649e-02 2.0479e-02 1.1504e-02
     1.1504e-02 1.1829e-02 4.5590e-02 4.5590e-02 7.0268e-01
     1.5880e+00 1.5880e+00 1.1712e+00 1.7892e-01 5.2624e-02
     2.0222e-02 1.2029e-02 1.2029e-02 1.2354e-02 4.8261e-02
     4.8261e-02 7.4323e-01 1.5880e+00 1.5880e+00 4.6283e-01
     8.2036e-02 2.3525e-02 8.7609e-03 4.0469e-03 4.0469e-03
     4.1419e-03 1.8180e-02 1.8180e-02 3.0805e-01 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.4073e+00 1.4073e+00 1.4452e+00 1.4452e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 7.5695e-01
     7.5695e-01 2.9543e-01 1.0399e-01 1.0399e-01 1.0656e-01
     1.0656e-01 3.5910e-01 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.1149e+00 1.1149e+00 4.3249e-01 1.6244e-01
     1.6244e-01 1.6680e-01 1.6680e-01 5.4930e-01 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 2.7938e-01 2.7938e-01
     1.1265e-01 3.7097e-02 3.7097e-02 3.7806e-02 3.7806e-02
     1.3673e-01 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00 1.5880e+00
     1.5880e+00 1.5880e+00 1.5880e+00 1.1394e+00 6.7161e-01
     6.7161e-01 6.9171e-01 6.9171e-01 1.5656e+00 1.5880e+00
     -1.0000e+00
wwn3:n 2.4622e-01 9.9597e-03 7.4392e-01 7.4392e-01 1.0193e-01
     2.5989e-02 9.6579e-03 2.7290e-03 7.7101e-04 7.5365e-04
     7.7837e-04 3.3590e-03 6.3425e-03 2.1031e-01 7.4392e-01
     7.4392e-01 2.8421e-01 8.3287e-02 7.1040e-02 9.6361e-03
     1.2119e-03 1.2386e-03 1.2144e-03 7.2849e-03 7.2849e-03
     4.6718e-01 7.4392e-01 7.4392e-01 7.4392e-01 6.9575e-01
     3.9413e-01 5.0412e-02 8.6695e-03 8.6385e-03 8.7032e-03
     1.0651e-01 1.0651e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 3.8527e-01 1.0286e-01 3.1077e-02
     3.1077e-02 3.1603e-02 1.0566e-01 1.0566e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 1.4784e-01 6.5230e-02
     1.4425e-02 4.3630e-03 4.3630e-03 4.4091e-03 3.9864e-02
     3.9864e-02 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     1.5171e-01 6.6566e-02 1.4620e-02 3.1288e-03 3.1288e-03
     3.1621e-03 2.6527e-02 2.6527e-02 7.4392e-01 7.4392e-01
     7.4392e-01 3.6778e-01 8.6468e-02 3.4112e-02 8.8659e-03
     1.9229e-03 1.9229e-03 1.9344e-03 1.2542e-02 1.2542e-02
```

```
     4.2176e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 3.4520e-01 1.8035e-01 1.8035e-01 1.8771e-01
     5.6850e-01 5.6850e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 3.4843e-01 1.2118e-01 4.9936e-02 2.6799e-02
     2.6799e-02 2.7828e-02 1.2044e-01 1.2044e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 3.4999e-01 1.2104e-01
     4.8447e-02 2.5786e-02 2.5786e-02 2.6712e-02 1.2085e-01
     1.2085e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     1.7893e-01 6.2291e-02 2.5493e-02 1.1093e-02 1.1093e-02
     1.1453e-02 5.2194e-02 5.2194e-02 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 4.2981e-01 4.2981e-01 4.5174e-01
     4.5174e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 6.0480e-01
     6.0480e-01 6.3601e-01 6.3601e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     5.2445e-01 1.7199e-01 1.7199e-01 1.7895e-01 1.7895e-01
     7.3665e-01 7.4392e-01 0.0000e+00 0.0000e+00 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
     7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01 7.4392e-01
    -1.0000e+00
wwn4:n 5.0000e-01 1.9691e-01 5.0000e-01 5.0000e-01 1.2681e-01
     3.8540e-02 1.3447e-02 5.7967e-03 2.2949e-03 2.1411e-03
     2.3194e-03 5.6218e-03 1.0135e-02 1.1683e-01 5.0000e-01
     5.0000e-01 2.7700e-01 1:1096e-01 4.7649e-02 1.4083e-02
     3.1627e-03 3.1948e-03 3.1849e-03 9.7673e-03 9.7673e-03
     1.7272e-01 5.0000e-01 5.0000e-01 5.0000e-01 4.1226e-01
     1.5339e-01 4.4614e-02 1.3383e-02 1.2935e-02 1.3586e-02
     5.9066e-02 5.9066e-02 5.0000e-01 5.0000e-01 5.0000e-01
     5.0000e-01 5.0000e-01 2.6053e-01 1.0159e-01 3.6332e-02
     3.6332e-02 3.7116e-02 1.0615e-01 1.0615e-01 5.0000e-01
     5.0000e-01 5.0000e-01 3.9516e-01 1.1521e-01 4.4561e-02
     1.5153e-02 5.7299e-03 5.7299e-03 5.8020e-03 2.1759e-02
     2.1759e-02 2.6441e-01 5.0000e-01 5.0000e-01 3.6032e-01
     1.1377e-01 4.3817e-02 1.4560e-02 4.7054e-03 4.7054e-03
     4.7644e-03 1.8428e-02 1.8428e-02 2.2288e-01 5.0000e-01
     5.0000e-01 2.0942e-01 6.6158e-02 2.4679e-02 8.5653e-03
     3.0691e-03 3.0691e-03 3.0952e-03 1.0104e-02 1.0104e-02
     1.2849e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
     3.5682e-01 1.7739e-01 1.0527e-01 1.0527e-01 1.0806e-01
```

```
    2.4056e-01 2.4056e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 1.7164e-01 6.9973e-02 3.1813e-02 1.9478e-02
    1.9478e-02 1.9909e-02 5.0191e-02 5.0191e-02 3.8875e-01
    5.0000e-01 5.0000e-01 5.0000e-01 1.6726e-01 6.7164e-02
    2.9747e-02 1.7888e-02 1.7888e-02 1.8290e-02 4.7680e-02
    4.7680e-02 3.7966e-01 5.0000e-01 5.0000e-01 3.3978e-01
    1.0372e-01 4.1477e-02 1.8368e-02 9.5938e-03 9.5938e-03
    9.7782e-03 2.5862e-02 2.5862e-02 2.1399e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 2.7805e-01 1.3206e-01 1.3206e-01 1.3544e-01
    1.3544e-01 3.3234e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 3.3009e-01 1.5837e-01
    1.5837e-01 1.6231e-01 1.6231e-01 3.9974e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 3.8364e-01 3.8364e-01
    1.4566e-01 6.8054e-02 6.8054e-02 6.9585e-02 6.9585e-02
    1.7728e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01 5.0000e-01
    -1.0000e+00
wwn5:n 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 2.0210e-01
    7.8339e-02 2.9105e-02 1.6076e-02 1.0422e-02 9.6449e-03
    1.0641e-02 1.5536e-02 2.4605e-02 1.7456e-01 6.5593e-01
    6.5593e-01 2.3103e-01 1.0401e-01 4.6624e-02 2.3474e-02
    1.1987e-02 1.1445e-02 1.2216e-02 1.9814e-02 1.9814e-02
    1.3353e-01 6.5593e-01 6.5593e-01 3.6752e-01 1.5445e-01
    7.4292e-02 3.8532e-02 2.1708e-02 2.0162e-02 2.2221e-02
    4.1334e-02 4.1334e-02 2.2691e-01 6.5593e-01 6.5593e-01
    5.2755e-01 2.4782e-01 1.2794e-01 7.3619e-02 4.0502e-02
    4.0502e-02 4.1381e-02 7.5969e-02 7.5969e-02 3.5231e-01
    6.5593e-01 6.5593e-01 2.6989e-01 1.1432e-01 5.5863e-02
    3.0300e-02 1.6086e-02 1.6086e-02 1.6399e-02 3.3423e-02
    3.3423e-02 1.7551e-01 6.5593e-01 6.5593e-01 2.6242e-01
    1.1077e-01 5.3539e-02 2.8525e-02 1.4847e-02 1.4847e-02
    1.5151e-02 3.1281e-02 3.1281e-02 1.6684e-01 6.5593e-01
    6.0373e-01 1.9382e-01 7.4164e-02 3.4342e-02 1.8415e-02
    1.1271e-02 1.1271e-02 1.1454e-02 2.1263e-02 2.1263e-02
    1.1919e-01 6.5593e-01 6.5593e-01 6.5593e-01 3.8911e-01
    2.1428e-01 1.3491e-01 9.4057e-02 9.4057e-02 9.6401e-02
    1.6281e-01 1.6281e-01 6.3185e-01 6.5593e-01 6.5593e-01
    3.9118e-01 1.5444e-01 8.1239e-02 4.9417e-02 3.5943e-02
```

```
     3.5943e-02 3.6887e-02 6.5540e-02 6.5540e-02 2.7761e-01
     6.5593e-01 6.5593e-01 3.7687e-01 1.4780e-01 7.6900e-02
     4.6030e-02 3.2707e-02 3.2707e-02 3.3596e-02 6.1201e-02
     6.1201e-02 2.6451e-01 6.5593e-01 6.5593e-01 2.5556e-01
     1.0329e-01 5.3342e-02 3.2002e-02 2.1341e-02 2.1341e-02
     2.1865e-02 3.9569e-02 3.9569e-02 1.7524e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     4.4861e-01 4.4861e-01 4.5836e-01 4.5836e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 4.4258e-01
     4.4258e-01 2.2366e-01 1.3216e-01 1.3216e-01 1.3562e-01
     1.3562e-01 2.5696e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 4.9646e-01 4.9646e-01 2.4892e-01 1.4945e-01
     1.4945e-01 1.5339e-01 1.5339e-01 2.9222e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 2.6836e-01 2.6836e-01
     1.3444e-01 7.8026e-02 7.8026e-02 7.9840e-02 7.9840e-02
     1.5446e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01
     6.5593e-01 6.5593e-01 6.5593e-01 6.5593e-01 5.5474e-01
     5.5474e-01 5.6948e-01 5.6948e-01 6.5593e-01 6.5593e-01
     -1.0000e+00
wwg     24 3 1.0 3.5 19.05 0
wwge:n  4.13-7 2.606-2 20
rdum    0.8
```

2.2.13 Installation Test Case 13

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob13 -- check of the volume calculator, rotational symmetry case
1   1 -3.7 -6 #(-4(3:-2):-5 -2):-7:-8 9:-10 11:2 -3 12:-3 2 -13 15
      :-14 15 20:-16 -17(18:19)
2   2 .075 #1 -1
3   0 1

1   so 25
2   pz -10
3   kz -9.9 .5625 1
```

```
4   cz 3
5   z -13 3 -16 4 -20.4 6.3
6   z -20.4 6.3 -6 10.7 7.5 3.1
7   tz 0 0 -10 11 2.2 1.6
8   tz 0 0 -10 15 2 2.8
9   tz 0 0 -10 17 .8 1.3
10  tz 0 0 -3 12 2.7 2
11  z -4 10 0 12
12  z 7 10 11 16
13  z 7.5 3.1 12 4 14.8 5
14  z 14.8 5 16 8 18.4 10
15  z 16 0 18.4 10
16  tz 0 0 2 19 5.6 4
17  tz 0 0 2 22 5.6 4
18  z 0 18 2 24
19  z 3 18 2 24
20  pz 14
21  sz -25 20
22  pz -2
23  z 2 24 16 0

imp:n   1 1 0
m1  13027.40c 1
m2  26000.40c 1
c   inward uniform source flux, biased toward the center
sdef sur 1 nrm -1 dir d1 erg 1 wgt 1963.495406
sb1  -21 2
fq  f s
fc4 the source bias causes the total bin to have zero variance.
f4:n   1 2 t
f2:n   3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 t
f24:n  1
fs24:n -21 -22 -23
f22:n  6
fs22:n -21 -22
void
nps  10000
print -98
prdmp 2j -1
```

2.2.14 Installation Test Case 14

The input file for this test problem islisted below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob14 -- test general source in repeated structures.
1   1 -.5  -7 #2 #3 #4 #5 #6  imp:n=1
2   0  1 -2 -3 4 5 -6    imp:n=2  trcl=2 fill=1
3   like 2 but trcl=3
4   like 2 but trcl=4
5   like 2 but trcl=5  imp:n=1
6   like 2 but trcl=6
7   0  7 imp:n=0
8   0  8 -9 -10 11  imp:n=1 trcl=(-.9 .9 0) fill=2 u=1
9   like 8 but trcl=(.9 .9 0)
10  like 8 but trcl=(.1 -.9 0)
11  2 -18 #8 #9 #10  imp:n=1 u=1
12  2 -18  -12 imp:n=1 trcl=(-.3 .3 0) u=2
13  like 12 but trcl=(.3 .3 0)
14  like 12 but trcl=(.3 -.3 0)
15  like 12 but trcl=(-.3 -.3 0)
16  1 -.5  #12 #13 #14 #15  u=2 imp:n=1

1   px -2
2   py 2
3   px 2
4   py -2
5   pz -2
6   pz 2
7   so 15
8   px -.7
9   py  .7
10  px  .7
11  py -.7
12  cz  .1

sdef erg=d1  cel=d2:d3:0  rad=d5  ext=d6  axs=0 0 1  pos=d7
#   si1  sp1  sb1
    1   0    0
    3   .22  .05
    4   .08  .05
    5   .25  .1
    6   .18  .1
    7   .07  .2
    8   .1   .2
    9   .05  .1
    11  .05  .2
si2  1 2 3 4 5 6
sp2   1 1 1 1 1
si3  1 8 9 10
sp3   1 1 1
si5  0 .1
sp5  -21 1
si6  -2 2
sp6   0 1
```

```
si7 1.3 .3 0  .3 -.3 0  -.3 .3 0  -.3 -.3 0
sp7  1 1 1 1
fcl:n 13j -.5  $ forced collision in lev.ne.0 geom crashes mcnp4.2
m1    6012.40c 1
m2   92235.40c 1
drxs
tr2  -6  7 1.2
tr3   7  6 1.1
tr4   8 -5 1.4
tr5* -1 -4 1  40 130 90 50 40 90 90 90 0
tr6  -9 -2 1.3
f4:n  12 13 14 15            $ union of all 15 cell 12s, 13s, etc.
    (12 13 14 15<(u=1))      $ same as previous line, i hope
    (12 13 14 15<u=2<u=1)    $ each cylinder tallied separately
sd4  1.8849555 3r  $ 1st tally line - 15 x volume of cell 12, 13, etc.
     1.8849555 3r  $ 2nd tally line - 15 x volume of cell 12, 13, etc.
     0.1256637 3r  $ 3rd tally line - volume of cell 12, 13, etc.
fq   f e
cut:n  1e20 .1
nps  10000
f7:n  (12<u=2<2) (12<2)  $ each cell 12 in cell 2, plus union
      (13<u=2<3) (13<3)  $ each cell 13 in cell 3, plus union
      (14<u=2<5) (14<5)  $ each cell 14 in cell 5, plus union
      (15<u=2<6) (15<6)  $ each cell 15 in cell 6, plus union
sd7  2.2619466 6.7858398  $ mass of cell 12, 3 x mass of cell 12
     2.2619466 6.7858398  $ mass of cell 13, 3 x mass of cell 13
     2.2619466 6.7858398  $ mass of cell 14, 3 x mass of cell 14
     2.2619466 6.7858398  $ mass of cell 15, 3 x mass of cell 15
fq7  f e
totnu
print -98
prdmp 2j -1
```

2.2.15 Installation Test Case 15

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob15 -- test filled lattice and skewed lattice.
1   1 -.6 -1                              imp:n=1
2   0 1 -2 -4  fill=1 (-6 -6.5 0)         imp:n=1
3   0 2 -3 -4  *fill=2 (-7 5 0 30 60 90 120 30 90)  imp:n=2
4   0 2 3 -4   *fill=2 (4 8 0 15 105 90 75 15 90)   imp:n=2
5   0 4                                   imp:n=0
```

```
6   0 -5 6 -7 8 -9 10    fill=3  u=1  lat=1     imp:n=1
7   3 -2.7  -11 12 -13 14 -15 16  u=2  lat=1     imp:n=1
8   2 -.8  -17                u=3          imp:n=1
9   0 17                      u=3          imp:n=1

1   sy -5 3
2   py 0
3   px 0
4   so 15
5   px 1.5
6   px -1.5
7   py 1
8   py -1
9   pz 3
10  pz -3
11  p 1 -.5 0 1.3
12  p 1 -.5 0 -1.3
13  py .5
14  py -.5
15  pz 3
16  pz -3
17  sq 1 2 0 0 0 0 -1 .2 0 0

sdef pos 0 -5 0 erg d1 rad d2
si1  0 10
sp1  0 1
si2  3
sp2  -21
f2:n 3
sd2  1
f4:n 8 9
sd4  1 1
m1   4009.00c 1
m2   6012.40c 1
m3   13027.40c 1
drxs
nps  2000
print -98
prdmp 2j -1
```

2.2.16 Installation Test Case 16

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob16 -- test general source in a lattice.
1 0 1:-3:-4:5:6:-7 imp:n=0
2 0 -2 3 4 -5 -6 7 imp:n=1 fill=1 (-25 0 0)
3   0 -1 2 4 -5 -6 7 imp:n=1 fill=2 (0 -20 0)
4   0 -11 12 -14 13 imp:n=1 lat=1 u=1 fill=3
5   0 -15 16 -18 17 imp:n=2 lat=1 u=2
c    interrupt card
     fill=0: &
1 0:3 0:0 4 4 4(5 0 0) 4 4 5 4 4
6   1 -.9 21:-22:-23:24 imp:n=1 u=3
7   1 -.9 19 imp:n=1 u=4
8   2 -18 -21 22 23 -24 imp:n=1 u=3
9   1 -.9 20(31:-32:-33:34) imp:n=1 u=5
11  2 -18 -19 imp:n=1 u=4
13  2 -18 -20 imp:n=1 u=5
15  2 -18 -31 32 33 -34 imp:n=1 u=5

1   -3 px 50
2 px 0
3 -1 px -50
4   -5 py -20
5  -4 py 20
6+  pz 60
7+  pz -60
11  px 8.334
12  px -8.334
13  py -6.67
14  py 6.67
15  px 25.0000001
16  px -.0000001
17  py -.0000001
18  py 10.0000001
19  c/z 10 5 3
20  c/z 10 5 3
21  px 4
22  px -4
23  py -3
24  py 3
31  px 20
32  px 16
33  py 3
34  py 6

m1   6012.40c .4 8016.40c .2 29000.40c .2
m2   92238.40c .98 92235.40c .02
sdef erg fcel d1 cel d6 x fcel d11 y fcel d13 z fcel d15 &
   rad fcel d17 ext fcel d19 pos fcel d21 axs fcel d23
ds1  s d2 d3 d4 d5
# sp2 sp3 sp4 sp5 &
-2 -2 -2 -2 &
```

```
   1.2 1.3 1.4 1.42 &
si6  s d7 d8 d9 d10
sp6  .65 .2 .1 .05
si7  1 -2:4:8
sp7  1
si8  1 3:5(0 0 0):11 3:5(1 0 0):11 3:5(0 1 0):11 3:5(1 1 0):11
     3:5(0 2 0):11 3:5(0 3 0):11 3:5(1 3 0):11
sp8  1 1 1 1 1 1 1
si9  1 3:5(1 2 0):13
sp9  1
si10 1 3:5(1 2 0):15
sp10 1
ds11 s d12 0 0 d25
ds13 s d14 0 0 d26
ds15 s d16 0 0 d16
ds17 s 0 d18 d18 0
ds19 s 0 d20 d20 0
ds21 s 0 d22 d22 0
si22 1 10 5 0
sp22 1
ds23 s 0 d24 d24 0
si24 1 0 0 1
sp24 1
# sp12 si12 si14 sp14 si16 sp16 si18 sp18 si20 sp20 si25 sp25 si26 sp26
0 -46 -17 0 -60 0 0 -21 -60 0 16 0 3 0
1 -4  17 1  60 1 3  1 60 1 20 1 6 1
f2:n  2
e2   .1 1 20
f6:n  2 4 6 8  3 5 7 9 11 13 15
sd6  1 1 1 1  1 1 1 1 1 1 1
print
fq6  f e
nps  2000
prdmp 2j -1
elpt:n 0 4r .05 .06 .05 .06 3r
cut:n 30
```

2.2.17 Installation Test Case 17

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob17 -- kcode in a rectangular finite lattice.
c    finite lattice fails in mcnp4.2
```

```
3 0 -8 7 -10 9 -12 11  lat=1  imp:n=1 &
              fill=-2:2 -2:2 -2:2 2 124r
4   0         -13:14:15       u=2   imp:n=1
5 &
2 &
 .100691   13 -14 -15 #6     u=-2  imp:n=1
6   1 &
 .0983726  16 -17 -18        u=-2  imp:n=1

7   px -17.15
8   px  17.15
9   py -17.15
10   py  17.15
11   pz -16.5
12   pz  16.5
13   pz  -9.5
14   pz   9.5
15   cz  10.15
16   pz  -8.839
17   pz   8.839
18   cz   9.489

kcode 200 1 5 10
m1    1001.00c .057776  7014.40c .002131  8016.40c .037403 &
92238.40c .0009846 &
92235.40c .000062
m2    1001.00c .053702  6012.40c .033564  8016.40c .013425
mt1 &
lwtr grph.01  $ lwtr , lwtr.01 combo fails in mcnp4.2
mt2 &
 benz lwtr.01t
print
prdmp 2j -1
```

2.2.18 Installation Test Case 18

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob18 -- kcode in a hexagonal prism lattice.
c    three half control rods and five whole control rods.
30   0 -905 -19 29 1  fill=1
31   0 -906 -19 29 1  fill=1 (16.7113 0 0)
37   0 -907 -19 29 1  fill=1 (-16.7113 0 0)
```

```
34  0 -913 -19 29   fill=1 (0 11.9185 0)
32  0 -914 -19 29   fill=1 (10.3217 5.9592 0)
33  0 -915 -19 29   fill=1 (8.3557 14.4724 0)
35  0 -916 -19 29   fill=1 (-8.3557 14.4724 0)
36  0 -917 -19 29   fill=1 (-10.3217 5.9592 0)
c   universe 1: structure of control rod.
38  11 -2.02    -880 u=1  $ control rod core
39   6 -8.4  880 -881 u=1  $ control rod cladding
40  12 -1.00 881 -882 u=1  $ control rod gap
41   6 -8.4  882     u=1  $ control rod sheath
c   the space between the control rods, filled with lattice.
140  0 -17 1 29 -19 905 906 907 913 914 915 916 917 fill=2
c   universe 2: lattice of fuel rods with water in between.
42   12 -1.00  -301 302 -303 304 -305 306  u=2  lat=2  fill=
    -37:27 -1:33 0:0 &
    2 4r 3 9r 2 4r 3 11r 2 4r 3 11r 2 4r 3 9r 2
    2 4r 3 9r 2 3r 3 12r 2 3r 3 12r 2 3r 3 9r 2 1r
    2 3r 3 10r 2 2r 3 13r 2 2r 3 13r 2 2r 3 10r 2 1r
    2 3r 3 57r 2 2r &
    2 2r 3 58r 2 2r
    2 2r 3 16r 2 2r 3 17r 2 2r 3 16r 2 3r
    2 2r 3 15r 2 3r 3 16r 2 3r 3 15r 2 4r
    2 1r 3 15r 2 4r 3 15r 2 4r 3 15r 2 4r
    2 1r 3 15r 2 3r 3 16r 2 3r 3 15r 2 5r
    2 1r 3 15r 2 2r 3 17r 2 2r 3 15r 2 6r
    2 1r 3 54r 2 7r &
c    can code remember & thru comment?
2 3 55r 2 7r
    2 3 25r 2 2r 3 25r 2 8r
    2 3 24r 2 3r 3 24r 2 9r
    2 3 23r 2 4r 3 23r 2 10r
    2 3 15r 2 2r 3 4r 2 3r 3 4r 2 2r 3 15r 2 11r
    2 3 14r 2 3r 3 4r 2 2r 3 4r 2 3r 3 14r 2 12r
    2 3 13r 2 4r 3 11r 2 4r 3 13r 2 13r
    2 3 13r 2 3r 3 12r 2 3r 3 13r 2 14r
    2 3 13r 2 2r 3 13r 2 2r 3 13r 2 15r
    2 3 46r 2 16r
    2 3 45r 2 17r
    2 3 44r 2 18r
    2 1r 3 41r 2 20r
    2 1r 3 40r 2 21r
    2 1r 3 39r 2 22r
    2 2r 3 36r 2 24r
    2 2r 3 35r 2 25r
    2 3r 3 32r 2 27r
    2 4r 3 29r 2 29r
    2 5r 3 26r 2 31r
    2 6r 3 23r 2 33r
    2 8r 3 18r 2 36r
    2 11r 3 11r 2 40r
```

```
   2 64r
c   universe 3:  structure of fuel rod lattice elements.
154  2 -13.75      -58    u=3  $ fuel element
149  12  -1.00   58 -268    u=3  $ gap
144  7 -19.66  268 -478    u=3  $ liner
159  6 -8.4   478 -698   u=3  $ cladding
141  12  -1.00  698         u=3  $ water between the fuel rods
162   0 17:-29:19:-1   $ outside world

  *1   py  0      $ x-z plane, reflective
17   cz  29.135
19   pz  31.75   $ top of reactor
29   pz -31.75   $ bottom of reactor
58   c/z    3.4414    .8515    .3240
268  c/z    3.4414    .8515    .3345
478  c/z    3.4414    .8515    .3475
698  c/z    3.4414    .8515    .4318
880  cz  1.7251
881  cz  1.8051
882  cz  1.9051
905  cz  2.1055
906  c/z  16.7113 0 2.1055
907  c/z  -16.7113 0 2.1055
913  c/z  0 11.9185 2.1055
914  c/z  10.3217 5.9592 2.1055
915  c/z  8.3557 14.4724 2.1055
916  c/z  -8.3557 14.4724 2.1055
917  c/z  -10.3217 5.9592 2.1055
301  px 3.9330
302  px 2.9498
303  p   1 1.7320508076 0  5.8994
304  p   1 1.7320508076 0  3.9330
305  p  -1 1.7320508076 0  -.9834
306  p  -1 1.7320508076 0 -2.9498
imp:n   1  18r  0
m2     92235.40c  -.70573   92238.40c  -.23821     7014.40c  -.05605
m6     41093.40c  -.99000   40000.40c  -.01000
m7     74000.40c  -.74000
m11     5010.03d  -.6870     5011.40c  -.0840     6012.40c  -.2290
m12     1001.00c 1   1002.55c 1   8016.40c 1
mt12    hwtr.01 lwtr.01
kcode    200  1  5  6
ksrc  3 .2 .2 .2 3 .2 -3 .2 .2 .2 3 .2 4 3 .2 -4 3 .2 4 3 .1 -4 3 .2
e    .01 .1 1. 10.
fq   f e
fc4   fuel rod flux in 5 y locations averaged over 5 x elements
f4:n  (154<(42[-10:-6 -1 0]))   $ average 5 x elements at j=-1
    (154<(42[-10:-6  3 0])) &  $ average 5 x elements at j=3
(154<(42[-10:-6 10 0]))   $ average 5 x elements at j=10 &
    (154<(42[-10:-6 21 0]))   $ average 5 x elements at j=21
```

```
    (154<(42[-10:-6 29 0])) $ average 5 x elements at j=29
sd4  104.7089062 4r         $ 5 times the volume of cell 154
print -98
prdmp 2j -1
ptrac buffer=20 file=asc write=all event=bnk
```

2.2.19 Installation Test Case 19

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No differences whatsoever were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob19 - multigroup boltzman-fokker-planck version of electron problem prob20.
1  1 1 1 -2 3 -4 5 -6
2  0 #1

1  pz 0
2  pz .00635
3  px -10
4  px 10
5  py -10
6  py 10

m1  74184.10m 1
sdef erg=1 sur=1
imp:n 1 0
*f1:n  1  2
  e1  .1 .191 .282 .373 .464 .555 .645 .736 .827 .918  1.1
fu1  .511 0
ft1  ptt
fq1  e u
fc1  50 group-electrons  30 group-photons
f4:n  1
fm4  1.  1  703
sd4  1
mgopt  f  -80
 nps  2000
ctme  40
prdmp  2j -1
print  110
```

2.2.20 Installation Test Case 20

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob20 - continuous energy electron version of problem prob19.
1  1 -19.3 1 -2 3 -4 5 -6
2  0 #1

1  z 0 2
2  pz .00635
3  px -10
4  x 10 0
5  y -10 3
6  p 0 10 0  1 10 0  0 10 1

m1  74184. 1
sdef erg=1 sur=1  vec=0 0 1  par=3
imp:p,e 1 0
mode p e
*f1:p 1 2
e0  .1 .191 .282 .373 .464 .555 .645 .736 .827 .918  1.1
*f11:e 1 2
tr9  0 0 0  1 0 0  0 1 0  0 0 0  1
fq  e f
f21:e 1 2
*f28:p  1
e28  -.001 0 1.e-6 .1 .191 .282 .373 .464 .555 .645 .736 .827 .918  1.1
e58  -.001 0 1.e-6 .1 .191 .282 .373 .464 .555 .645 .736 .827 .918  1.1
f58:e 1
f6:p 1
f31:e 1 2
ft31 elc 1
f41:e 1 2
ft41 elc 2
f51:e 1 2
ft51 elc 3
e8  1000 nt
*f8:p,e 1
 nps 10000
ctme 30
prdmp 2j -1
cut:p 1j .1
cut:e 1j .1
print 110 70
```

2.2.21 Installation Test Case 21

The input file for this test problem islisted below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob21 - electron-photon problem - generates surface source for prob22.
c  au cones
1  0 -502 503 -1 2
2  0 -502 503 -2 3
c  cu cones
3  1 -8.92 -502 503 -3 4
4  1 -8.92 -502 503 -4 5
5  1 -8.92 -502 503 -5 6
6  1 -8.92 -502 503 -6 7
7  1 -8.92 -502 503 -7 8
8  1 -8.92 -502 503 -8 9
9  1 -8.92 -502 503 -9 10
10  1 -8.92 -502 503 -10 11
11  1 -8.92 -502 503 -11 12
12  1 -8.92 -502 503 -12 13
13  1 -8.92 -502 503 -13 14
c  al cones
14  2 -2.7 -502 503 -14 15
15  2 -2.7 -502 503 -15 16
16  2 -2.7 -502 503 -16 17
17  2 -2.7 -502 503 -17 18
18  2 -2.7 -502 503 -18 19
19  2 -2.7 -502 503 -19 20
20  2 -2.7 -502 503 -20 21
21  2 -2.7 -502 503 -21 22
22  2 -2.7 -502 503 -22 23
23  2 -2.7 -502 503 -23 24
c  detector box cells
101  0 -504 507 101 -301 201 -401 #(102 -302 202 -402)  $side au
102  0 -504 507 102 -302 202 -402 #(103 -303 203 -403)  $side au
103  1 -8.92 -504 507 103 -303 203 -403 #(104 -304 204 -404)  $side cu
104  1 -8.92 -504 507 104 -304 204 -404 #(105 -305 205 -405)  $side cu
105  1 -8.92 -504 507 105 -305 205 -405 #(106 -306 206 -406)  $side cu
106  1 -8.92 -504 507 106 -306 206 -406 #(107 -307 207 -407)  $side cu
107  1 -8.92 -504 507 107 -307 207 -407 #(108 -308 208 -408)  $side cu
108  1 -8.92 -504 507 108 -308 208 -408 #(109 -309 209 -409)  $side cu
109  1 -8.92 -504 507 109 -309 209 -409 #(110 -310 210 -410)  $side cu
110  1 -8.92 -504 507 110 -310 210 -410 #(111 -311 211 -411)  $side cu
111  1 -8.92 -504 507 111 -311 211 -411 #(112 -312 212 -412)  $side cu
112  1 -8.92 -504 507 112 -312 212 -412 #(113 -313 213 -413)  $side cu
113  1 -8.92 -504 507 113 -313 213 -413 #(114 -314 214 -414)  $side cu
```

```
114  2 -2.7 -504 507 114 -314 214 -414 #(115 -315 215 -415)  $side al
115  2 -2.7 -504 507 115 -315 215 -415 #(116 -316 216 -416)  $side al
116  2 -2.7 -504 507 116 -316 216 -416 #(117 -317 217 -417)  $side al
117  2 -2.7 -504 507 117 -317 217 -417 #(118 -318 218 -418)  $side al
118  2 -2.7 -504 507 118 -318 218 -418 #(119 -319 219 -419)  $side al
119  2 -2.7 -504 507 119 -319 219 -419 #(120 -320 220 -420)  $side al
120  2 -2.7 -504 507 120 -320 220 -420 #(121 -321 221 -421)  $side al
121  2 -2.7 -504 507 121 -321 221 -421 #(122 -322 222 -422)  $side al
122  2 -2.7 -504 507 122 -322 222 -422 #(123 -323 223 -423)  $side al
123  2 -2.7 -504 507 123 -323 223 -423 #(124 -324 224 -424)  $side al
c   rest of detector
500  5 -1.637-4 -502 503 -24 : -503 504 -513  $he inside cone
501  4 -1.85 -504 505 124 -324 224 -424  $be window into xe active
502  6 -5.370-3 -505 506 126 -326 226 -426  $xe active
503  6 -5.370-3 -506 507 125 -325 225 -425 :  $xe anti-c
       -505 506 125 -325 225 -425 #(126 -326 226 -426)  $edge anti-c
504  6 -5.370-3 -505 507 124 -324 224 -424 #(125 -325 225 -425)  $edge xe
505  7 -4.5 -503 504 513 101 -301 201 -401  $ti
506  2 -2.7 -507 508 101 -301 201 -401  $bottom al 1, .02cm
507  2 -2.7 -508 509 101 -301 201 -401  $bottom al 2, .02cm
508  2 -2.7 -509 510 101 -301 201 -401  $bottom al 3, .02cm
509  2 -2.7 -510 511 101 -301 201 -401  $bottom al 1, .067cm
510  0      -511 512 101 -301 201 -401  $bottom void, .067cm
599  4 -1.85 -501 502 -1  $be end cap
c   outside world
998  0 (501 : -501 503 1 : -503 512 #(101 -301 201 -401) : -512) -999  $outside
999  0 999

c   cones
1   z 0 21.20637 15 .78337  $au-other, t=.002"total
2   z 0 21.20201 15 .77901  $au-other, t=.002"total
3   z 0 21.19765 15 .77465  $cu, t=.013" total
4   z 0 21.19250 15 .7695  $cu, t=.013" total
5   z 0 21.18735 15 .76435  $cu, t=.013" total
6   z 0 21.18220 15 .7592  $cu, t=.013" total
7   z 0 21.17705 15 .75405  $cu, t=.013" total
8   z 0 21.17190 15 .7489  $cu, t=.013" total
9   z 0 21.16675 15 .74375  $cu, t=.013" total
10  z 0 21.16160 15 .7386  $cu, t=.013" total
11  z 0 21.15645 15 .73345  $cu, t=.013" total
12  z 0 21.15130 15 .7283  $cu, t=.013" total
13  z 0 21.14615 15 .72315  $cu, t=.013" total
14  z 0 21.14100 15 .7180  $al, t=.050" total
15  z 0 21.11920 15 .6962  $al, t=.050" total
16  z 0 21.09740 15 .6744  $al, t=.050" total
17  z 0 21.07560 15 .6526  $al, t=.050" total
18  z 0 21.05380 15 .6308  $al, t=.050" total
19  z 0 21.03200 15 .6090  $al, t=.050" total
```

```
20  z 0 21.01020 15 .5872  $al, t=.050" total
21  z 0 20.98840 15 .5654  $al, t=.050" total
22  z 0 20.96660 15 .5436  $al, t=.050" total
23  z 0 20.94480 15 .5218  $al, t=.050" total
24  z 0 20.92300 15 .5  $al, t=.050" total
c   detector box planes
101 px -21.08808
102 px -21.08554
103 px -21.083
104 px -21.080
105 px -21.077
106 px -21.074
107 px -21.071
108 px -21.068
109 px -21.065
110 px -21.062
111 px -21.059
112 px -21.056
113 px -21.053
114 px -21.050
115 px -21.0373
116 px -21.0246
117 px -21.0119
118 px -20.9992
119 px -20.9865
120 px -20.9738
121 px -20.9611
122 px -20.9484
123 px -20.9357
124 px -20.9230
125 px -16.89
126 px -16.
c
201 py -21.08808
202 py -21.08554
203 py -21.083
204 py -21.080
205 py -21.077
206 py -21.074
207 py -21.071
208 py -21.068
209 py -21.065
210 py -21.062
211 py -21.059
212 py -21.056
213 py -21.053
214 py -21.050
215 py -21.0373
216 py -21.0246
217 py -21.0119
```

```
218  py -20.9992
219  py -20.9865
220  py -20.9738
221  py -20.9611
222  py -20.9484
223  py -20.9357
224  py -20.9230
225  py -16.89
226  py -16.
c
301  px +21.08808
302  px +21.08554
303  px +21.083
304  px +21.080
305  px +21.077
306  px +21.074
307  px +21.071
308  px +21.068
309  px +21.065
310  px +21.062
311  px +21.059
312  px +21.056
313  px +21.053
314  px +21.050
315  px +21.0373
316  px +21.0246
317  px +21.0119
318  px +20.9992
319  px +20.9865
320  px +20.9738
321  px +20.9611
322  px +20.9484
323  px +20.9357
324  px +20.9230
325  px +16.89
326  px +16.
c
401  py +21.08808
402  py +21.08554
403  py +21.083
404  py +21.080
405  py +21.077
406  py +21.074
407  py +21.071
408  py +21.068
409  py +21.065
410  py +21.062
411  py +21.059
412  py +21.056
413  py +21.053
```

```
414  py +21.050
415  py +21.0373
416  py +21.0246
417  py +21.0119
418  py +20.9992
419  py +20.9865
420  py +20.9738
421  py +20.9611
422  py +20.9484
423  py +20.9357
424  py +20.9230
425  py +16.89
426  py +16.
c    cone planes
501  pz 15.00508
502  pz 15.
503  pz 0
504  pz -.127
505  pz -.13462
506  pz -1.135
507  pz -2.135
508  pz -2.155
509  pz -2.175
510  pz -2.195
511  pz -2.262
512  pz -2.3
513  cz 20.923  $ti cyl
c    outside surf
999  sz 15. 35  $sphere at be window

m1  29000 1.  $cu
m2  13000 1.  $al
m3  79000 1.  $au
m4   4000 1.  $be
m5   2000 1.  $he
m6  54000 1.  $xe, rho=5.370-3 g/cc
m7  22000 1.  $ti
c
 mode p  $no expl. e-, ttb
cut:e  1j  .001
elpt:e .001 59r  $ecut by cell
 phys:p  10
cut:p  1.e+10  .001  -.5 -.25
 nps  10000
prdmp 2j -1
ctme 60.
print -50 -60 -70 -85 -98
dd  .5 500
c
f01:p 24 (124 224 324 424)
```

```
fq0  e u
ft1  scx 1
e01  .002 .003 .004 .005 .006 .007 .008 .009 .01
     .015 .020878 .03 .04 .05 .06 .07 .08 .09 .1
     .2 .5 1
f11:p 24 (124 224 324 424)
e11  .002 .020878 1
c
sdef erg=d1  sur=999  nrm=-1  wgt=1 dir=d2   $inward cosine
sb2 -21 4000  $bias to match h
sc1 moss cosmic photon source for detector design
si1 h .002 .003 .004 .005 .006 .007 .008 .009 .01
     .015 .020878 .03 .04 .05 .06 .07 .08 .09 .1
     .2 .5 1
sp1 d  0 2.41 1.49 1.04 .785 .621 .507 .426 .364  $corr 11/2
     1.265 .893 .719 .363 .197 .122 .0815 .0579 .0429 .0329  $corr 11/2
     .129 .0579 .01405  $corr 11/2
sb1 0 1 20r
c
c   surface source write
ssw  -24 124 224 -324 -424  $inner wall of shield
c   to change starting imp, change in 3 places
imp:p,e 1 1r  $cone au
      1.5m 1.5m 1.5m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m  $cone cu
      1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m       $cone al
      1 1r      $box au
      1.5m 1.5m 1.5m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m  $box cu
      1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m 1.1m       $box al
      0 0 0 0 0 18.8 0  $500-506
      .5 .25 .1 0  $2nd-4th al, void below
      0  $be end cap
      1 0  $outside
```

2.2.22 Installation Test Case 22

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob22 - electron-photon surface source read from prob 21
c   au cones
1   0 -502 503 -1 2
2   0 -502 503 -2 3
c   cu cones
3   1 -8.92 -502 503 -3 4
```

```
4   1 -8.92 -502 503 -4 5
5   1 -8.92 -502 503 -5 6
6   1 -8.92 -502 503 -6 7
7   1 -8.92 -502 503 -7 8
8   1 -8.92 -502 503 -8 9
9   1 -8.92 -502 503 -9 10
10  1 -8.92 -502 503 -10 11
11  1 -8.92 -502 503 -11 12
12  1 -8.92 -502 503 -12 13
13  1 -8.92 -502 503 -13 14
c   al cones
14  2 -2.7 -502 503 -14 15
15  2 -2.7 -502 503 -15 16
16  2 -2.7 -502 503 -16 17
17  2 -2.7 -502 503 -17 18
18  2 -2.7 -502 503 -18 19
19  2 -2.7 -502 503 -19 20
20  2 -2.7 -502 503 -20 21
21  2 -2.7 -502 503 -21 22
22  2 -2.7 -502 503 -22 23
23  2 -2.7 -502 503 -23 24
c   detector box cells
101 0 -504 507 101 -301 201 -401 #(102 -302 202 -402)  $side au
102 0 -504 507 102 -302 202 -402 #(103 -303 203 -403)  $side au
103 1 -8.92 -504 507 103 -303 203 -403 #(104 -304 204 -404)  $side cu
104 1 -8.92 -504 507 104 -304 204 -404 #(105 -305 205 -405)  $side cu
105 1 -8.92 -504 507 105 -305 205 -405 #(106 -306 206 -406)  $side cu
106 1 -8.92 -504 507 106 -306 206 -406 #(107 -307 207 -407)  $side cu
107 1 -8.92 -504 507 107 -307 207 -407 #(108 -308 208 -408)  $side cu
108 1 -8.92 -504 507 108 -308 208 -408 #(109 -309 209 -409)  $side cu
109 1 -8.92 -504 507 109 -309 209 -409 #(110 -310 210 -410)  $side cu
110 1 -8.92 -504 507 110 -310 210 -410 #(111 -311 211 -411)  $side cu
111 1 -8.92 -504 507 111 -311 211 -411 #(112 -312 212 -412)  $side cu
112 1 -8.92 -504 507 112 -312 212 -412 #(113 -313 213 -413)  $side cu
113 1 -8.92 -504 507 113 -313 213 -413 #(114 -314 214 -414)  $side cu
114 2 -2.7 -504 507 114 -314 214 -414 #(115 -315 215 -415)  $side al
115 2 -2.7 -504 507 115 -315 215 -415 #(116 -316 216 -416)  $side al
116 2 -2.7 -504 507 116 -316 216 -416 #(117 -317 217 -417)  $side al
117 2 -2.7 -504 507 117 -317 217 -417 #(118 -318 218 -418)  $side al
118 2 -2.7 -504 507 118 -318 218 -418 #(119 -319 219 -419)  $side al
119 2 -2.7 -504 507 119 -319 219 -419 #(120 -320 220 -420)  $side al
120 2 -2.7 -504 507 120 -320 220 -420 #(121 -321 221 -421)  $side al
121 2 -2.7 -504 507 121 -321 221 -421 #(122 -322 222 -422)  $side al
122 2 -2.7 -504 507 122 -322 222 -422 #(123 -323 223 -423)  $side al
123 2 -2.7 -504 507 123 -323 223 -423 #(124 -324 224 -424)  $side al
c   rest of detector
500 5 -1.637-4 -502 503 -24 : -503 504 -513  $he inside cone
501 4 -1.85 -504 505 124 -324 224 -424  $be window into xe active
502 6 -5.370-3 -505 506 126 -326 226 -426  $xe active
503 6 -5.370-3 -506 507 125 -325 225 -425 :  $xe anti-c
```

```
     -505 506 125 -325 225 -425 #(126 -326 226 -426)  $edge anti-c
504  6 -5.370-3 -505 507 124 -324 224 -424 #(125 -325 225 -425)  $edge xe
505  7 -4.5 -503 504 513 101 -301 201 -401   $ti
506  2 -2.7 -507 508 101 -301 201 -401   $bottom al 1, .02cm
507  2 -2.7 -508 509 101 -301 201 -401   $bottom al 2, .02cm
508  2 -2.7 -509 510 101 -301 201 -401   $bottom al 3, .02cm
509  2 -2.7 -510 511 101 -301 201 -401   $bottom al 1, .067cm
510  0       -511 512 101 -301 201 -401   $bottom void, .067cm
599  4 -1.85 -501 502 -1   $be end cap
c    outside world
998  0 (501 : -501 503 1 : -503 512 #(101 -301 201 -401) : -512) -999   $outside
999  0 999

c    cones
1    z 0 21.20637 15 .78337   $au-other, t=.002"total
2    z 0 21.20201 15 .77901   $au-other, t=.002"total
3    z 0 21.19765 15 .77465   $cu, t=.013" total
4    z 0 21.19250 15 .7695   $cu, t=.013" total
5    z 0 21.18735 15 .76435   $cu, t=.013" total
6    z 0 21.18220 15 .7592   $cu, t=.013" total
7    z 0 21.17705 15 .75405   $cu, t=.013" total
8    z 0 21.17190 15 .7489   $cu, t=.013" total
9    z 0 21.16675 15 .74375   $cu, t=.013" total
10   z 0 21.16160 15 .7386   $cu, t=.013" total
11   z 0 21.15645 15 .73345   $cu, t=.013" total
12   z 0 21.15130 15 .7283   $cu, t=.013" total
13   z 0 21.14615 15 .72315   $cu, t=.013" total
14   z 0 21.14100 15 .7180   $al, t=.050" total
15   z 0 21.11920 15 .6962   $al, t=.050" total
16   z 0 21.09740 15 .6744   $al, t=.050" total
17   z 0 21.07560 15 .6526   $al, t=.050" total
18   z 0 21.05380 15 .6308   $al, t=.050" total
19   z 0 21.03200 15 .6090   $al, t=.050" total
20   z 0 21.01020 15 .5872   $al, t=.050" total
21   z 0 20.98840 15 .5654   $al, t=.050" total
22   z 0 20.96660 15 .5436   $al, t=.050" total
23   z 0 20.94480 15 .5218   $al, t=.050" total
24   z 0 20.92300 15 .5   $al, t=.050" total
c    detector box planes
101  px -21.08808
102  px -21.08554
103  px -21.083
104  px -21.080
105  px -21.077
106  px -21.074
107  px -21.071
108  px -21.068
109  px -21.065
110  px -21.062
111  px -21.059
```

112 px -21.056
113 px -21.053
114 px -21.050
115 px -21.0373
116 px -21.0246
117 px -21.0119
118 px -20.9992
119 px -20.9865
120 px -20.9738
121 px -20.9611
122 px -20.9484
123 px -20.9357
124 px -20.9230
125 px -16.89
126 px -16.
c
201 py -21.08808
202 py -21.08554
203 py -21.083
204 py -21.080
205 py -21.077
206 py -21.074
207 py -21.071
208 py -21.068
209 py -21.065
210 py -21.062
211 py -21.059
212 py -21.056
213 py -21.053
214 py -21.050
215 py -21.0373
216 py -21.0246
217 py -21.0119
218 py -20.9992
219 py -20.9865
220 py -20.9738
221 py -20.9611
222 py -20.9484
223 py -20.9357
224 py -20.9230
225 py -16.89
226 py -16.
c
301 px +21.08808
302 px +21.08554
303 px +21.083
304 px +21.080
305 px +21.077
306 px +21.074
307 px +21.071

```
308 px +21.068
309 px +21.065
310 px +21.062
311 px +21.059
312 px +21.056
313 px +21.053
314 px +21.050
315 px +21.0373
316 px +21.0246
317 px +21.0119
318 px +20.9992
319 px +20.9865
320 px +20.9738
321 px +20.9611
322 px +20.9484
323 px +20.9357
324 px +20.9230
325 px +16.89
326 px +16.
c
401 py +21.08808
402 py +21.08554
403 py +21.083
404 py +21.080
405 py +21.077
406 py +21.074
407 py +21.071
408 py +21.068
409 py +21.065
410 py +21.062
411 py +21.059
412 py +21.056
413 py +21.053
414 py +21.050
415 py +21.0373
416 py +21.0246
417 py +21.0119
418 py +20.9992
419 py +20.9865
420 py +20.9738
421 py +20.9611
422 py +20.9484
423 py +20.9357
424 py +20.9230
425 py +16.89
426 py +16.
c   cone planes
501 pz 15.00508
502 pz 15.
503 pz 0
```

```
504 pz -.127
505 pz -.13462
506 pz -1.135
507 pz -2.135
508 pz -2.155
509 pz -2.175
510 pz -2.195
511 pz -2.262
512 pz -2.3
513 cz 20.923  $ti cyl
c   outside surf
999 sz 15.35  $sphere at be window

m1  29000 1.  $cu
m2  13000 1.  $al
m3  79000 1.  $au
m4   4000 1.  $be
m5   2000 1.  $he
m6  54000 1.  $xe, rho=5.370-3 g/cc
m7  22000 1.  $ti
c
 mode p  $no expl. e-, ttb
phys:e 5j 1.2 1.1 .8 .9
cut:e 1j .001
elpt:e .001 59r  $ecut by cell
 phys:p 10
 cut:p 1.e+10 .001 -.5 -.25
  nps 10000
prdmp 2j -1
ctme 60.
print -98
dbcn 12j 4297
dd .5 500
c
f08:p 502
c  ft01 scx 1 21
e08  .002 .003 .004 .005 .006 .007 .008 .009 .01
     .015 .020878 .03 .04 .05 .06 .07 .08 .09 .1
     .2 .5 1
f18:p 502
e18  .002 .020878 1
c
c   surface source write
ssr wgt=1
c   to change starting imp, change in 3 places
imp:p,e 1 1r  $cone au
     1 1 1 1 1 1 1 1 1 1 1  $cone cu
     1 1 1 1 1 1 1 1 1 1     $cone al
     1 1r      $box au
     1 1 1 1 1 1 1 1 1 1 1  $box cu
```

```
1 1 1 1 1 1 1 1 1 1      $box al
1 1 1 1 1 1 1  $500-506
1 1 1 0  $2nd-4th al, void below
1  $be end cap
1 0  $outside
```

2.2.23 Installation Test Case 23

The input file for this test problem islisted below. The input and output files are included on the electronic copy. No differences whatsoever were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob23 - forward 80 group electron-photon detector chip problem
c   region 1 aluminum
  10 1 -2.7 1  -10  31 -40  71 -72
  11 1 -2.7 1  -10  31 -32  72 -82
  12 1 -2.7 1  -10  39 -40  72 -82
  13 1 -2.7 1  -2   32 -39  72 -82
  14 1 -2.7 9  -10  32 -39  72 -82
  15 1 -2.7 1  -10  31 -40  82 -83
c   regions 13 and 14 aluminum and oxygen
 130 4 -3.7 2  -9   32 -33  72 -75
 131 4 -3.7 2  -9   38 -39  72 -75
 132 4 -3.7 2  -3   33 -38  72 -75
 133 4 -3.7 8  -9   33 -38  72 -75
c   region 8 void
  80 0      3  -8  33 -38  72 -73
  81 0      3  -8  33 -34  73 -74
  82 0      3  -8  37 -38  73 -74
  83 0      3  -4  34 -37  73 -74
  84 0      7  -8  34 -37  73 -74
c   region 7 tungsten
  70 2 -19.3 4  -7  34 -37  73 -74
  71 2 -19.3 3  -8  33 -38  74 -75
c   region 12 aluminum and oxygen
 120 4 -3.7 2  -9   32 -39  75 -76
c   region 11 aluminum and oxygen
 110 4 -3.7 2  -9   32 -35  76 -78
 111 4 -3.7 2  -9   36 -39  76 -78
 112 4 -3.7 2  -5   35 -36  76 -78
 113 4 -3.7 6  -9   35 -36  76 -78
c   region 6 silicon
  60 3 -2.33 5  -6  35 -36  76 -77
c   region 5 void
  50 0      5  -6  35 -36  77 -78
```

```
c   region  10 aluminum and oxygen
 100 4 -3.7 2  -9   32 -34   78 -80
 101 4 -3.7 2  -9   37 -39   78 -80
 102 4 -3.7 2  -4   34 -37   78 -80
 103 4 -3.7 7  -9   34 -37   78 -80
c   region  4 void
  40 0     4  -7   34 -37   78 -79
c   region  3 aluminum
  30 1 -2.7 4  -7   34 -37   79 -80
c   region 9  void
  90 0      2  -9   32 -33   80 -81
  91 0      2  -9   38 -39   80 -81
 92 0     2  -3   33 -38   80 -81
  93 0      8  -9   33 -38   80 -81
  94 0      2  -9   32 -34   81 -82
  95 0      2  -9   37 -39   81 -82
  96 0      2  -4   34 -37   81 -82
  97 0      7  -9   34 -37   81 -82
c   region 2 tungsten
  20 2 -19.3 3  -8   33 -38   80 -81
  21 2 -19.3 4  -7   34 -37   81 -82
c   region 15 outer void
 150 0      1 -10  -31  71 -83
 151 0      1 -10 40  71  -83
 152 0     -1  71 -83
 153 0      10  71 -83
 154 0     -71
 155 0      83

  1 px  -1.31
  2 px  -1.21
  3 px  -.794
  4 px  -.603
  5 px  -.476
  6 px   .476
  7 px   .603
  8 px   .794
  9 px   1.21
  10 px   1.31
  31 py  -1.31
  32 py  -1.21
  33 py  -.794
  34 py  -.603
  35 py  -.476
  36 py   .476
  37 py   .603
  38 py   .794
  39 py   1.21
  40 py   1.31
  71 pz  -.102
```

```
 72 pz  0.
 73 pz  .0381
 74 pz  .102
 75 pz  .152
 76 pz  .229
 77 pz  .244
 78 pz  .305
 79 pz  .335
 80 pz  .343
 81 pz  .394
 82 pz  .457
 83 pz  .559

imp:p 1 39r 0 5r
imp:e .0625 .125 3r 1. .0625 3r 1. 4r .125 .25 .5 4. 3r 16
     1 4 3r 1 8 1 7r 4 2 0 5r
  m1 13027  1.
  m2 74184  1.
  m3 14000  1.
  m4 13027 -.5295 8016 -.4705
c    the source surface area is 6.86440
mode p e
bbrem 5 15i 3 15i 1 15i .3    1
 sdef x=d1 y=d2 z=.559 vec=0 0 1. dir=d3 erg=d5 wgt=6.86440
     par=3 sur=83
 si1 -1.31 -.603 .603  1.31
 sp1 0 .27 .46 .27
 si2 -1.31 -.603 .603 1.31
 sp2 0 .27 .46 .27
 si3 -1. 0.
 sp3 -21 1
 si5    0.50000e-01 0.21061e+00 0.37121e+00 0.53182e+00 0.69242e+00
       0.85303e+00 0.10136e+01 0.11742e+01 0.13348e+01 0.14955e+01
       0.16561e+01 0.18167e+01 0.19773e+01 0.21379e+01 0.22985e+01
       0.24591e+01 0.26197e+01 0.27803e+01 0.29409e+01 0.31015e+01
       0.32621e+01 0.34227e+01 0.35833e+01 0.37439e+01 0.39045e+01
       0.40651e+01 0.42258e+01 0.43864e+01 0.45470e+01 0.47076e+01
       0.48682e+01 0.50288e+01 0.51894e+01 0.53500e+01 0.55106e+01
       0.56712e+01 0.58318e+01 0.59924e+01 0.61530e+01 0.63136e+01
       0.64742e+01 0.66348e+01 0.67955e+01 0.69561e+01 0.71167e+01
       0.72773e+01 0.74379e+01 0.75985e+01 0.77591e+01 0.79197e+01
       0.80803e+01
  sp5    0.00000e+00 0.10951e+00 0.99484e-01 0.90118e-01 0.81402e-01
       0.73321e-01 0.65855e-01 0.58981e-01 0.52676e-01 0.46911e-01
       0.41659e-01 0.36890e-01 0.32574e-01 0.28682e-01 0.25183e-01
       0.22049e-01 0.19250e-01 0.16758e-01 0.14548e-01 0.12594e-01
       0.10871e-01 0.93572e-02 0.80315e-02 0.68740e-02 0.58667e-02
       0.49928e-02 0.42371e-02 0.35856e-02 0.30256e-02 0.25459e-02
       0.21361e-02 0.17873e-02 0.14911e-02 0.12406e-02 0.10292e-02
       0.85136e-03 0.70229e-03 0.57767e-03 0.47383e-03 0.38755e-03
```

```
      0.31608e-03 0.25706e-03 0.20847e-03 0.16859e-03 0.13595e-03
      0.10932e-03 0.87652e-04 0.70083e-04 0.55877e-04 0.44424e-04
      0.35218e-04
sb5 0 1 28r 2 20r
*f818:p,e 60
sd818 .031939
f414:p 60
f424:e 60
sd414 .031939
sd424 .031939
f6:p 60
ft6 scx 5
fq6 u t
*f8:e 60
phys:e 8.080301 0 0 1 1 .6 .7 1.3 1.4
phys:p 0 0 1
cut:p 1j .05
cut:e 1j .05
 nps 2000
prdmp 2j -1
elpt:e .05 15r 1. 3r .05 17r 1. 1. 0 5r
fcl:p 0 21r 1 0 22r
print -140 -85 -98
+f18:e 60
ptrac file=asc write=all event=src,bnk,sur,col,ter filter=1,8,erg
   type=e surface=5,6 tally=-8 value=1
```

2.2.24 Installation Test Case 24

The input file for this test problem islisted below. The input and output files are included on the electronic copy. No differences whatsoever were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob 24 -- reflecting lattice. 15x15 at 3.75 w/o u-235 enrichment.
1  1 -10.182 -1 u=2
2  2 -.001 1 -2 u=2
3  3 -6.55 2 -3 u=2
4  4 -1.0 3 u=2
5  4 -1.0 -14:15 u=3
6  3 -6.55 14 -15 u=3
7  4 -1.0 -4 +5 -6 +7 u=1 lat=1 fill=-8:8 -8:8 0:0
   1 17r 2 14r 1 1 2 14r 1 1 2 2 3 2 2 2 3 2 2r 3 2 2
   3 2 2 1 1 2 6r 3 2 6r 1 1 2 3r 3
   2 4r 3 2 3r 1 1 2 2 3 2 8r 3 2 2
   1 1 2 14r 1 1 2 2r 3 2 2r 3 2 2r
   3 2 2r 1 1 2 14r 1 1 2 2 3 2 8r 3
```

```
   2 2 1 1 2 3r 3 2 4r 3 2 3r 1 1
   2 6r 3 2 6r 1 1 2 2 3 2 2 3
   2 2r 3 2 2 3 2 2 1 1 2 14r 1 1 2 14r 1 17r
8  0 -8   -10   -12 u=4 fill=1
9  5 -7.9 8:10 u=4
10  4 -1.0 -8   -10   +12 u=4
11  4 -1.0 -16 +9      u=5 lat=1 fill=0:6 0:0 0:0 4 3r 5 2r
12  0 +28 +29 -19 -17 +13 -18 fill=5
13  0 +28 -19 +17 -31 +13 -18 fill=5 (-11.5 23 0)
14  0 +28 -19 +31 -32 +13 -18 fill=5 (-23 46 0)
15  0 +28 -19 +32 -33 +13 -18 fill=5 (-69 69 0)
16  4 -1.0 +28 -19 +33 +13 -18
17  4 -1.0 +28 +29 -19 -24 +18
18  6 -7.9 (+28 +29 +19 -20 +23 -25):(+28 +29 -19 +23 -13)
   :(+28 +29 -19 +24 -25)
19  7 -7.088254305 (+28 +29 +20 -21 +22 -25):(+28 +29 -20 +22 -23)
20  0 -28:-29:+21:-22:+25

1  cz .464693
2  cz .483743
3  cz .535940
4  px .71501
5  px -.71501
6  py .71501
7  py -.71501
8  px 11.0
9  px -11.0
10  py 11.0
12  pz 400.903
13  pz 34.0
14  cz .652018
15  cz .690118
16  px 12.0
17  py 12.0
18  pz 439.0
19  cz 82.25
20  cz 83.25
21  cz 116.35
22  pz 0.0
23  pz 33.0
24  pz 447.9
25  pz 485.9
*28  px 0.0
*29  py 0.0
31  py 35.0
32  py 58.0
33  py 81.0

imp:n 1 18r 0
kcode 250 .7 2 4 4500 0
```

```
ksrc 1.5 1.5 217.4515
m1  92235.40c 1.31964e20  92238.40c 2.15905e22
m2   8016.40c 1.00000000
m3  40000.40c 1.
m4   1001.00c .666666667   8016.40c .333333333
m5  26000.40c -.68874500   5010. -.00178200   5011.40c -.00721800
m6  26000.40c -.69500000
m7  26000.40c .830266962   6012.40c .133437328   14000.40c .002370386
mt4 lwtr.01t
drxs
prdmp 2j -1
f6:n  8 12 13 14 15 $ heating in mat=0 cells kills mcnp4.2
sd6   1 4r
```

2.2.25 Installation Test Case 25

The input file for this test problem is listed below. The input and output files are included on the electronic copy. No significant differences were observed between the sample test run and the output provided with the MCNP4A code package. This installation test problem was therefore successfully completed.

```
prob25 -- fission surface source from prob9
1    1 -14.1   -1 2 3(-4:-16)5 -6(12:13:-14)(10:-9:-11:-7:6)15
2    2 -7.58   -10 9 11 7 -6 -1:2 -12 14 -6 -13 3
3    3 -.01    -17(1:-2:-5:6:-3:-15:16 4)
4    0 17

1    pz 10
2    pz -10
3    py -10
4    py 10
5    px -10
6    px 10
7    px -1
9    py -2
10   py 0
11   pz 5
12   pz -8
13   py -3
14   px 2
15   ky -1 .3 -1
16   ky 13 1 -1
17   so 20

imp:n 1 1 1 0
ssr
```

```
nonu
m1   92235.40c 1  $ test of getting 92235.51c instead
m2   29000.40c -1  $ test getting 29000.51c instead
m3   8016.40c 1  7014.40c 1
print -98
prdmp 2j -1
vol  1 j 1 j
fq0  e f
f4:n  1 2 3
e0          .162524  .266043  .358425  .445672  .530293  .613680
      .696783  .780264  .864702  .950540 1.038286 1.128326 1.221111
      1.317206 1.417070 1.521302 1.630646 1.745929 1.868073 1.998282
      2.138046 2.289259 2.454356 2.636707 2.840830 3.073518 3.344965
      3.672134 4.086420 4.656234 5.588725 9.000000
```

2.2.26 Results of Installation Test Cases

Satisfactory agreement between the results of the sample problems executed on the QUICHE HP9000/C160 workstation and those included with the installation package sent by the developer verify the correct installation of the MCNP4A code package and confirm that the criticality safety and shielding capabilities are functioning correctly. Any differences in output files that were noted consisted of a unit change in the 5th or 6th significant digit of particular values. In all cases, these minor differences occurred in intermediate calculational steps and were determined to be the result of differences in numerical processing (round-off) inherent in the CPU architecture of the HP 9000/C160 workstation. These differences were determined to be insignificant.

Installation test cases 1-25 were run on the QUICHE HP 9000/C160 workstation and on the PORTNOY HP 9000/700 workstation NFS mount to QUICHE. This approach assured correct performance of the code for both operating systems and both types of CPUs.

The results of the installation test cases for the QUICHE HP 9000/C160 workstation, the PORTNOY HP 9000/700 workstation, and the desktop GATEWAY2000 P5-90 PC indicate that MCNP4A code package is operating correctly on all three systems. No significant differences were determined in output comparisons on all three systems.

2.3 ENDF/B-VI Cross Section Library Installation

The MCNP4A code package has previously been qualified with cross section libraries based primarily on the ENDF/B-V nuclear data set. The purpose of this cross section update is to add the capability of utilizing MCNPDAT6, an ENDF/B-VI based cross section library, on the HP9000 workstations.

The cross section installation test cases (benchmarks) are briefly described in section 3.3 and Table 3.3-1. They are a subset of those listed in Reference 2 and demonstrate that the cross section installation has been correctly performed on the HP 9000/C160 series workstation. The relevant output for the 17 test cases requires numerous printed pages and is too large to include in this SQR. This output is archived in electronic media, MI: 30006-M03-002.

The procedure followed for installation of the ENDF/B-VI cross section library for use with MCNP4A is described below. Instructions for accessing these cross sections and the results of test cases utilizing these cross sections are included.

The procedure for installing the ENDF/B-VI cross sections is as follows:

1) Copied the d00181allcp01.tar.Z file provided by RSIC to directory QUICHE:/opt/neut/mcnp/ENDFB6.

2) Ran uncompress and tar -xvf on the file to extract the cross section files in ascii format comprising MCNPDAT6.

3) Updated the MCNPDAT6 manual based on instructions from LANL memo (Attachment IV) provided based on personal communications with S. Frankles of LANL.

4) Deleted the cross section files am95242 and np93238 and their entries in the xsdir file per instructions in the memo Frankles/LANL dated 4/5/96 (Attachment IV).

5) Modified the cross section files c6000 and sc21045 per the instructions in the memo Frankles/LANL dated 6/21/95 (Attachment V).

6) Ran MAKXSF to convert the cross section files into binary form and consolidate them into one file name endfbvi2. In addition, a new photon library included in the MCNPDAT6 package was converted to binary format and named mpclib22.

7) Modified the atomic weights section of the xsdir file to include the atomic weights for the missing Kidman isotopes (44103, 45105, 53135, 60147, 61147, 61148, 61149, 62151, 63155) based on the atomic weights included with the cross section directory listing provided in the second section of the xsdir file.

8) Modified the xsdir file so that the preferred ENDF/B-V cross sections were listed first in the xsdir file (default values) followed by the ENDF/B-VI files. In addition, mpclib22 was made

the preferred photon cross section set. A copy of the new xsdir file is included in Attachment VI.

9) Copied the files xsdir, endfbvi2, and mpclib2 into the directory QUICHE:/opt/neut/mcnp/lib for access on all machines. Previous versions of the xsdir file and libraries were renamed and moved to directory QUICHE:/opt/neut/mcnp/lib/evold.

These cross sections are currently accessed by normal use of the MCNP4A code. The normal operation DATAPATH is set to the following directory:

MESSAGE: DATAPATH=/opt/neut/mcnp/lib

As long as the user has the environment variable DATAPATH set as indicated above all the other cross section files provided in that directory can be accessed as well.

To access the ENDF/B-V cross sections with the previous atomic weights listing, the alternate xsdir filename must be listed on the command line for running MCNP4A and the following DATAPATH line should be added to the input file. This line is followed by a blank line then the title card of the input file.

MESSAGE: DATAPATH=/opt/neut/mcnp/lib/evold

Note, that in most cases, both ENDF/B-V and ENDF/B-VI cross sections may need to be accessed concurrently. A new Table 1 for Appendix G of the MCNP4A manual which lists the available cross sections for use in MCNP4A is included in Attachment IV.

3.0 VALIDATION

3.1 MCNP4A Validation Tests

A series of benchmark experiments are analyzed to insure that the MCNP4A code package provides correct answers for problems of the type required for the waste package design program. These benchmark test cases are selected from published experiments. The agreement noted by this comparison provides the validation for the MCNP4A code package for design applications consistent with the type of problems analyzed by the WPDD.

Descriptions of the benchmark test cases used in the validation of the MCNP4A code package installed on the HP 9000 workstations and the GATEWAY2000 P5-90 are described in detail in the following sections.

3.1.1 Rodded Lattices

Critical Configurations of Subcritical Clusters of 2.35 wt% Enriched UO2 Rods in Water with Fixed Neutron Absorber Plates

This section includes four unique critical configurations (Ref. 6) each consisting of three fuel assemblies of various size arranged in a row with various absorber plates positioned between them. The fuel assemblies in each critical experiment contained 2.35 wt% U-235 enriched UO2 fuel rods with a square pitch of 2.032 cm. The absorber plates placed between the fuel assemblies were either Boral, aluminum, or stainless steel. One experiment did not use absorber plates. These critical experiments demonstrate MCNP4A's ability to accurately predict the critical multiplication factor (keff) for configurations containing light-water reactor fuel separated by absorber plates as is often found in waste package designs. The general configuration for the four experiments is shown is Figure 3.1.1-1.

The fuel rod description is shown in Figure 3.1.1-2. The UO2 composition used in the MCNP4A models is shown in Table 3.1.1-1. The 1100, 5052-H32, and 6061 aluminum compositions used in the MCNP4A models are shown in Table 3.1.1-2. The acrylic spacer grids and base plate shown in Figure 3.1.1-1 were modeled as plexiglass. Substituting plexiglass for acrylic in the models will have an insignificant effect on the critical multiplication factor of the configurations due the limited reactivity worth of the spacer grids and base plate. The plexiglass composition used in the models is shown in Table 3.1.1-3.

Table 3.1.1-1
2.35 wt% U-235 Enriched UO2 Composition (9.20 g/cc)

Element/Isotope	Weight Percent
U-234	0.0049
U-235	2.0715
U-238	86.0741
Oxygen	11.8495

Table 3.1.1-2
Aluminum Compositions

Element/Isotope	Weight Percent	
	Type 6061 Aluminum (2.6989 g/cc)	Type 5052-H32 Aluminum (2.70 g/cc)
Aluminum	96.93	96.4
Carbon	1.0	2.5
Silicon	0.6	0.25
Titanium	0.15	---
Chromium	0.195	0.25
Manganese	0.15	0.1
Iron	0.7	0.4
Copper	0.275	0.1

Table 3.1.1-3
Plexiglass Composition (1.18 g/cc)

Element/Isotope	Atom Density (atoms/b-cm)
Hydrogen	0.05678
Carbon	0.03549
Oxygen	0.01420

The first experiment, designated EXP1, consisted of three 20 x 16 fuel rod lattices separated by water only. The rod-to-rod spacing between the fuel lattices was 8.39 cm. The configuration was uniformly surrounding by a 30 cm water reflector. This critical experiment was analyzed with MCNP4A using the input in Figure 4.2.1-3. This configuration's x-y plane, x-z plane, and y-z plane cross-sectional views obtained from the MCNP4A plotting sequence are presented in Figures 3.1.1-4, -5, -6, respectively. The WPDD's MCNP4A k_{eff} result was 0.9991 with a standard deviation of 0.0013.

The second experiment, designated EXP2, consisted of a 20 x 16 fuel rod lattice positioned between two 22 x 16 fuel rod lattices. The rod-to-rod spacing between the fuel lattices was 5.05 cm. Boral absorber plates were positioned between the center and outer fuel lattices. The absorber plates were positioned 0.645 cm from the cell boundaries of the center assembly. The Boral absorber plates were 36.5 cm wide, 91.5 cm long, and 0.713 cm thick. The 0.713 cm thickness includes a 0.102 cm thick aluminum cladding on both sides of the B4C-Al absorber material. The Boral composition used in the MCNP4A model is shown in Table 3.1.1-4. The configuration was uniformly surrounded by a 30 cm water reflector. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.1-7. This configuration's x-y plane, x-z plane, and y-z plane cross-sectional views obtained from the MCNP plotting sequence are presented in Figures 3.1.1-8, -9, -10, respectively. The WPDD's MCNP4A k_{eff} result was 0.9986 with a standard deviation of 0.0013.

Table 3.1.1-4
Boral Absorber Plate Composition (2.49 g/cc)

Element/Isotope	Weight Percent
Carbon	7.97
Aluminum	63.0
Iron	0.33
Boron-10	5.28
Boron-11	23.42

The third experiment, designated EXP3, consisted of three 20 x 16 fuel rod lattices. The rod-to-rod spacing between the fuel lattices was 8.67 cm. Type 6061 aluminum absorber plates were positioned between the center and outer fuel lattices. Table 3.1.1-2 shows the type 6061 aluminum composition used in the MCNP4A model. The absorber plates were positioned 0.645 cm from the cell boundaries of the center assembly. The aluminum absorber plates were 35.6 cm wide, 91.5 cm long, and 0.625 cm thick. The configuration was uniformly surrounded by a 30 cm water reflector. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.1-11. This configuration's x-y plane, x-z plane, and y-z plane cross-sectional views obtained from the MCNP plotting sequence are presented in Figures 3.1.1-12, -13, -14, respectively. The WPDD's MCNP4A k_{eff} result was 1.0018 with a standard deviation of 0.0013.

The fourth experiment, designated EXP4, consisted of three 20 x 16 fuel rod lattices. The rod-to-rod spacing between the fuel lattices was 6.88 cm. Type 304 stainless steel absorber plates were positioned between the center and outer fuel lattices. Table 3.1.1-5 shows the type 304 stainless steel composition used in the MCNP4A model. The absorber plates were positioned 0.645 cm from the cell boundaries of the center assembly. The aluminum absorber plates were 35.6 cm wide, 91.5 cm long, and 0.485 cm thick. The configuration was uniformly surrounded by a 30 cm water reflector. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.1-15. This configuration's x-y plane, x-z plane, and y-z plane cross-sectional views obtained from the MCNP plotting sequence are presented in Figures 3.1.1-16 and -17, respectively. The WPDD's MCNP4A k_{eff} result was 0.9993 with a standard deviation of 0.0013.

Table 3.1.1-5
Type 304 Stainless Steel Composition (7.9 g/cc)

Element/Isotope	Weight Percent
Carbon	0.08
Nitrogen	0.40
Silicon	1.0
Phosphorous	0.045
Sulfur	0.03
Chromium	19.0
Manganese	2.0
Iron	67.245
Cobalt	0.20
Nickel	10.0

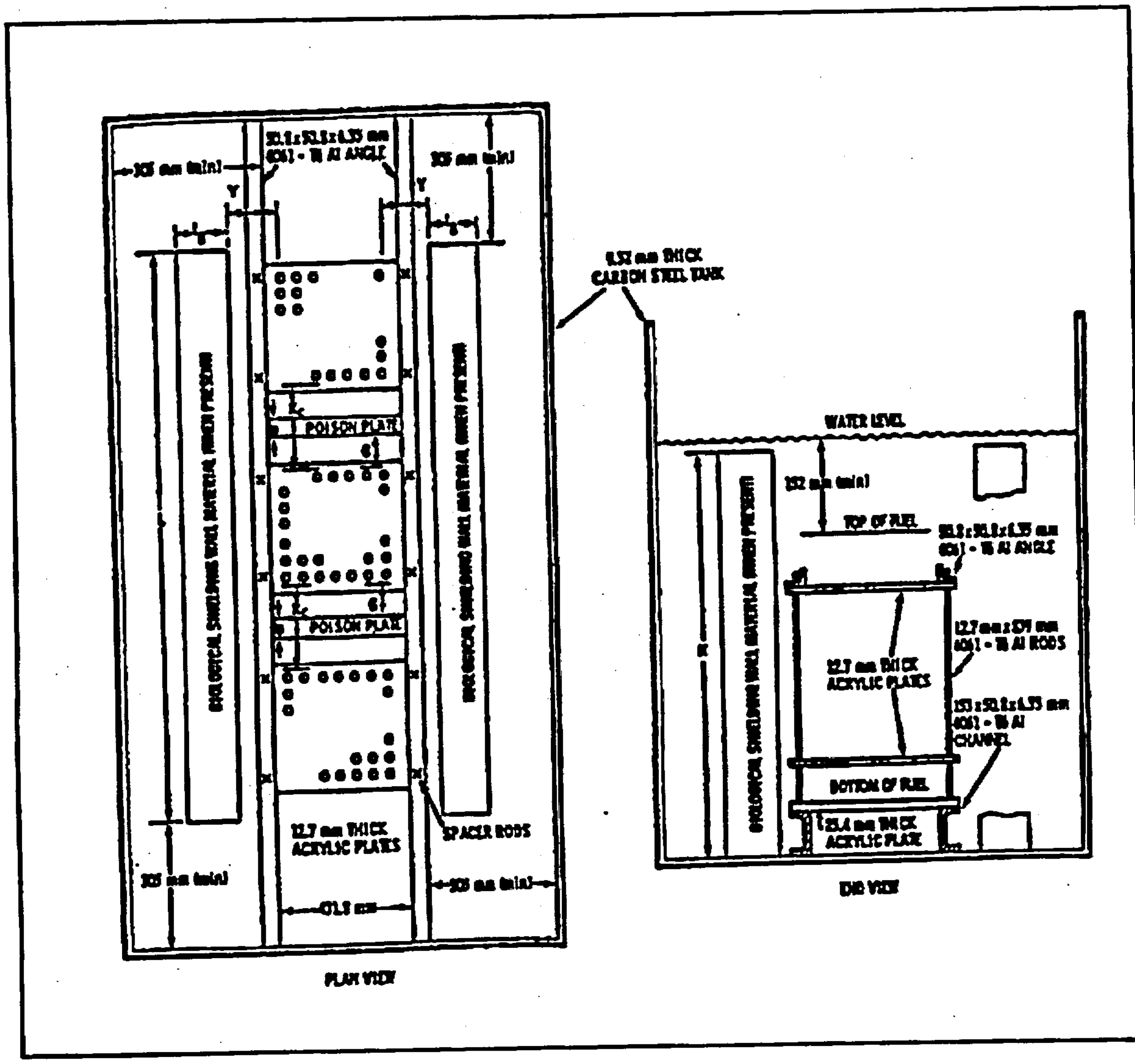
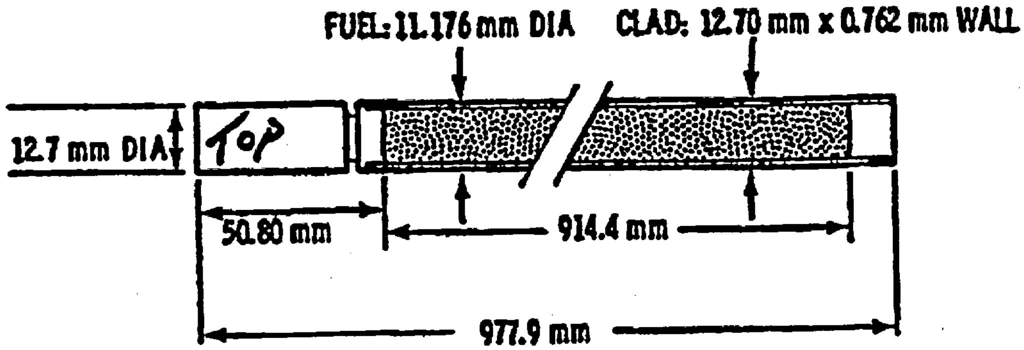


Figure 3.1.1-1 Absorber Plate Experimental Setup

DESCRIPTION OF 2.35 wt% ^{235}U ENRICHED UO_2 RODS



CLADDING: 6061 ALUMINUM TUBING SEAL WELDED WITH A LOWER END PLUG OF 5052-H32 ALUMINUM AND A TOP PLUG OF 1100 ALUMINUM

TOTAL WEIGHT OF LOADED FUEL RODS: 917 gm (AVERAGE)

LOADING:

825 gm OF UO_2 POWDER/ROD, 726 gm OF U/ROD, 17.08 gm OF U-235/ROD
ENRICHMENT - 2.35 ± 0.05 w/o U-235
FUEL DENSITY - 9.20 mg/mm^3 (84% THEORETICAL DENSITY)

Figure 3.1.1-2 Absorber Plate Experiments' Fuel Rod Description

Figure 3.1.1-3 MCNP Input File: EXP1

```
CRITICAL EXPERIMENT No. 1. (p2438x05). 2.35w/o with No Absorber Plates
C
C   FILENAME: exp1
C   INITIAL SOURCE DISTRIBUTION WITHIN INPUT DECK.
C
C   EXPERIMENT DESCRIPTION
C
C   2.35% U-235 ENRICHED UO2 RODS, 1.270 CM OD AL CLAD, 1.1176 ID
C   1.1176 CM OD UO2 91.44 CM LONG, ROD 97.79 CM LONG
C   3-20X16 CLUSTERS, 2.032 CM SQUARE PITCH, 8.39 CM ROD-TO-ROD CLUSTER
C   SEPARATION.  NO ABSORBER PLATES BETWEEN FUEL CLUSTERS.
C   ORIGINAL REFERENCE: PNL-2438 EXPERIMENT NO. 5
C
C   CELL SPECIFICATIONS
C
C   FUEL ROD
1  1  -9.20     (-1 +4 -29)      IMP:N=1  U=1
2  1  -9.20     (-1 +29 -28)     IMP:N=1  U=1
3  1  -9.20     (-1 +28 -27)     IMP:N=1  U=1
4  1  -9.20     (-1 +27 -26)     IMP:N=1  U=1
5  1  -9.20     (-1 +26 -3)      IMP:N=1  U=1
6  2  -2.6989   (+1 -2 -29 +4)   IMP:N=1  U=1
34 2  -2.6989   (+1 -2 -4)       IMP:N=1  U=1
7  2  -2.6989   (+1 -2 +29 -28)  IMP:N=1  U=1
8  2  -2.6989   (+1 -2 +28 -27)  IMP:N=1  U=1
9  2  -2.6989   (+1 -2 +27 -26)  IMP:N=1  U=1
10 2  -2.6989   (+1 -2 +26 -3)   IMP:N=1  U=1
33 2  -2.6989   (+1 -2 +3)       IMP:N=1  U=1
11 6  -2.71     (-1 +3)          IMP:N=1  U=1
12 3  -2.70     (-1 -4)          IMP:N=1  U=1
13 4  -1.0      (+2 -29)         IMP:N=1  U=1
14 4  -1.0      (+2 +28 -27)     IMP:N=1  U=1
15 4  -1.0      (+2 +26 -3)      IMP:N=1  U=1
32 4  -1.0      (+2 +3)          IMP:N=1  U=1
16 5  -1.18     (-26 +27 +2)     IMP:N=1  U=1
17 5  -1.18     (-28 +29 +2)     IMP:N=1  U=1
C
C   20X16 ARRAY OF FUEL RODS
18  4  -1.0  -5 +6 -7 +8  IMP:N=1  LAT=1  U=2
    FILL 0:21 0:17 0:0
    2 21R
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
```

Figure 3.1.1-3 (continued) MCNP Input File: EXP1

```
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 21R
C
C  FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
19  4  -1.0  -17 +24 +12 -11 +20 -9   IMP:N=1
20  4  -1.0  +9  -10 +12 -11 +18 -17  IMP:N=1 FILL=2 (-69.604 -17.272 0)
21  4  -1.0  -17 +18 +12 -11 +10 -13  IMP:N=1
22  4  -1.0  +13 -14 +12 -11 +18 -17  IMP:N=1 FILL=2 (-21.336 -17.272 0)
23  4  -1.0  -17 +18 +12 -11 +14 -15  IMP:N=1
24  4  -1.0  +15 -16 +12 -11 +18 -17  IMP:N=1 FILL=2 (26.932 -17.272 0)
25  4  -1.0  -17 +24 +12 -11 +16 -19  IMP:N=1
C
C  GLOBAL CONFIGURATIONS
C
C  PLEXIGLASS BOTTOM
26  5  -1.18   +9 -16 +24 -18 +12 -11   IMP:N=1
C  WATER SURROUNDING FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
27  4  -1.0   -19 +20 -21 +22 -24 +23   IMP:N=1
28  4  -1.0   -19 +20 -21 +22 -25 +17   IMP:N=1
29  4  -1.0   -17 +24 +22 -12 +20 -19   IMP:N=1
30  4  -1.0   -17 +24 +11 -21 +20 -19   IMP:N=1
C  ZERO IMPORTANCE REST OF WORLD
31  0        -20:+19:-22:+21:-23:+25   IMP:N=0

C  SURFACE SPECIFICATIONS
C
1   CZ   0.5588
2   CZ   0.6350
3   PZ   45.72
4   PZ   -45.72
5   PX    1.016
6   PX   -1.016
7   PY    1.016
8   PY   -1.016
9   PX   -68.5879
10   PX  -27.9481
11   PY   16.2559
12   PY  -16.2559
13   PX  -20.319
14   PX   20.319
```

Figure 3.1.1-3 (continued) MCNP Input File: EXP1

```
15  PX  27.9481
16  PX  68.5879
17  PZ  50.80
18  PZ  -46.99
19  PX  98.588
20  PX  -98.588
21  PY  46.256
22  PY  -46.256
23  PZ  -79.53
24  PZ  -49.53
25  PZ  80.80
26  PZ  34.74
27  PZ  33.47
28  PZ  -33.47
29  PZ  -34.74

C   MATERIAL SPECIFICATIONS
C
C   4.31 w/o URANIUM DIOXIDE
M1   92234.50C  -0.0049
    92235.50C  -2.0715
    92238.50C  -86.0741
    8016.50C  -11.8495
C   6061 ALUMINUM
M2    13027.50C  -96.93
     12000.50C  -1.0
     14000.50C  -0.6
     22000.50C  -0.15
     24000.50C  -0.195
     25055.50C  -0.15
     26000.55C  -0.7
     29000.50C  -0.275
C    5052-H32 ALUMINUM
M3    13027.50C  -96.40
     12000.50C  -2.5
     14000.50C  -0.25
     24000.50C  -0.25
     25055.50C  -0.10
     26000.55C  -0.4
     29000.50C  -0.10
C   WATER
M4    1001.50C  2.0
     8016.50C  1.0
MT4   LWTR.01T
C   PLEXIGLASS
M5    6012.50C  0.03549
     1001.50C  0.05678
```

Figure 3.1.1-3 (continued) MCNP Input File: EXP1

```
    8016.50C  0.01420
C    1100 ALUMINUM
M6    13027.50C  -99.00
    14000.50C  -0.825
    25055.50C  -0.05
    29000.50C  -0.125
C
C    CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE   500   1   25   525
KSRC   -63.508 7.112 0 -63.508 9.144 0 -63.508 -7.112 0 -63.508 -9.144 0
     -61.476 7.112 0 -61.476 9.144 0 -61.476 -7.112 0 -61.476 -9.144 0
     -51.316 1.016 0 -51.316 -1.016 0 -49.284 1.016 0 -49.284 -1.016 0
     -39.124 7.112 0 -39.124 9.144 0 -39.124 -7.112 0 -39.124 -9.144 0
     -37.092 7.112 0 -37.092 9.144 0 -37.092 -7.112 0 -37.092 -9.144 0
     -15.24 7.112 0 -15.24 9.144 0 -15.24 -7.112 0 -15.24 -9.144 0
     -13.208 7.112 0 -13.208 9.144 0 -13.208 -7.112 0 -13.208 -9.144 0
     -3.048 1.016 0 -3.048 -1.016 0 -1.016 1.016 0 -1.016 -1.016 0
     9.144 7.112 0 9.144 9.144 0 9.144 -7.112 0 9.144 -9.144 0
     11.176 7.112 0 11.176 9.144 0 11.176 -7.112 0 11.176 -9.144 0
     33.028 7.112 0 33.028 9.144 0 33.028 -7.112 0 33.028 -9.144 0
     35.06 7.112 0 35.06 9.144 0 35.06 -7.112 0 35.06 -9.144 0
     45.22 1.016 0 45.22 -1.016 0 47.252 1.016 0 47.252 -1.016 0
     57.412 7.112 0 57.412 9.144 0 57.412 -7.112 0 57.412 -9.144 0
     59.444 7.112 0 59.444 9.144 0 59.444 -7.112 0 59.444 -9.144 0
PRINT
```

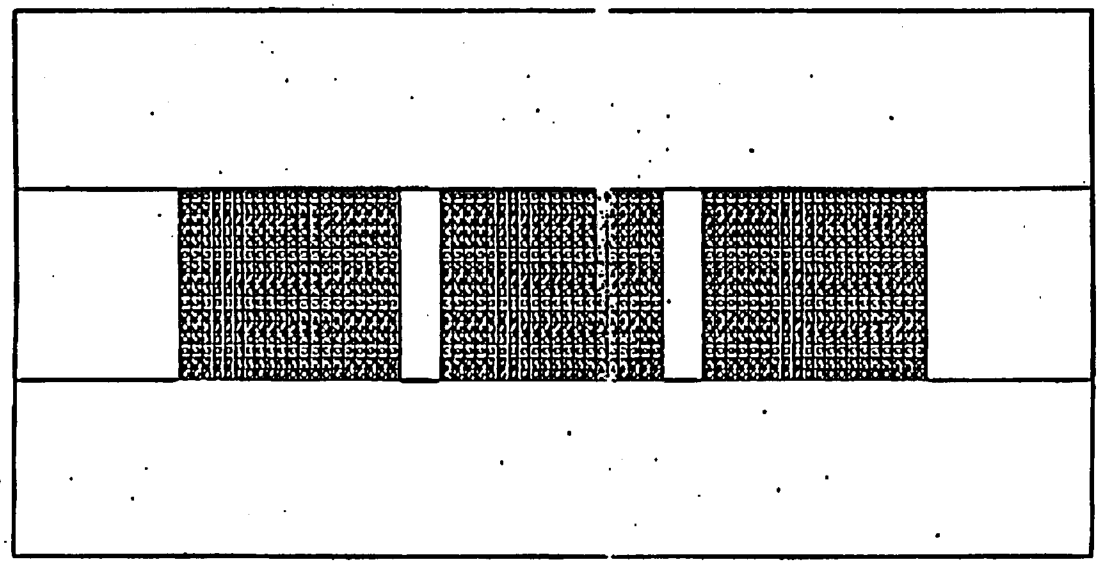


Figure 3.1.1-4 MCNP Plot: EXP1 x-y plane cross-section

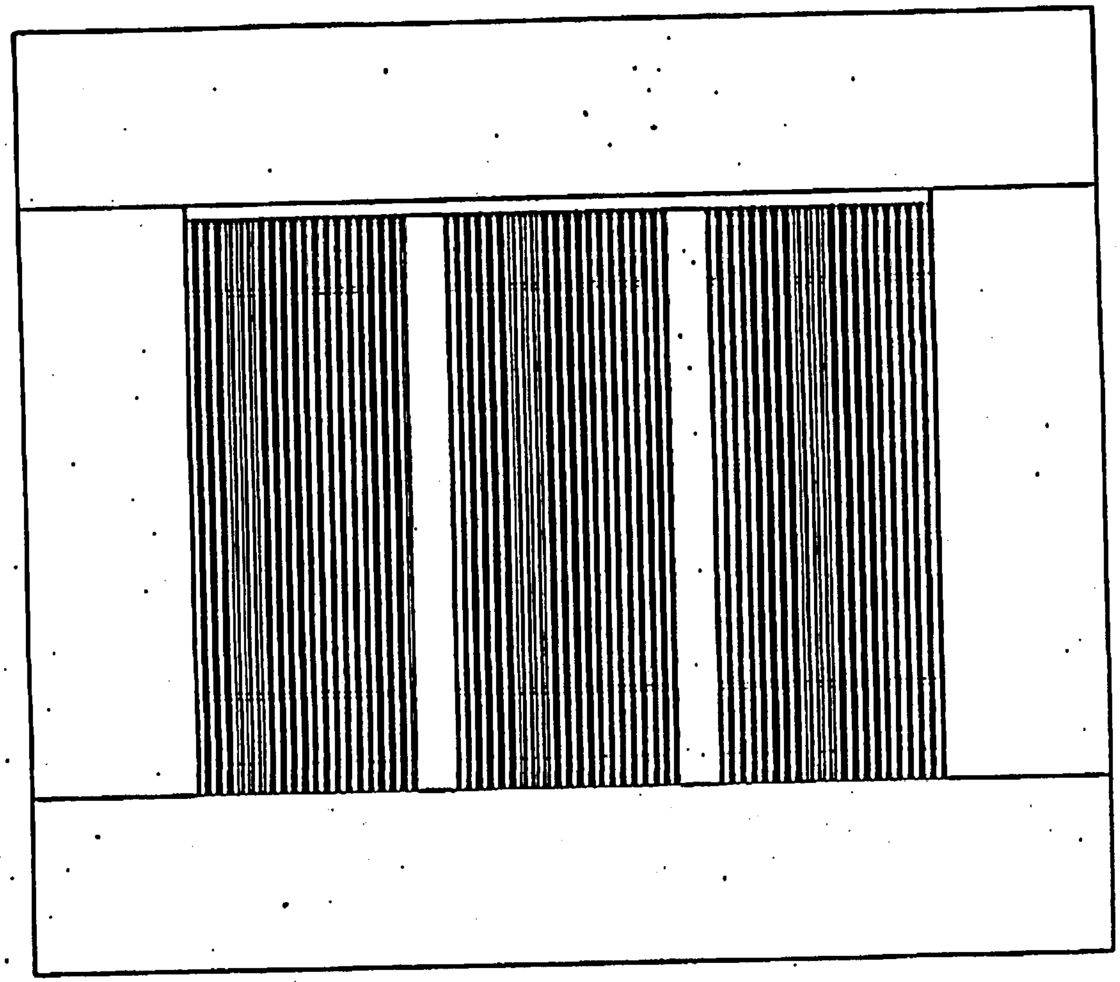


Figure 3.1.1-5 MCNP Plot: EXP1 x-z plane cross-section

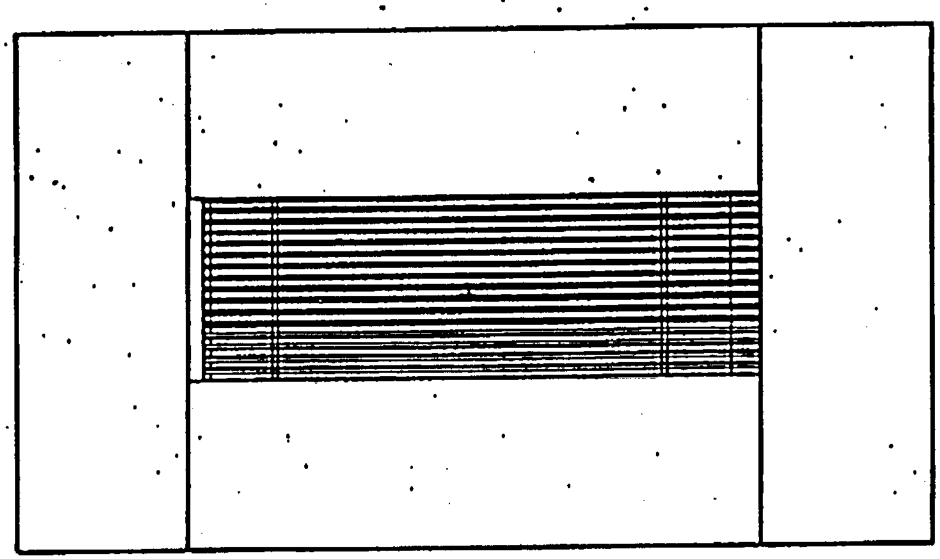


Figure 3.1.1-6 MCNP Plot EXP1 y-z plane cross-section

Figure 3.1.1-7 MCNP Input File: EXP2

```
CRITICAL EXPERIMENT No. 2. (p2438x17). 2.35w/o with Boral Absorber Plates
C
C   FILENAME: exp2
C   INITIAL SOURCE DISTRIBUTION WITHIN INPUT DECK.
C
C   EXPERIMENT DESCRIPTION
C
C   2.35% U-235 ENRICHED UO2 RODS, 1.270 CM OD AL CLAD, 1.1176 ID,
C   1.1176 CM OD UO2 91.44 CM LONG, ROD 97.79 CM LONG,
C   1-20X16 FUEL CLUSTER BETWEEN 2-22X16 FUEL CLUSTERS,
C   2.032 CM SQUARE PITCH, 0.645 CM BETWEEN CENTRAL CLUSTER AND ABSORBERS,
C   5.05 CM SEPARATION BETWEEN CLUSTERS, BORAL ABSORBER PLATE THICKNESS OF
C   0.713 CM, H2O MODERATED AND REFLECTED.
C   ORIGINAL REFERENCE: PNL-2438 EXPERIMENT NO. 17
C
C   CELL SPECIFICATIONS
C
C   FUEL ROD
1  1 -9.20     (-1 +4 -29)      IMP:N=1  U=1
2  1 -9.20     (-1 +29 -28)     IMP:N=1  U=1
3  1 -9.20     (-1 +28 -27)     IMP:N=1  U=1
4  1 -9.20     (-1 +27 -26)     IMP:N=1  U=1
5  1 -9.20     (-1 +26 -3)      IMP:N=1  U=1
6  2 -2.6989   (+1 -2 -29 +4)   IMP:N=1  U=1
7  2 -2.6989   (+1 -2 -4)       IMP:N=1  U=1
8  2 -2.6989   (+1 -2 +29 -28)  IMP:N=1  U=1
9  2 -2.6989   (+1 -2 +28 -27)  IMP:N=1  U=1
10 2 -2.6989   (+1 -2 +27 -26)  IMP:N=1  U=1
11 2 -2.6989   (+1 -2 +26 -3)   IMP:N=1  U=1
12 2 -2.6989   (+1 -2 +3)       IMP:N=1  U=1
13 6 -2.71     (-1 +3)          IMP:N=1  U=1
14 3 -2.70     (-1 -4)          IMP:N=1  U=1
15 4 -1.0      (+2 -29)         IMP:N=1  U=1
16 4 -1.0      (+2 +28 -27)     IMP:N=1  U=1
17 4 -1.0      (+2 +26 -3)      IMP:N=1  U=1
18 4 -1.0      (+2 +3)          IMP:N=1  U=1
19 5 -1.18     (-26 +27 +2)     IMP:N=1  U=1
20 5 -1.18     (-28 +29 +2)     IMP:N=1  U=1
C
C   20X16 ARRAY OF FUEL RODS
21  4 -1.0 -5 +6 -7 +8 IMP:N=1 LAT=1 U=2
    FILL 0:21 0:17 0:0
    2 21R
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
```

Figure 3.1.1-7 (continued) MCNP Input File: EXP2

```
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 21R
C
C    22X16 ARRAY OF FUEL RODS
22   4  -1.0  -5 +6 -7 +8  IMP:N=1  LAT=1  U=3
     FILL 0:23 0:17 0:0
     3 23R
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 1 21R 3
     3 23R
C
C    GLOBAL CONFIGURATIONS
C
C    FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
23   4  -1.0     -17 +24 +12 -11 +20 -9   IMP:N=1
24   4  -1.0     +9 -10 +12 -11 +18 -17   IMP:N=1 FILL=3 (-70.328 -17.272 0)
25   4  -1.0     -17 +18 +12 -11 +10 -30   IMP:N=1
26   2  -2.6989  +30 -31 +35 -34 +18 -36   IMP:N=1
27   7  -2.49    +31 -32 +35 -34 +18 -36   IMP:N=1
28   2  -2.6989  +32 -33 +35 -34 +18 -36   IMP:N=1
29   4  -1.0     +33 -13 +12 -11 +18 -17   IMP:N=1
30   4  -1.0     +13 -14 +12 -11 +18 -17   IMP:N=1 FILL=2 (-21.336 -17.272 0)
31   4  -1.0     -17 +18 +12 -11 +14 -37   IMP:N=1
```

Figure 3.1.1-7 (continued) MCNP Input File: EXP2

```
32  2  -2.6989  +37 -38 +35 -34 +18 -36  IMP:N=1
33  7  -2.49    +38 -39 +35 -34 +18 -36  IMP:N=1
34  2  -2.6989  +39 -40 +35 -34 +18 -36  IMP:N=1
35  4  -1.0     +40 -15 +12 -11 +18 -17  IMP:N=1
36  4  -1.0     +15 -16 +12 -11 +18 -17  IMP:N=1 FILL=3 (23.591 -17.272 0)
37  4  -1.0     -17 +24 +12 -11 +16 -19  IMP:N=1
C
C   PLEXIGLASS BOTTOM
38  5  -1.18  +9 -16 +24 -18 +12 -11  IMP:N=1
C   WATER SURROUNDING FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
39  4  -1.0  -19 +20 -21 +22 -24 +23  IMP:N=1
40  4  -1.0  -19 +20 -21 +22 -25 +17  IMP:N=1
41  4  -1.0  -17 +24 +22 -35 +20 -19  IMP:N=1
42  4  -1.0  -17 +24 +34 -21 +20 -19  IMP:N=1
43  4  -1.0  +20 -30 +11 -34 +24 -17  IMP:N=1
44  4  -1.0  +33 -37 +11 -34 +24 -17  IMP:N=1
45  4  -1.0  +40 -19 +11 -34 +24 -17  IMP:N=1
46  4  -1.0  +20 -30 +35 -12 +24 -17  IMP:N=1
47  4  -1.0  +33 -37 +35 -12 +24 -17  IMP:N=1
48  4  -1.0  +40 -19 +35 -12 +24 -17  IMP:N=1
49  4  -1.0  +30 -33 +35 -34 +36 -17  IMP:N=1
50  4  -1.0  +37 -40 +35 -34 +36 -17  IMP:N=1
51  4  -1.0  +30 -33 +11 -34 +24 -18  IMP:N=1
52  4  -1.0  +30 -33 +35 -12 +24 -18  IMP:N=1
53  4  -1.0  +37 -40 +11 -34 +24 -18  IMP:N=1
54  4  -1.0  +37 -40 +35 -12 +24 -18  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
55  0        -20:+19:-22:+21:-23:+25  IMP:N=0

C   SURFACE SPECIFICATIONS
C
1   CZ   0.5588
2   CZ   0.6350
3   PZ   45.72
4   PZ   -45.72
5   PX   1.016
6   PX   -1.016
7   PY   1.016
8   PY   -1.016
9   PX   -69.3119
10  PX   -24.6081
11  PY   16.2559
12  PY   -16.2559
13  PX   -20.319
14  PX   20.319
15  PX   24.6071
16  PX   69.3109
```

Figure 3.1.1-7 (continued) MCNP Input File: EXP2

```
17  PZ  50.80
18  PZ  -46.99
19  PX  99.3119
20  PX  -99.3119
21  PY  46.256
22  PY  -46.256
23  PZ  -79.53
24  PZ  -49.53
25  PZ  80.80
26  PZ  34.74
27  PZ  33.47
28  PZ  -33.47
29  PZ  -34.74
30  PX  -21.677
31  PX  -21.575
32  PX  -21.066
33  PX  -20.964
34  PY  18.25
35  PY  -18.25
36  PZ  44.51
37  PX  20.964
38  PX  21.066
39  PX  21.575
40  PX  21.677

C   MATERIAL SPECIFICATIONS
C
C   4.31 w/o URANIUM DIOXIDE
M1   92234.50C  -0.0049
     92235.50C  -2.0715
     92238.50C  -86.0741
     8016.50C  -11.8495
C   6061 ALUMINUM
M2   13027.50C  -96.93
     12000.50C  -1.0
     14000.50C  -0.6
     22000.50C  -0.15
     24000.50C  -0.195
     25055.50C  -0.15
     26000.55C  -0.7
     29000.50C  -0.275
C   5052-H32 ALUMINUM
M3   13027.50C  -96.40
     12000.50C  -2.5
     14000.50C  -0.25
     24000.50C  -0.25
     25055.50C  -0.10
```

Figure 3.1.1-7 (continued) MCNP Input File: EXP2

```
      26000.55C  -0.4
      29000.50C  -0.10
C    WATER
M4     1001.50C  2.0
       8016.50C  1.0
MT4   LWTR.01T
C    PLEXIGLASS
M5     6012.50C  0.03549
       1001.50C  0.05678
       8016.50C  0.01420
C    1100 ALUMINUM
M6    13027.50C  -99.00
      14000.50C  -0.825
      25055.50C  -0.05
      29000.50C  -0.125
C    BORAL
M7     5010.50C  -5.28
       5011.50C  -23.42
      13027.50C  -63.0
       6012.50C  -7.97
      26000.55C  -0.33
C
C    CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE   500   1   25   525
KSRC   -69.312 7.112 0 -69.312 9.144 0 -69.312 -7.112 0 -69.312 -9.144 0
       -67.28 7.112 0 -67.28 9.144 0 -67.28 -7.112 0 -67.28 -9.144 0
       -59.152 1.016 0 -59.152 -1.016 0 -57.12 1.016 0 -57.12 -1.016 0
       -48.992 7.112 0 -48.992 9.144 0 -48.992 -7.112 0 -48.992 -9.144 0
       -46.96 7.112 0 -46.96 9.144 0 -46.96 -7.112 0 -46.96 -9.144 0
       -15.24 7.112 0 -15.24 9.144 0 -15.24 -7.112 0 -15.24 -9.144 0
       -13.208 7.112 0 -13.208 9.144 0 -13.208 -7.112 0 -13.208 -9.144 0
       -3.048 1.016 0 -3.048 -1.016 0 -1.016 1.016 0 -1.016 -1.016 0
       9.144 7.112 0 9.144 9.144 0 9.144 -7.112 0 9.144 -9.144 0
       11.176 7.112 0 11.176 9.144 0 11.176 -7.112 0 11.176 -9.144 0
       28.671 7.112 0 28.671 9.144 0 28.671 -7.112 0 28.671 -9.144 0
       30.703 7.112 0 30.703 9.144 0 30.703 -7.112 0 30.703 -9.144 0
       38.831 1.016 0 38.831 -1.016 0 40.863 1.016 0 40.863 -1.016 0
       48.991 7.112 0 48.991 9.144 0 48.991 -7.112 0 48.991 -9.144 0
       51.023 7.112 0 51.023 9.144 0 51.023 -7.112 0 51.023 -9.144 0
PRINT
```

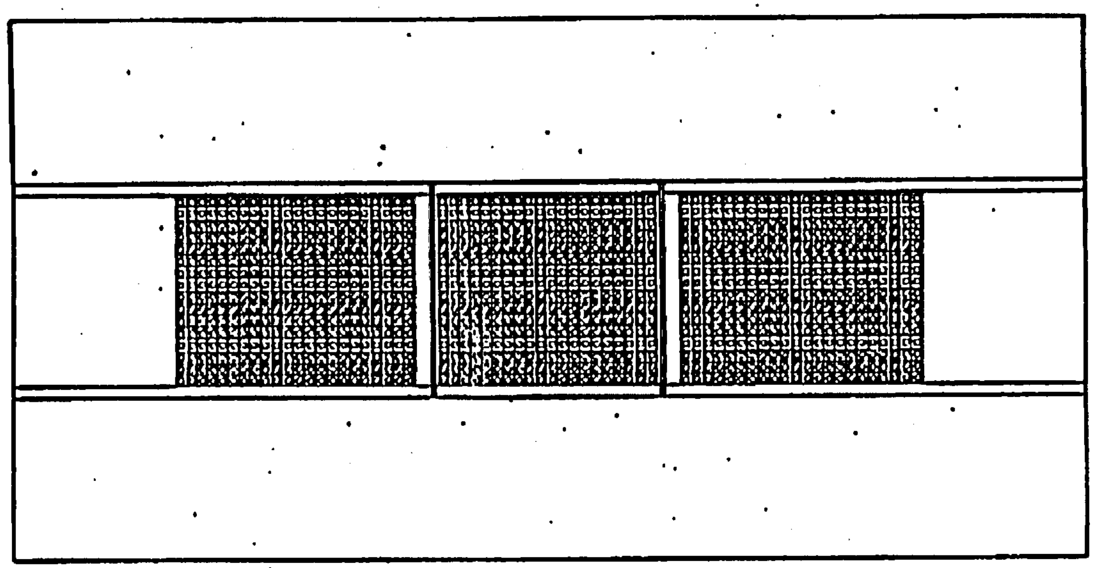


Figure 3.1.1-8 MCNP Plot: EXP2 x-y plane cross-section

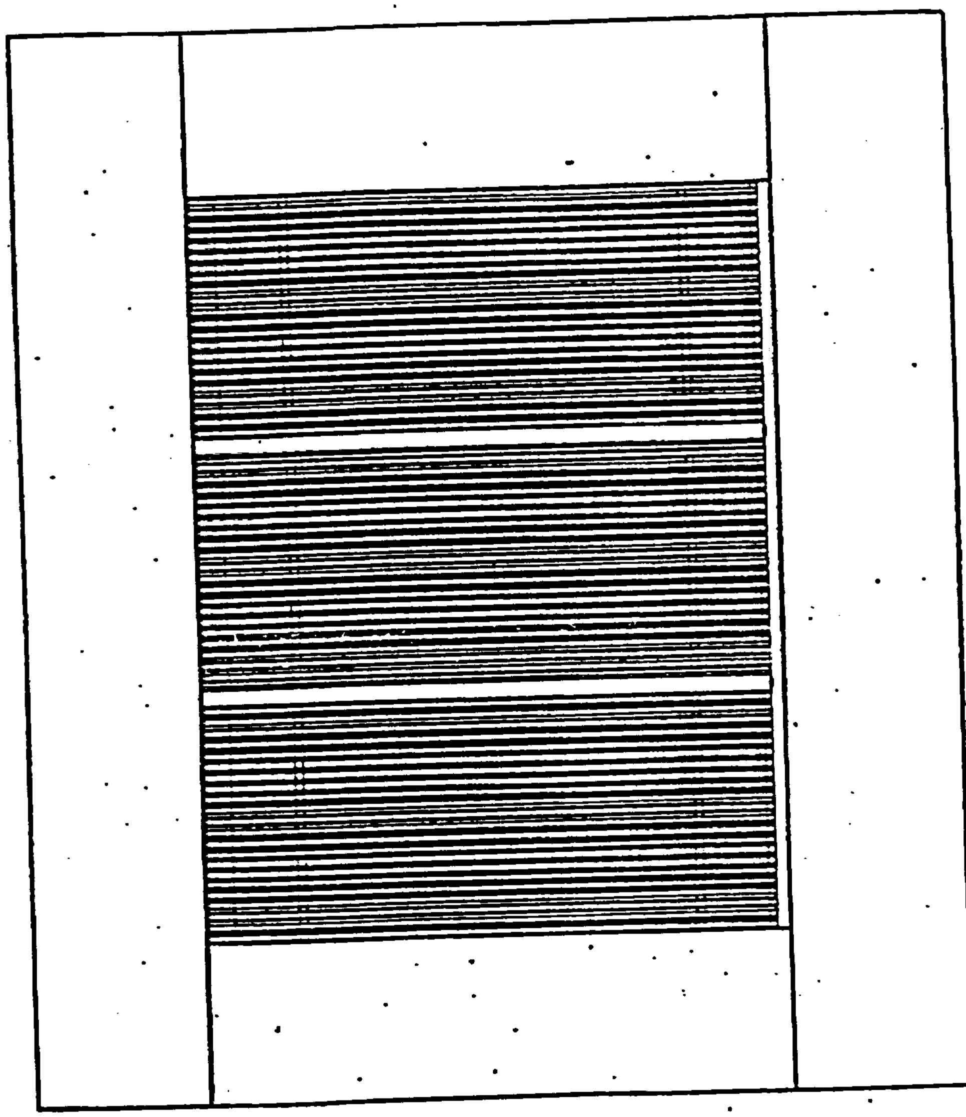


Figure 3.1.1-9 MCNP Plot: EXP2 x-z plane cross-section

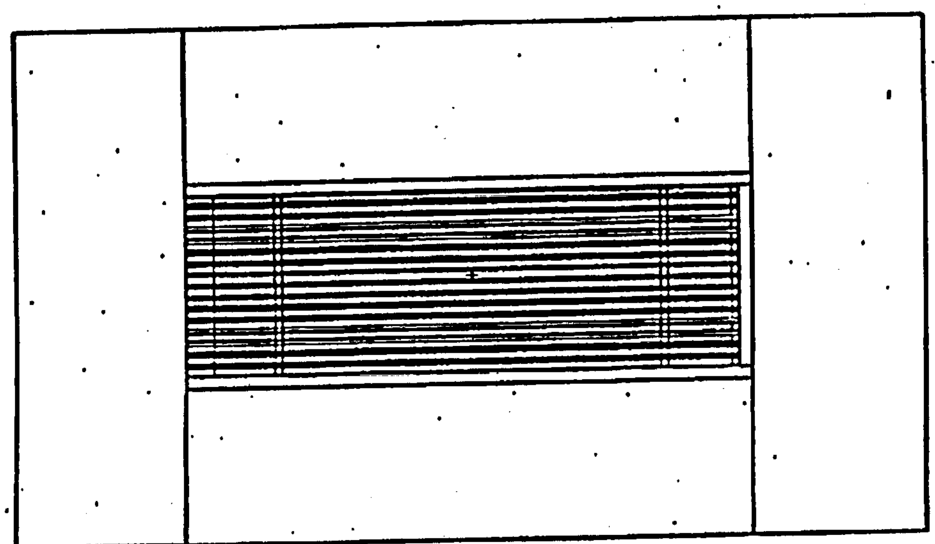


Figure 3.1.1-10 MCNP Plot: EXP2 y-z plane cross-section

Figure 3.1.1-11 MCNP Input File: EXP3

```
     CRITICAL EXPERIMENT No. 3. (p2438x24). 2.35w/o with Aluminum Absorber Plates
C
C    FILENAME: exp3
C    INITIAL SOURCE DISTRIBUTION WITHIN INPUT DECK.
C
C    EXPERIMENT DESCRIPTION
C
C    2.35% U-235 ENRICHED UO2 RODS, 1.270 CM OD AL CLAD, 1.1176 ID,
C    1.1176 CM OD UO2 91.44 CM LONG, ROD 97.79 CM LONG,
C    3-20X16 FUEL CLUSTERS,
C    2.032 CM SQUARE PITCH, 0.645 CM BETWEEN CENTRAL CLUSTER AND ABSORBERS,
C    8.67 CM SEPARATION BETWEEN CLUSTERS, ALUMINUM ABSORBER PLATE THICKNESS OF
C    0.625 CM, H2O MODERATED AND REFLECTED.
C    ORIGINAL REFERENCE: PNL-2438 EXPERIMENT NO. 24
C
C    CELL SPECIFICATIONS
C
C    FUEL ROD
1  1 -9.20     (-1 +4 -29)      IMP:N=1 U=1
2  1 -9.20     (-1 +29 -28)     IMP:N=1 U=1
3  1 -9.20     (-1 +28 -27)     IMP:N=1 U=1
4  1 -9.20     (-1 +27 -26)     IMP:N=1 U=1
5  1 -9.20     (-1 +26 -3)      IMP:N=1 U=1
6  2 -2.6989   (+1 -2 -29 +4)   IMP:N=1 U=1
7  2 -2.6989   (+1 -2 -4)       IMP:N=1 U=1
8  2 -2.6989   (+1 -2 +29 -28)  IMP:N=1 U=1
9  2 -2.6989   (+1 -2 +28 -27)  IMP:N=1 U=1
10 2 -2.6989   (+1 -2 +27 -26)  IMP:N=1 U=1
11 2 -2.6989   (+1 -2 +26 -3)   IMP:N=1 U=1
12 2 -2.6989   (+1 -2 +3)       IMP:N=1 U=1
13 6 -2.71     (-1 +3)          IMP:N=1 U=1
14 3 -2.70     (-1 -4)          IMP:N=1 U=1
15 4 -1.0      (+2 -29)         IMP:N=1 U=1
16 4 -1.0      (+2 +28 -27)     IMP:N=1 U=1
17 4 -1.0      (+2 +26 -3)      IMP:N=1 U=1
18 4 -1.0      (+2 +3)          IMP:N=1 U=1
19 5 -1.18     (-26 +27 +2)     IMP:N=1 U=1
20 5 -1.18     (-28 +29 +2)     IMP:N=1 U=1
C
C    20X16 ARRAY OF FUEL RODS
21  4 -1.0 -5 +6 -7 +8 IMP:N=1 LAT=1 U=2
     FILL 0:21 0:17 0:0
     2 21R
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
```

Figure 3.1.1-11 (continued) MCNP Input File: EXP3

```
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 1 19R 2
   2 21R
C
C   GLOBAL CONFIGURATIONS
C
C   FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
23  4  -1.0    -17 +24 +12 -11 +20 -9   IMP:N=1
24  4  -1.0    +9 -10 +12 -11 +18 -17   IMP:N=1 FILL=2 (-69.883 -17.272 0)
25  4  -1.0    -17 +18 +12 -11 +10 -30   IMP:N=1
26  2  -2.6989  +30 -33 +35 -34 +18 -36   IMP:N=1
29  4  -1.0    +33 -13 +12 -11 +18 -17   IMP:N=1
30  4  -1.0    +13 -14 +12 -11 +18 -17   IMP:N=1 FILL=2 (-21.336 -17.272 0)
31  4  -1.0    -17 +18 +12 -11 +14 -37   IMP:N=1
32  2  -2.6989  +37 -40 +35 -34 +18 -36   IMP:N=1
35  4  -1.0    +40 -15 +12 -11 +18 -17   IMP:N=1
36  4  -1.0    +15 -16 +12 -11 +18 -17   IMP:N=1 FILL=2 (27.211 -17.272 0)
37  4  -1.0    -17 +24 +12 -11 +16 -19   IMP:N=1
C
C   PLEXIGLASS BOTTOM
38  5  -1.18   +9 -16 +24 -18 +12 -11   IMP:N=1
C   WATER SURROUNDING FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
39  4  -1.0  -19 +20 -21 +22 -24 +23   IMP:N=1
40  4  -1.0  -19 +20 -21 +22 -25 +17   IMP:N=1
41  4  -1.0  -17 +24 +22 -35 +20 -19   IMP:N=1
42  4  -1.0  -17 +24 +34 -21 +20 -19   IMP:N=1
43  4  -1.0  +20 -30 +11 -34 +24 -17   IMP:N=1
44  4  -1.0  +33 -37 +11 -34 +24 -17   IMP:N=1
45  4  -1.0  +40 -19 +11 -34 +24 -17   IMP:N=1
46  4  -1.0  +20 -30 +35 -12 +24 -17   IMP:N=1
47  4  -1.0  +33 -37 +35 -12 +24 -17   IMP:N=1
48  4  -1.0  +40 -19 +35 -12 +24 -17   IMP:N=1
49  4  -1.0  +30 -33 +35 -34 +36 -17   IMP:N=1
50  4  -1.0  +37 -40 +35 -34 +36 -17   IMP:N=1
51  4  -1.0  +30 -33 +11 -34 +24 -18   IMP:N=1
52  4  -1.0  +30 -33 +35 -12 +24 -18   IMP:N=1
53  4  -1.0  +37 -40 +11 -34 +24 -18   IMP:N=1
54  4  -1.0  +37 -40 +35 -12 +24 -18   IMP:N=1
```

Figure 3.11-11 (continued) MCNP Input File: EXP3

```
C   ZERO IMPORTANCE REST OF WORLD
55  0      -20:+19:-22:+21:-23:+25  IMP:N=0

C   SURFACE SPECIFICATIONS
C
1   CZ   0.5588
2   CZ   0.6350
3   PZ   45.72
4   PZ   -45.72
5   PX   1.016
6   PX   -1.016
7   PY   1.016
8   PY   -1.016
9   PX   -68.8669
10  PX   -28.2271
11  PY   16.2559
12  PY   -16.2559
13  PX   -20.319
14  PX   20.319
15  PX   28.2271
16  PX   68.8669
17  PZ   50.80
18  PZ   -46.99
19  PX   99.3119
20  PX   -99.3119
21  PY   46.256
22  PY   -46.256
23  PZ   -79.53
24  PZ   -49.53
25  PZ   80.80
26  PZ   34.74
27  PZ   33.47
28  PZ   -33.47
29  PZ   -34.74
30  PX   -21.589
33  PX   -20.964
34  PY   17.8
35  PY   -17.8
36  PZ   44.51
37  PX   20.964
40  PX   21.589

C   MATERIAL SPECIFICATIONS
C
C   4.31 w/o URANIUM DIOXIDE
M1    92234.50C  -0.0049
      92235.50C  -2.0715
```

Figure 3.1.1-11 (continued) MCNP Input File: EXP3

```
     92238.50C  -86.0741
     8016.50C  -11.8495
C    6061 ALUMINUM
M2    13027.50C  -96.93
     12000.50C  -1.0
     14000.50C  -0.6
     22000.50C  -0.15
     24000.50C  -0.195
     25055.50C  -0.15
     26000.55C  -0.7
     29000.50C  -0.275
C    5052-H32 ALUMINUM
M3    13027.50C  -96.40
     12000.50C  -2.5
     14000.50C  -0.25
     24000.50C  -0.25
     25055.50C  -0.10
     26000.55C  -0.4
     29000.50C  -0.10
C    WATER
M4    1001.50C  2.0
     8016.50C  1.0
MT4    LWTR.01T
C    PLEXIGLASS
M5    6012.50C  0.03549
     1001.50C  0.05678
     8016.50C  0.01420
C    1100 ALUMINUM
M6    13027.50C  -99.00
     14000.50C  -0.825
     25055.50C  -0.05
     29000.50C  -0.125
C
C    CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE  500  1  25  525
KSRC   -63.787 7.112 0 -63.787 9.144 0 -63.787 -7.112 0 -63.787 -9.144 0
      -61.755 7.112 0 -61.755 9.144 0 -61.755 -7.112 0 -61.755 -9.144 0
      -53.627 1.016 0 -53.627 -1.016 0 -51.595 1.016 0 -51.595 -1.016 0
      -43.467 7.112 0 -43.467 9.144 0 -43.467 -7.112 0 -43.467 -9.144 0
      -41.435 7.112 0 -41.435 9.144 0 -41.435 -7.112 0 -41.435 -9.144 0
      -15.24 7.112 0 -15.24 9.144 0 -15.24 -7.112 0 -15.24 -9.144 0
      -13.208 7.112 0 -13.208 9.144 0 -13.208 -7.112 0 -13.208 -9.144 0
      -3.048 1.016 0 -3.048 -1.016 0 -1.016 1.016 0 -1.016 -1.016 0
      9.144 7.112 0 9.144 9.144 0 9.144 -7.112 0 9.144 -9.144 0
      11.176 7.112 0 11.176 9.144 0 11.176 -7.112 0 11.176 -9.144 0
```

Figure 3.1.1-11 (continued) MCNP Input File: EXP3

```
      33.307 7.112 0 33.307 9.144 0 33.307 -7.112 0 33.307 -9.144 0
      35.339 7.112 0 35.339 9.144 0 35.339 -7.112 0 35.339 -9.144 0
      43.467 1.016 0 43.467 -1.016 0 45.499 1.016 0 45.499 -1.016 0
      53.627 7.112 0 53.627 9.144 0 53.627 -7.112 0 53.627 -9.144 0
      55.659 7.112 0 55.659 9.144 0 55.659 -7.112 0 55.659 -9.144 0
PRINT
```

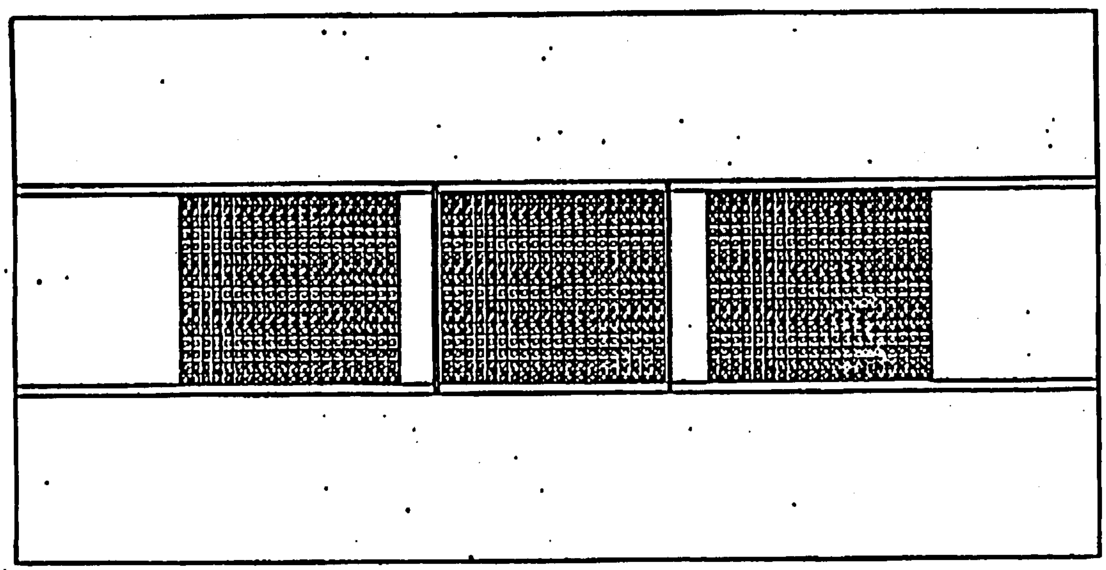


Figure 3.1.1-12 MCNP Plot: EXP3 x-y plane cross-section

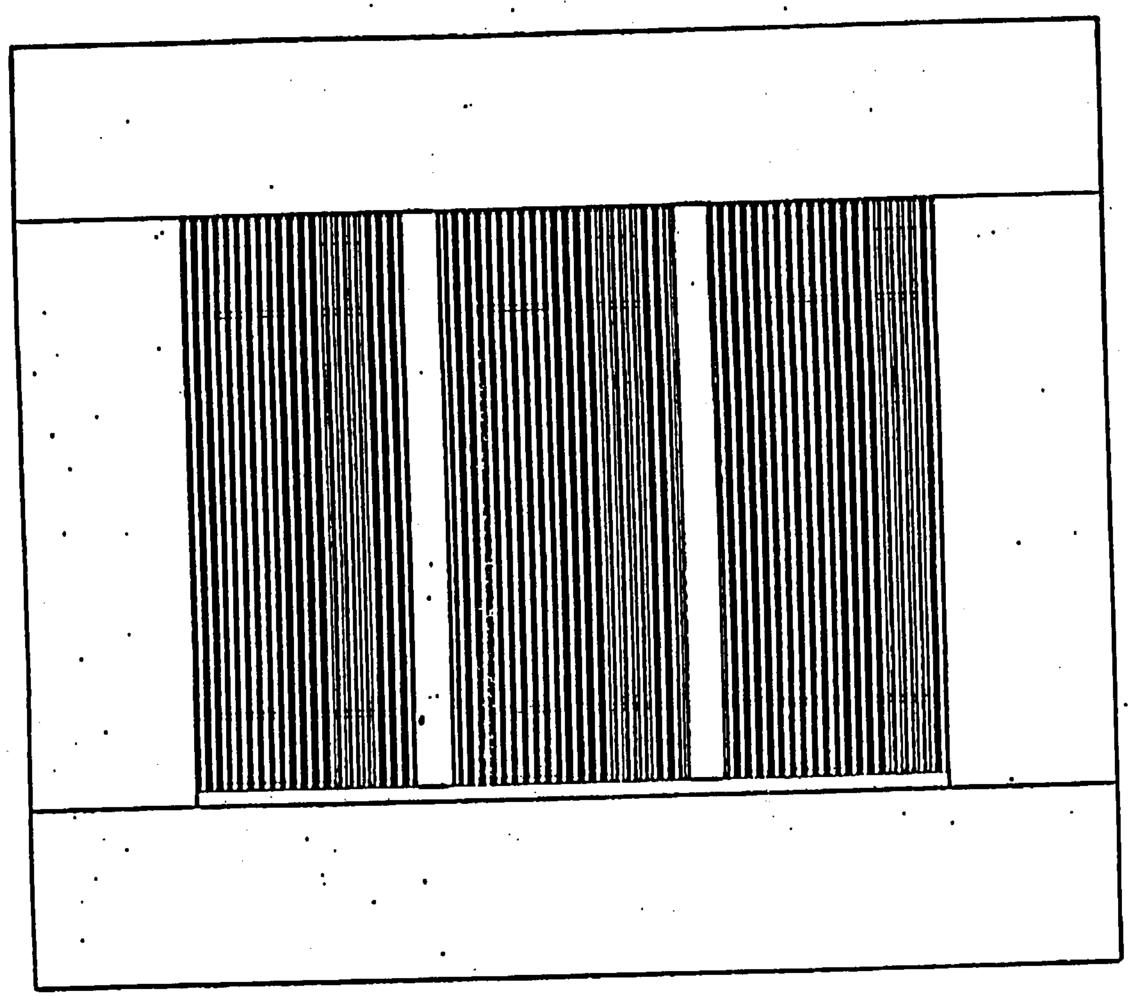


Figure 3.1.1-13 MCNP Plot: EXP3 x-z plane cross-section

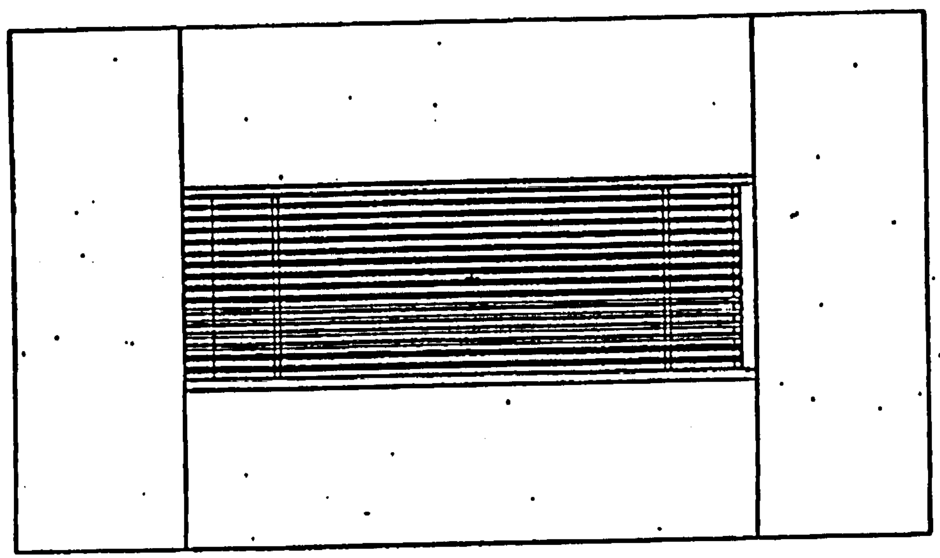


Figure 3.1.1-14 MCNP Plot: EXP3 y-z plane cross-section

Figure 3.1.1-15 MCNP Input File: EXP4

```
CRITICAL EXPERIMENT No. 4. (p2438x28). 2.35w/o with Steel Absorber Plates
C
C   FILENAME: exp4
C   INITIAL SOURCE DISTRIBUTION WITHIN INPUT DECK.
C
C   EXPERIMENT DESCRIPTION
C
C   2.35% U-235 ENRICHED UO2 RODS, 1.270 CM OD AL CLAD, 1.1176 ID,
C   1.1176 CM OD UO2 91.44 CM LONG, ROD 97.79 CM LONG,
C   3-20X16 FUEL CLUSTERS,
C   2.032 CM SQUARE PITCH, 0.645 CM BETWEEN CENTRAL CLUSTER AND ABSORBERS,
C   6.88 CM SEPARATION BETWEEN CLUSTERS, STEEL ABSORBER PLATE THICKNESS OF
C   0.485 CM, H2O MODERATED AND REFLECTED.
C   ORIGINAL REFERENCE: PNL-2438 EXPERIMENT NO. 28
C
C   CELL SPECIFICATIONS
C
C   FUEL ROD
1  1  -9.20     (-1 +4 -29)     IMP:N=1  U=1
2  1  -9.20     (-1 +29 -28)    IMP:N=1  U=1
3  1  -9.20     (-1 +28 -27)    IMP:N=1  U=1
4  1  -9.20     (-1 +27 -26)    IMP:N=1  U=1
5  1  -9.20     (-1 +26 -3)     IMP:N=1  U=1
6  2  -2.6989   (+1 -2 -29 +4)  IMP:N=1  U=1
7  2  -2.6989   (+1 -2 -4)      IMP:N=1  U=1
8  2  -2.6989   (+1 -2 +29 -28) IMP:N=1  U=1
9  2  -2.6989   (+1 -2 +28 -27) IMP:N=1  U=1
10 2  -2.6989   (+1 -2 +27 -26) IMP:N=1  U=1
11 2  -2.6989   (+1 -2 +26 -3)  IMP:N=1  U=1
12 2  -2.6989   (+1 -2 +3)      IMP:N=1  U=1
13 6  -2.71     (-1 +3)         IMP:N=1  U=1
14 3  -2.70     (-1 -4)         IMP:N=1  U=1
15 4  -1.0      (+2 -29)        IMP:N=1  U=1
16 4  -1.0      (+2 +28 -27)    IMP:N=1  U=1
17 4  -1.0      (+2 +26 -3)     IMP:N=1  U=1
18 4  -1.0      (+2 +3)         IMP:N=1  U=1
19 5  -1.18     (-26 +27 +2)    IMP:N=1  U=1
20 5  -1.18     (-28 +29 +2)    IMP:N=1  U=1
C
C   20X16 ARRAY OF FUEL RODS
21  4  -1.0  -5 +6 -7 +8  IMP:N=1  LAT=1  U=2
    FILL 0:21 0:17 0:0
    2 21R
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
    2 1 19R 2
```

Figure 3.1.1-15 (continued) MCNP Input File: EXP4

```
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 1 19R 2
     2 21R
C
C    GLOBAL CONFIGURATIONS
C
C    FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
23  4  -1.0    -17 +24 +12 -11 +20 -9   IMP:N=1
24  4  -1.0    +9  -10 +12 -11 +18 -17  IMP:N=1 FILL=2 (-68.093 -17.272 0)
25  4  -1.0    -17 +18 +12 -11 +10 -30  IMP:N=1
26  7  -7.9    +30 -33 +35 -34 +18 -36  IMP:N=1
29  4  -1.0    +33 -13 +12 -11 +18 -17  IMP:N=1
30  4  -1.0    +13 -14 +12 -11 +18 -17  IMP:N=1 FILL=2 (-21.336 -17.272 0)
31  4  -1.0    -17 +18 +12 -11 +14 -37  IMP:N=1
32  7  -7.9    +37 -40 +35 -34 +18 -36  IMP:N=1
35  4  -1.0    +40 -15 +12 -11 +18 -17  IMP:N=1
36  4  -1.0    +15 -16 +12 -11 +18 -17  IMP:N=1 FILL=2 (25.421 -17.272 0)
37  4  -1.0    -17 +24 +12 -11 +16 -19  IMP:N=1
C
C    PLEXIGLASS BOTTOM
38  5  -1.18  +9 -16 +24 -18 +12 -11  IMP:N=1
C    WATER SURROUNDING FUEL CLUSTERS AND INTERMEDIATE WATER REGIONS
39  4  -1.0  -19 +20 -21 +22 -24 +23  IMP:N=1
40  4  -1.0  -19 +20 -21 +22 -25 +17  IMP:N=1
41  4  -1.0  -17 +24 +22 -35 +20 -19  IMP:N=1
42  4  -1.0  -17 +24 +34 -21 +20 -19  IMP:N=1
43  4  -1.0  +20 -30 +11 -34 +24 -17  IMP:N=1
44  4  -1.0  +33 -37 +11 -34 +24 -17  IMP:N=1
45  4  -1.0  +40 -19 +11 -34 +24 -17  IMP:N=1
46  4  -1.0  +20 -30 +35 -12 +24 -17  IMP:N=1
47  4  -1.0  +33 -37 +35 -12 +24 -17  IMP:N=1
48  4  -1.0  +40 -19 +35 -12 +24 -17  IMP:N=1
49  4  -1.0  +30 -33 +35 -34 +36 -17  IMP:N=1
50  4  -1.0  +37 -40 +35 -34 +36 -17  IMP:N=1
51  4  -1.0  +30 -33 +11 -34 +24 -18  IMP:N=1
52  4  -1.0  +30 -33 +35 -12 +24 -18  IMP:N=1
53  4  -1.0  +37 -40 +11 -34 +24 -18  IMP:N=1
54  4  -1.0  +37 -40 +35 -12 +24 -18  IMP:N=1
```

Figure 3.1.1-15 (continued) MCNP Input File: EXP4

```
C  ZERO IMPORTANCE REST OF WORLD
55 0      -20:+19:-22:+21:-23:+25  IMP:N=0

C  SURFACE SPECIFICATIONS
C
1   CZ  0.5588
2   CZ  0.6350
3   PZ  45.72
4   PZ  -45.72
5   PX  1.016
6   PX  -1.016
7   PY  1.016
8   PY  -1.016
9   PX  -67.0769
10  PX  -26.4371
11  PY  16.2559
12  PY  -16.2559
13  PX  -20.319
14  PX  20.319
15  PX  26.4371
16  PX  67.0769
17  PZ  50.80
18  PZ  -46.99
19  PX  99.3119
20  PX  -99.3119
21  PY  46.256
22  PY  -46.256
23  PZ  -79.53
24  PZ  -49.53
25  PZ  80.80
26  PZ  34.74
27  PZ  33.47
28  PZ  -33.47
29  PZ  -34.74
30  PX  -21.449
33  PX  -20.964
34  PY  17.8
35  PY  -17.8
36  PZ  44.51
37  PX  20.964
40  PX  21.449

C  MATERIAL SPECIFICATIONS
C
C  4.31 w/o URANIUM DIOXIDE
M1   92234.50C  -0.0049
     92235.50C  -2.0715
```

Figure 3.1.1-15 (continued) MCNP Input File: EXP4

```
     92238.50C  -86.0741
     8016.50C  -11.8495
C    6061 ALUMINUM
M2   13027.50C  -96.93
     12000.50C  -1.0
     14000.50C  -0.6
     22000.50C  -0.15
     24000.50C  -0.195
     25055.50C  -0.15
     26000.55C  -0.7
     29000.50C  -0.275
C    5052-H32 ALUMINUM
M3   13027.50C  -96.40
     12000.50C  -2.5
     14000.50C  -0.25
     24000.50C  -0.25
     25055.50C  -0.10
     26000.55C  -0.4
     29000.50C  -0.10
C    WATER
M4   1001.50C  2.0
     8016.50C  1.0
MT4  LWTR.01T
C    PLEXIGLASS
M5   6012.50C  0.03549
     1001.50C  0.05678
     8016.50C  0.01420
C    1100 ALUMINUM
M6   13027.50C  -99.00
     14000.50C  -0.825
     25055.50C  -0.05
     29000.50C  -0.125
C    STAINLESS STEEL 304 ABSORBER PLATE
M7   6012.50C  -0.0800
     7014.50C  -0.4000
     14000.50C  -1.0000
     15031.50C  -0.0450
     16032.50C  -0.0300
     24000.50C  -19.0000
     25055.50C  -2.0000
     26000.55C  -67.2450
     27059.50C  -0.2000
     28000.50C  -10.0000
C
C    CONTROL CARD SPECIFICATIONS
C
MODE N
```

Figure 3.1.1-15 (continued) MCNP Input File: EXP4

```
KCODE  500  1  25  525
KSRC  -61.997 7.112 0 -61.997 9.144 0 -61.997 -7.112 0 -61.997 -9.144 0
     -59.965 7.112 0 -59.965 9.144 0 -59.965 -7.112 0 -59.965 -9.144 0
     -51.837 1.016 0 -51.837 -1.016 0 -49.805 1.016 0 -49.805 -1.016 0
     -41.677 7.112 0 -41.677 9.144 0 -41.677 -7.112 0 -41.677 -9.144 0
     -39.645 7.112 0 -39.645 9.144 0 -39.645 -7.112 0 -39.645 -9.144 0
     -15.24 7.112 0 -15.24 9.144 0 -15.24 -7.112 0 -15.24 -9.144 0
     -13.208 7.112 0 -13.208 9.144 0 -13.208 -7.112 0 -13.208 -9.144 0
     -3.048 1.016 0 -3.048 -1.016 0 -1.016 1.016 0 -1.016 -1.016 0
     9.144 7.112 0 9.144 9.144 0 9.144 -7.112 0 9.144 -9.144 0
     11.176 7.112 0 11.176 9.144 0 11.176 -7.112 0 11.176 -9.144 0
     31.517 7.112 0 31.517 9.144 0 31.517 -7.112 0 31.517 -9.144 0
     33.549 7.112 0 33.549 9.144 0 33.549 -7.112 0 33.549 -9.144 0
     41.677 1.016 0 41.677 -1.016 0 41.677 1.016 0 41.677 -1.016 0
     43.709 7.112 0 43.709 9.144 0 43.709 -7.112 0 43.709 -9.144 0
     55.659 7.112 0 55.659 9.144 0 55.659 -7.112 0 55.659 -9.144 0
PRINT
```

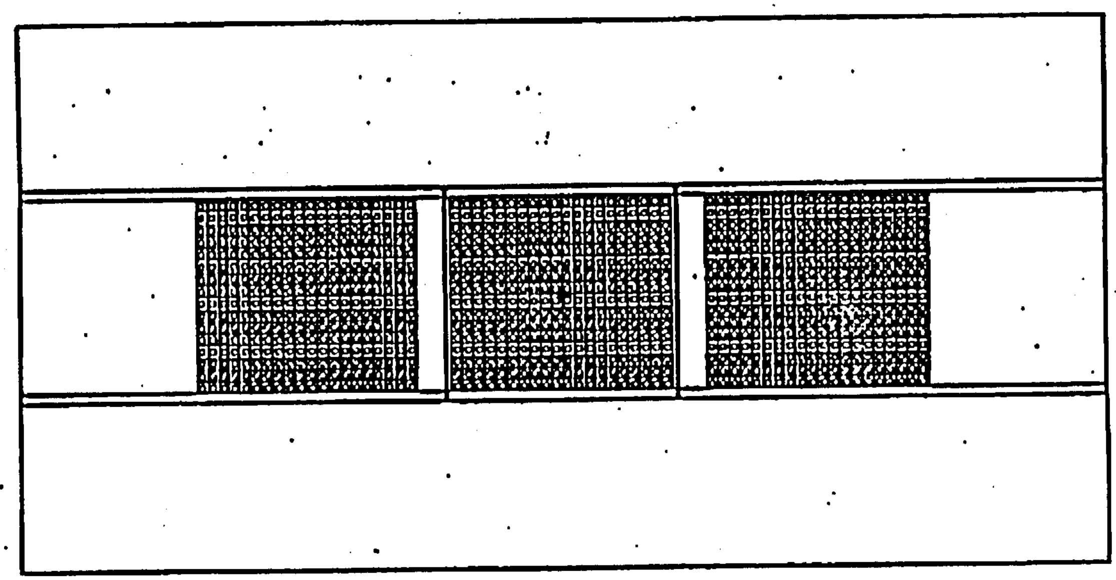


Figure 3.1.1-16 MCNP Plot: EXP4 x-y plane cross-section

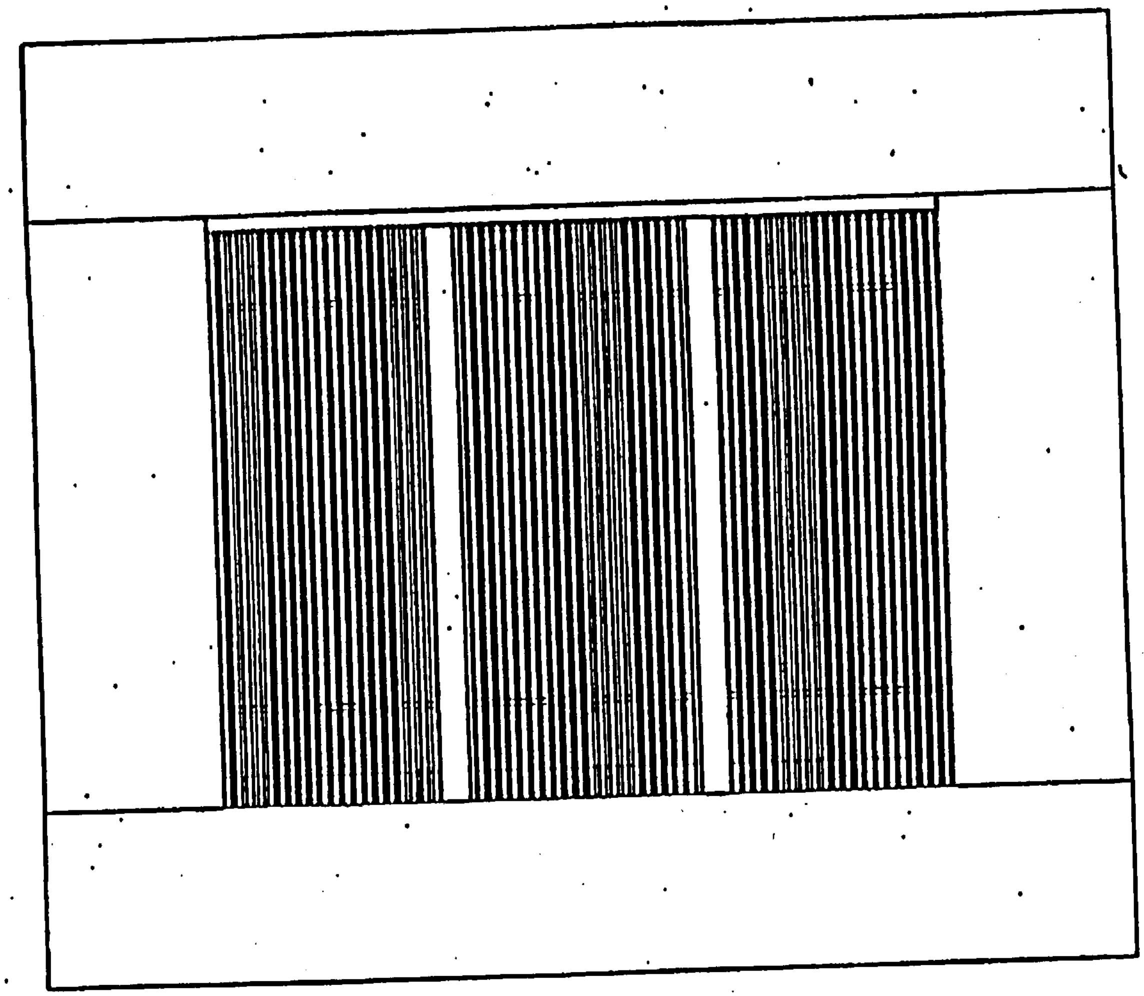


Figure 3.1.1-17 MCNP Plot: EXP4 x-z plane cross-section

3.1.2 Mixed Oxide Fuel

Electric Power Research Institute Mixed Oxide Critical Configurations

This section contains six critical experiment configurations (Ref. 7) composed of unborated and borated water moderated lattices of 2 wt% PuO2 (8 wt% Pu-240)/98 wt% UO2 (natural) fuel rods. The PuO2/UO2 fuel rod description is shown in Figure 3.1.2-1. The PuO2/UO2 composition used in the MCNP models in shown in Table 3.1.2-1. The fuel rods were supported in a core structure composed of "eggcrate" type lattice plates with an upper lead shield. The axial view of the general core configuration is shown in Figure 3.1.2-2. The eggcrate lattice description is shown in Figure 3.1.2-3. The aluminum compositions used in the MCNP models are shown in Table 3.1.2-2. A water reflector of at least 30 cm thickness was located below the aluminum base plate and around the fuel rod configuration in each experiment.

Table 3.1.2-1
2 wt% PuO2 (8 wt% Pu-240)/98 wt% UO2 (natural) Fuel Composition (9.54 g/cc)

Element/Isotope	Atom Density (atoms/b-cm)
U-234	1.2462E-6
U-235	1.4891E-4
U-236	2.0943E-9
U-238	2.0619E-2
Pu-238	3.8850E-8
Pu-239	3.9477E-4
Pu-240	3.3218E-5
Pu-241	1.6023E-6
Pu-242	1.1887E-7
Am-241	1.5024E-6
Oxygen	4.3763E-2

Table 4.2.2-2
Type 6061 Aluminum Composition (2.6989 g/cc)

Element/Isotope	Weight Percent
Aluminum	96.93
Carbon	1.0
Silicon	0.6
Titanium	0.15
Chromium	0.195
Manganese	0.15
Iron	0.7
Copper	0.275

The first experiment, designated EXP22, is a 1.778 cm square pitch lattice composed of 469 fuel rods. The core loading diagram is shown in Figure 3.1.2-4. The water-to-fuel volume ratio is 1.195, and the water moderator is unborated. This critical experiment was analyzed with the WPDD MCNP4A code system. The MCNP4A input file is presented in Figure 3.1.2-5. This configuration's x-y plane, x-z plane, and y-z plane cross-sectional views obtained from the MCNP plotting sequence are presented in Figures 3.1.2-6, -7, -8, respectively. The WPDD's MCNP4A k_{eff} result is 0.9966 with a standard deviation of 0.0015.

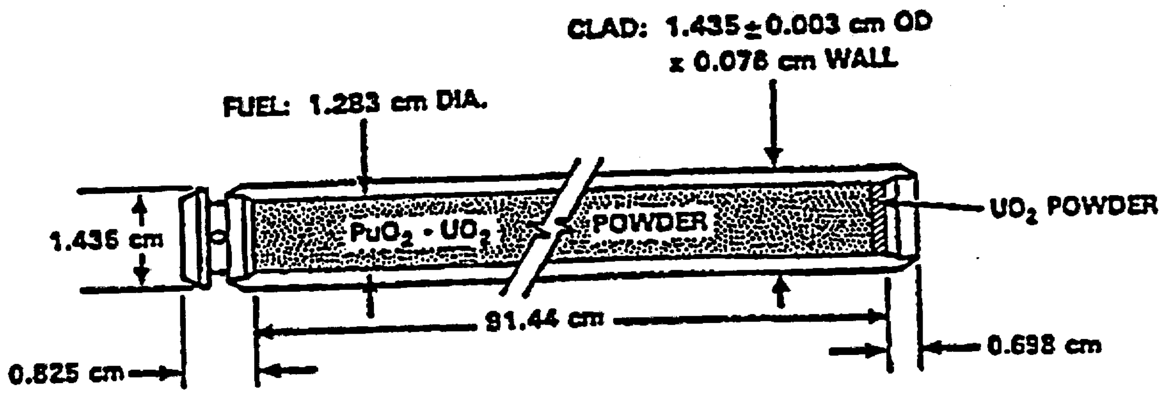
The second experiment, designated EXP23, is a 1.778 cm square pitch lattice composed of 761 fuel rods. The core loading diagram is shown in Figure 3.1.2-9. The water-to-fuel volume ratio is 1.195, and the water moderator contains 680.9 ppm of boron. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.2-10. This configuration's x-y plane cross-sectional view obtained from the MCNP plotting sequence is presented in Figure 3.1.2-11. The WPDD's MCNP4A k_{eff} result is 1.0018 with a standard deviation of 0.0015.

The third experiment, designated EXP24, is a 2.210 cm square pitch lattice composed of 197 fuel rods. The core loading diagram is shown in Figure 3.1.2-12. The 1.562 cm pitch eggcrate lattice plate is used in this experiment. The fuel rods are loaded into every other lattice location to obtain the 2.210 cm pitch. The water-to-fuel volume ratio is 2.527, and the water moderator is unborated. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.2-13. This configuration's x-y plane cross-sectional view obtained from the MCNP plotting sequence is presented in Figure 3.1.2-14. The WPDD's MCNP4A k_{eff} result is 1.0066 with a standard deviation of 0.0015.

The fourth experiment, designated EXP25, is a 2.210 cm square pitch lattice composed of 761 fuel rods. The core loading diagram is shown in Figure 3.1.2-15. The 1.562 cm pitch eggcrate lattice plate is used in this experiment. The fuel rods are loaded into every other lattice location to obtain the 2.210 cm pitch. The water-to-fuel volume ratio is 2.527, and the water moderator contains 1090.4 ppm of boron. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.2-16. This configuration's x-y plane cross-sectional view obtained from the MCNP plotting sequence is presented in Figure 3.1.2-17. The WPDD's MCNP4A k_{eff} result is 1.0050 with a standard deviation of 0.0015.

The fifth experiment, designated EXP26, is a 2.515 cm square pitch lattice composed of 160 fuel rods. The core loading diagram is shown in Figure 3.1.2-18. The 1.778 cm pitch eggcrate lattice plate is used in this experiment. The fuel rods are loaded into every other lattice location to obtain the 2.515 cm pitch. The water-to-fuel volume ratio is 3,641, and the water moderator is unborated. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.2-19. This configuration's x-y plane cross-sectional view obtained from the MCNP plotting sequence is presented in Figure 3.1.2-20. The WPDD's MCNP4A k_{eff} result is 1.0086 with a standard deviation of 0.0014.

The sixth experiment, designated EXP27, is a 2.515 cm square pitch lattice composed of 689 fuel rods. The core loading diagram is shown in Figure 3.1.2-21. The 1.778 cm pitch eggcrate lattice plate is used in this experiment. The fuel rods are loaded into every other lattice location to obtain the 2.515 cm pitch. The water-to-fuel volume ratio is 3.641, and the water moderator contains 767.2 ppm of boron. This critical experiment was analyzed with MCNP4A using the input in Figure 3.1.2-22. This configuration's x-y plane cross-sectional view obtained from the MCNP plotting sequence is presented in Figure 3.1.2-23. The WPDD's MCNP4A k_{eff} result is 1.0073 with a standard deviation of 0.0014.



CLADDING: ZIRCALOY-2 TUBING WITH PLUGS SEAL WELDED AT BOTH ENDS

LOADING:

ENRICHMENT - 2.00 WT% PuO_2 IN NATURAL UO_2
OXIDE DENSITY - 9.54 g/cm^3
$PuO_2 + UO_2$ - 1128g/ROD
Pu - 20.169 ± 0.004 g/ROD
U - 970.306 ± 0.225 g/ROD
UO_2 POWDER - NATURAL URANIUM ABOUT 0.2 cm THICK

Figure 3.1.2-1 2 wt% PuO2 (8 wt% Pu-240)/98 wt% UO2 (natural) Fuel Rod

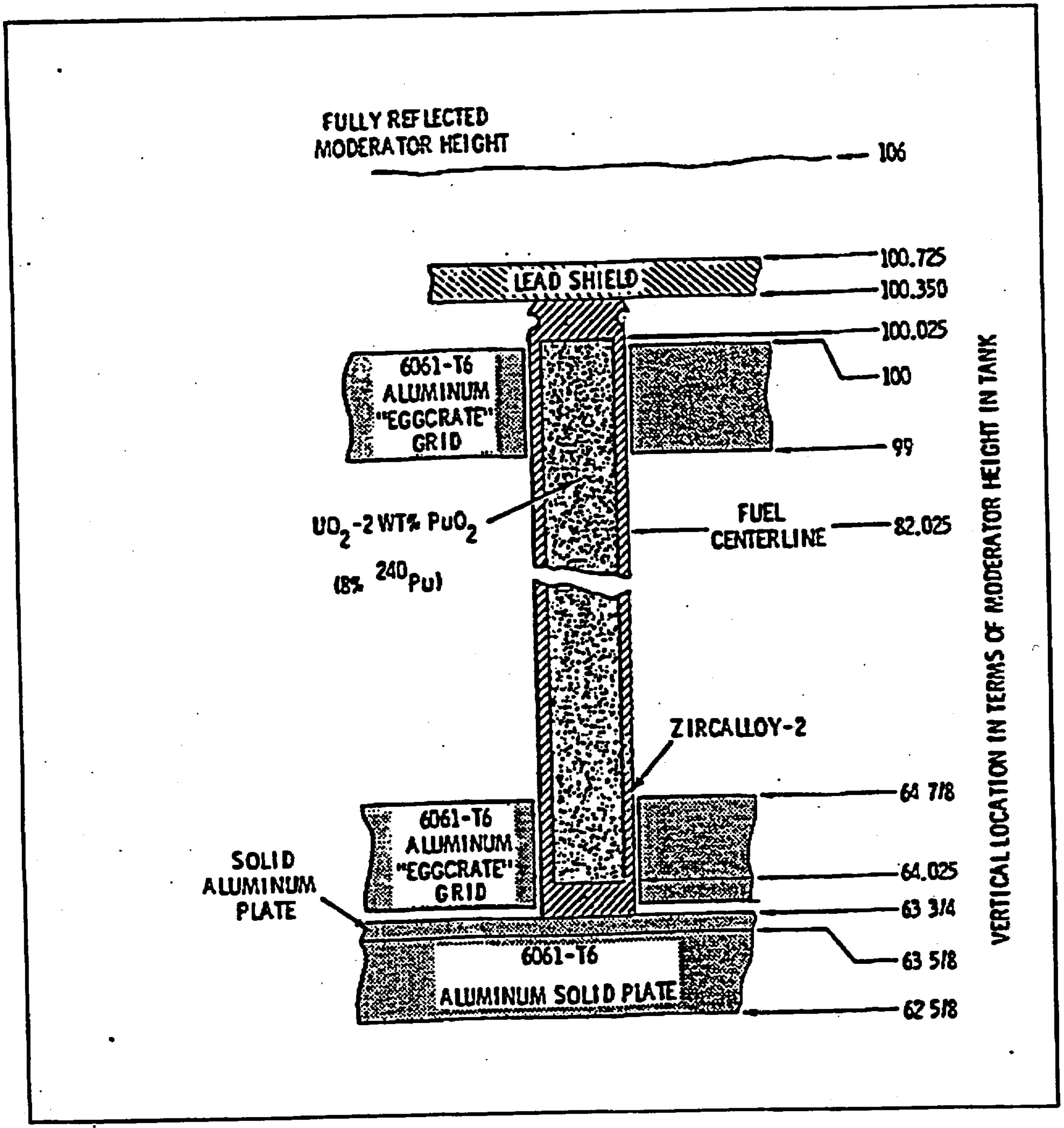
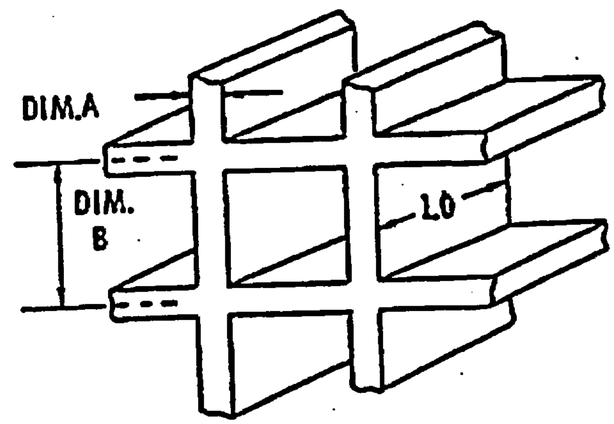


Figure 3.1.2-2 Axial View of the EPRI Mixed Oxide General Core Configuration



FUEL TYPE	PITCH	GRID	DIM.A	DIM B
UO_2-2.35% ^{235}U	0.615 0.87	UPPER LOWER	0.032 0.090	0.615
UO_2-2 WT% PuO_2 (8% ^{240}Pu)	0.87	UPPER LOWER	0.032 0.032	0.615
UO_2-2 WT% PuO_2 (8% ^{240}Pu)	0.70 0.99	UPPER LOWER	0.125 0.125	0.70

Figure 3.1.2-3 Mixed Oxide Experiment Eggcrate Lattice Plate Description

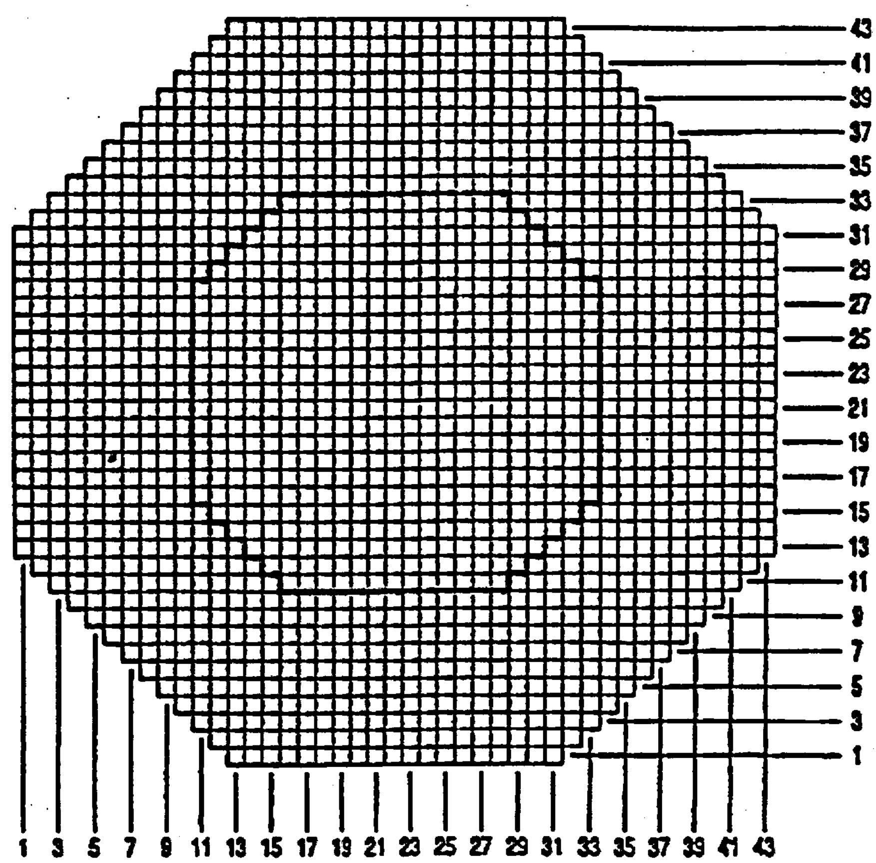


Figure 3.1.2-4 EXP22 Core Loading Description

Figure 3.1.2-5 MCNP Input File: EXP22

```
CRITICAL EXPERIMENT NO. 22, 0.71 wt% U-235, 0.700-in. pitch, 0 ppmb
C
C   EXPERIMENT DESCRIPTION (FILENAME: EXP22A)
C
C   THIS EXPERIMENT CONSISTS OF A WATER MODERATED AND REFLECTED CORE
C   OF 469 PuO2-UO2 FUEL RODS. THE WATER-TO-FUEL VOLUME RATIO IS 1.195.
C   THE CORE LATTICE HAS A SQUARE PITCH OF 0.7 INCHES OR 1.778 CM.
C   A 0.9525 CM LEAD SHIELD COVERS THE CORE AT THE TOP OF THE FUEL RODS.
C   THE FUEL RODS ARE SUPPORTED BY A 2.8575 CM ALUMINUM PLATE. THE CORE
C   IS COMPLETELY REFLECTED ON ALL SIDES BY 30 CM OF WATER.
C
C   REFERENCE: EPRI NP-196
C
C   CELL SPECIFICATIONS
C
C   UNIT CELL CONTAINING A FUEL ROD
1  1 -9.54    -1 +5 -9              IMP:N=1  U=1
2  2 -9.54    -1 +4 -5              IMP:N=1  U=1
3  3 4.3333-2  -2 +9                IMP:N=1  U=1
4  3 4.3333-2  -2 +1 -9 +4          IMP:N=1  U=1
5  3 4.3333-2  -2 -4                IMP:N=1  U=1
6  5 -1.0     +2 -11 +12 -13 +14 -8 +7  IMP:N=1  U=1
7  5 -1.0     +2 -11 +12 -13 +14 -6 +3  IMP:N=1  U=1
8  5 -1.0     +2 +8                 IMP:N=1  U=1
9  5 -1.0     +2 -7 +6              IMP:N=1  U=1
10 5 -1.0     +2 -3                 IMP:N=1  U=1
11 4 -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=1
12 4 -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=1
C
C   UNIT CELL CONTAINING ONLY THE SPACER GRIDS
13 5 -1.0     +8                    IMP:N=1  U=2
14 5 -1.0     -11 +12 -13 +14 -8 +7  IMP:N=1  U=2
15 5 -1.0     -7 +6                 IMP:N=1  U=2
16 5 -1.0     -11 +12 -13 +14 -6 +3  IMP:N=1  U=2
17 5 -1.0     -3                    IMP:N=1  U=2
18 4 -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=2
19 4 -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=2
C
C   ARRAY OF CORE
20 5 -1.0  -15 +16 -17 +18  LAT=1  U=3  IMP:N=1
   FILL 0:42 0:42 0:0
   1 11R 2 9R 3 20R
   1 11R 2 9R 3 20R
   1 11R 2 9R 3 20R
   1 11R 2 9R 3 20R
   1 11R 2 9R 3 20R
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
      1 11R 2 9R 3 20R
      1 11R 2 9R 3 20R
      1 10R 2 10R 3 20R
      1 9R 2 11R 3 20R
      1 8R 2 12R 3 20R
      1 7R 2 12R 3 21R
      1 6R 2 12R 3 22R
      2 18R 3 23R
      2 17R 3 24R
      2 16R 3 25R
      2 15R 3 26R
      2 14R 3 27R
      2 13R 3 28R
      2 12R 3 29R
      2 11R 3 30R
      2 10R 3 31R
      2 9R 3 32R
      3 42R
      3 859R
C
C   GLOBAL CONFIGURATIONS
C
C   WINDOW FOR CORE ARRAY
21  5  -1.0    +19 +21 +22 -20 -10  IMP:N=1  FILL=3
C   LEAD SHIELD
22  6  -11.4    +10 -23 +19 +21 -20  IMP:N=1
C   6061 ALUMINUM PLATE
23  4  -2.6989  -22 +24 +19 +21 -20  IMP:N=1
C   WATER REFLECTOR REGIONS
24  5  -1.0    +23 -25 +19 +21 -20  IMP:N=1
25  5  -1.0    +26 -24 +19 +21 -20  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
26  0          +25:-26:+20:-19:-21  IMP:N=0

C   SURFACE SPECIFICATIONS
1    CZ  0.6415
2    CZ  0.7175
3    PZ  0.3175
4    PZ  0.698
5    PZ  0.898
6    PZ  2.8575
7    PZ  89.535
8    PZ  92.075
9    PZ  92.138
10   PZ  92.964
11   PX  0.73025
12   PX  -0.73025
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
13    PY  0.73025
14    PY  -0.73025
15    PX  0.889
16    PX  -0.889
17    PY  0.889
18    PY  -0.889
19*   PX  0.0
20    CZ  69.0
21*   PY  0.0
22    PZ  0.0
23    PZ  93.9165
24    PZ  -2.8575
25    PZ  124.0
26    PZ  -33.0

C   MATERIAL SPECIFICATIONS
C
C   PuO2-UO2 FUEL
M1    92234.50C   1.2462-6
     92235.50C   1.4891-4
     92236.50C   2.0943-9
     92238.50C   2.0619-2
     94238.50C   3.885-8
     94239.55C   3.9477-4
     94240.50C   3.3218-5
     94241.50C   1.6023-6
     94242.50C   1.1887-7
     95241.50C   1.5024-6
      8016.50C   4.3763-2
 C   UO2 WITH NATURAL ENRICHMENT
 M2    92234.50C   1.1702-6
      92235.50C   1.5318-4
      92238.50C   2.1121-2
       8016.50C   4.2551-2
 C   ZIRCALOY-2
 M3     8016.50C   -0.12
      24000.50C   -0.10
      26000.55C   -0.10
      40000.50C   -98.23
      50000.35C   -1.40
      28000.50C   -0.05
 C   6061 ALUMINUM
 M4    13027.50C   -96.93
      12000.50C   -1.0
      14000.50C   -0.6
      22000.50C   -0.15
      24000.50C   -0.195
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
   25055.50C   -0.15
   26000.55C   -0.7
   29000.50C   -0.275
C  WATER
M5   8016.50C   1.0
     1001.50C   2.0
MT5   LWTR.01T
C  LEAD
M6   82000.50C   1.0
C
C   CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE   500  1  25  525
KSRC   1.778 1.778 46 3.556 1.778 46 1.778 3.556 46 3.556 3.556 46
     8.89 1.778 46 10.668 1.778 46 8.89 3.556 46 10.668 3.556 46
     16.002 1.778 46 17.78 1.778 46 16.002 3.556 46 17.78 3.556 46
     5.334 7.112 46 5.334 8.89 46 7.112 7.112 46 7.112 8.89 46
     12.446 7.112 46 12.446 8.89 46 14.224 7.112 46 14.224 8.89 46
     1.778 12.446 46 1.778 14.224 46 3.556 12.446 46 3.556 14.224 46
     8.89 12.446 46 8.89 14.224 46 10.668 12.446 46 10.668 14.224 46
     5.335 16.002 46 5.335 17.78 46 7.112 16.002 46 7.112 17.78 46
C
C   TALLY CARD SPECIFICATIONS
F24:N   (1 2)
FM24    1.0 1 -6
*F34:N   (1 2)
FM34    1.0 1 -6
F44:N   (1 2)
FM44    1.0 1 -6
*F54:N   (1 2)
FM54    1.0 1 -6
F64:N   (1 2)
FM64    1.0 1 -6
*F74:N   (1 2)
FM74    1.0 1 -6
F84:N   (1 2)
FM84    1.0 1 -6
*F94:N   (1 2)
FM94    1.0 1 -6
F104:N   (1 2)
FM104    1.0 1 -6
*F114:N   (1 2)
FM114    1.0 1 -6
F124:N   (1 2)
FM124    1.0 1 -6
*F134:N   (1 2)
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

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FM144    1.0 1 -6
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FM154    1.0 1 -6
F164:N   (1 2)
FM164    1.0 1 -6
*F174:N  (1 2)
FM174    1.0 1 -6
F184:N   (1 2)
FM184    1.0 1 -6
*F194:N  (1 2)
FM194    1.0 1 -6
F204:N   (1 2)
FM204    1.0 1 -6
*F214:N  (1 2)
FM214    1.0 1 -6
F224:N   (1 2)
FM224    1.0 1 -6
*F234:N  (1 2)
FM234    1.0 1 -6
F244:N   (1 2)
FM244    1.0 1 -6
*F254:N  (1 2)
FM254    1.0 1 -6
F264:N   (1 2)
FM264    1.0 1 -6
*F274:N  (1 2)
FM274    1.0 1 -6
F284:N   (1 2)
FM284    1.0 1 -6
*F294:N  (1 2)
FM294    1.0 1 -6
F304:N   (1 2)
FM304    1.0 1 -6
*F314:N  (1 2)
FM314    1.0 1 -6
F324:N   (1 2)
FM324    1.0 1 -6
*F334:N  (1 2)
FM334    1.0 1 -6
F344:N   (1 2)
FM344    1.0 1 -6
*F354:N  (1 2)
FM354    1.0 1 -6
F364:N   (1 2)
FM364    1.0 1 -6
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
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FM374    1.0 1 -6
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FM384    1.0 1 -6
*F394:N  (1 2)
FM394    1.0 1 -6
F404:N   (1 2)
FM404    1.0 1 -6
*F414:N  (1 2)
FM414    1.0 1 -6
F424:N   (1 2)
FM424    1.0 1 -6
*F434:N  (1 2)
FM434    1.0 1 -6
F444:N   (1 2)
FM444    1.0 1 -6
*F454:N  (1 2)
FM454    1.0 1 -6
F464:N   (1 2)
FM464    1.0 1 -6
*F474:N  (1 2)
FM474    1.0 1 -6
F484:N   (1 2)
FM484    1.0 1 -6
*F494:N  (1 2)
FM494    1.0 1 -6
F504:N   (1 2)
FM504    1.0 1 -6
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F564:N   (1 2)
FM564    1.0 1 -6
*F574:N  (1 2)
FM574    1.0 1 -6
F584:N   (1 2)
FM584    1.0 1 -6
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FM594    1.0 1 -6
F604:N   (1 2)
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

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FM614    1.0 1 -6
F624:N   (1 2)
FM624    1.0 1 -6
*F634:N  (1 2)
FM634    1.0 1 -6
F644:N   (1 2)
FM644    1.0 1 -6
*F654:N  (1 2)
FM654    1.0 1 -6
F664:N   (1 2)
FM664    1.0 1 -6
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FM674    1.0 1 -6
F684:N   (1 2)
FM684    1.0 1 -6
*F694:N  (1 2)
FM694    1.0 1 -6
F704:N   (1 2)
FM704    1.0 1 -6
*F714:N  (1 2)
FM714    1.0 1 -6
F724:N   (1 2)
FM724    1.0 1 -6
*F734:N  (1 2)
FM734    1.0 1 -6
F744:N   (1 2)
FM744    1.0 1 -6
*F754:N  (1 2)
FM754    1.0 1 -6
F764:N   (1 2)
FM764    1.0 1 -6
*F774:N  (1 2)
FM774    1.0 1 -6
F784:N   (1 2)
FM784    1.0 1 -6
*F794:N  (1 2)
FM794    1.0 1 -6
F804:N   (1 2)
FM804    1.0 1 -6
*F814:N  (1 2)
FM814    1.0 1 -6
F824:N   (1 2)
FM824    1.0 1 -6
*F834:N  (1 2)
FM834    1.0 1 -6
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
F844:N   (1 2)
FM844    1.0 1 -6
*F854:N  (1 2)
FM854    1.0 1 -6
F864:N   (1 2)
FM864    1.0 1 -6
*F874:N  (1 2)
FM874    1.0 1 -6
F884:N   (1 2)
FM884    1.0 1 -6
*F894:N  (1 2)
FM894    1.0 1 -6
F904:N   (1 2)
FM904    1.0 1 -6
*F914:N  (1 2)
FM914    1.0 1 -6
F924:N   (1 2)
FM924    1.0 1 -6
*F934:N  (1 2)
FM934    1.0 1 -6
F944:N   (1 2)
FM944    1.0 1 -6
*F954:N  (1 2)
FM954    1.0 1 -6
F964:N   (1 2)
FM964    1.0 1 -6
*F974:N  (1 2)
FM974    1.0 1 -6
F984:N   (1 2)
FM984    1.0 1 -6
*F994:N  (1 2)
FM994    1.0 1 -6
E24     2.00E-7 20.0
E34     2.00E-7 20.0
E44     3.00E-7 20.0
E54     3.00E-7 20.0
E64     4.00E-7 20.0
E74     4.00E-7 20.0
E84     5.00E-7 20.0
E94     5.00E-7 20.0
E104    6.00E-7 20.0
E114    6.00E-7 20.0
E124    7.00E-7 20.0
E134    7.00E-7 20.0
E144    8.00E-7 20.0
E154    8.00E-7 20.0
E164    9.00E-7 20.0
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
E174    9.00E-7 20.0
E184    1.00E-6 20.0
E194    1.00E-6 20.0
E204    1.10E-6 20.0
E214    1.10E-6 20.0
E224    1.20E-6 20.0
E234    1.20E-6 20.0
E244    1.30E-6 20.0
E254    1.30E-6 20.0
E264    1.40E-6 20.0
E274    1.40E-6 20.0
E284    1.50E-6 20.0
E294    1.50E-6 20.0
E304    1.60E-6 20.0
E314    1.60E-6 20.0
E324    1.70E-6 20.0
E334    1.70E-6 20.0
E344    1.80E-6 20.0
E354    1.80E-6 20.0
E364    1.90E-6 20.0
E374    1.90E-6 20.0
E384    2.00E-6 20.0
E394    2.00E-6 20.0
E404    2.10E-6 20.0
E414    2.10E-6 20.0
E424    2.20E-6 20.0
E434    2.20E-6 20.0
E444    2.30E-6 20.0
E454    2.30E-6 20.0
E464    2.40E-6 20.0
E474    2.40E-6 20.0
E484    2.50E-6 20.0
E494    2.50E-6 20.0
E504    2.60E-6 20.0
E514    2.60E-6 20.0
E524    2.70E-6 20.0
E534    2.70E-6 20.0
E544    2.80E-6 20.0
E554    2.80E-6 20.0
E564    2.90E-6 20.0
E574    2.90E-6 20.0
E584    3.00E-6 20.0
E594    3.00E-6 20.0
E604    3.10E-6 20.0
E614    3.10E-6 20.0
E624    3.20E-6 20.0
E634    3.20E-6 20.0
```

Figure 3.1.2-5 (continued) MCNP Input File: EXP22

```
E644     3.30E-6 20.0
E654     3.30E-6 20.0
E664     3.40E-6 20.0
E674     3.40E-6 20.0
E684     3.50E-6 20.0
E694     3.50E-6 20.0
E704     3.60E-6 20.0
E714     3.60E-6 20.0
E724     3.70E-6 20.0
E734     3.70E-6 20.0
E744     3.80E-6 20.0
E754     3.80E-6 20.0
E764     3.90E-6 20.0
E774     3.90E-6 20.0
E784     4.00E-6 20.0
E794     4.00E-6 20.0
E804     4.10E-6 20.0
E814     4.10E-6 20.0
E824     4.20E-6 20.0
E834     4.20E-6 20.0
E844     4.30E-6 20.0
E854     4.30E-6 20.0
E864     4.40E-6 20.0
E874     4.40E-6 20.0
E884     4.50E-6 20.0
E894     4.50E-6 20.0
E904     4.60E-6 20.0
E914     4.60E-6 20.0
E924     4.70E-6 20.0
E934     4.70E-6 20.0
E944     4.80E-6 20.0
E954     4.80E-6 20.0
E964     4.90E-6 20.0
E974     4.90E-6 20.0
E984     5.00E-6 20.0
E994     5.00E-6 20.0
PRINT
```

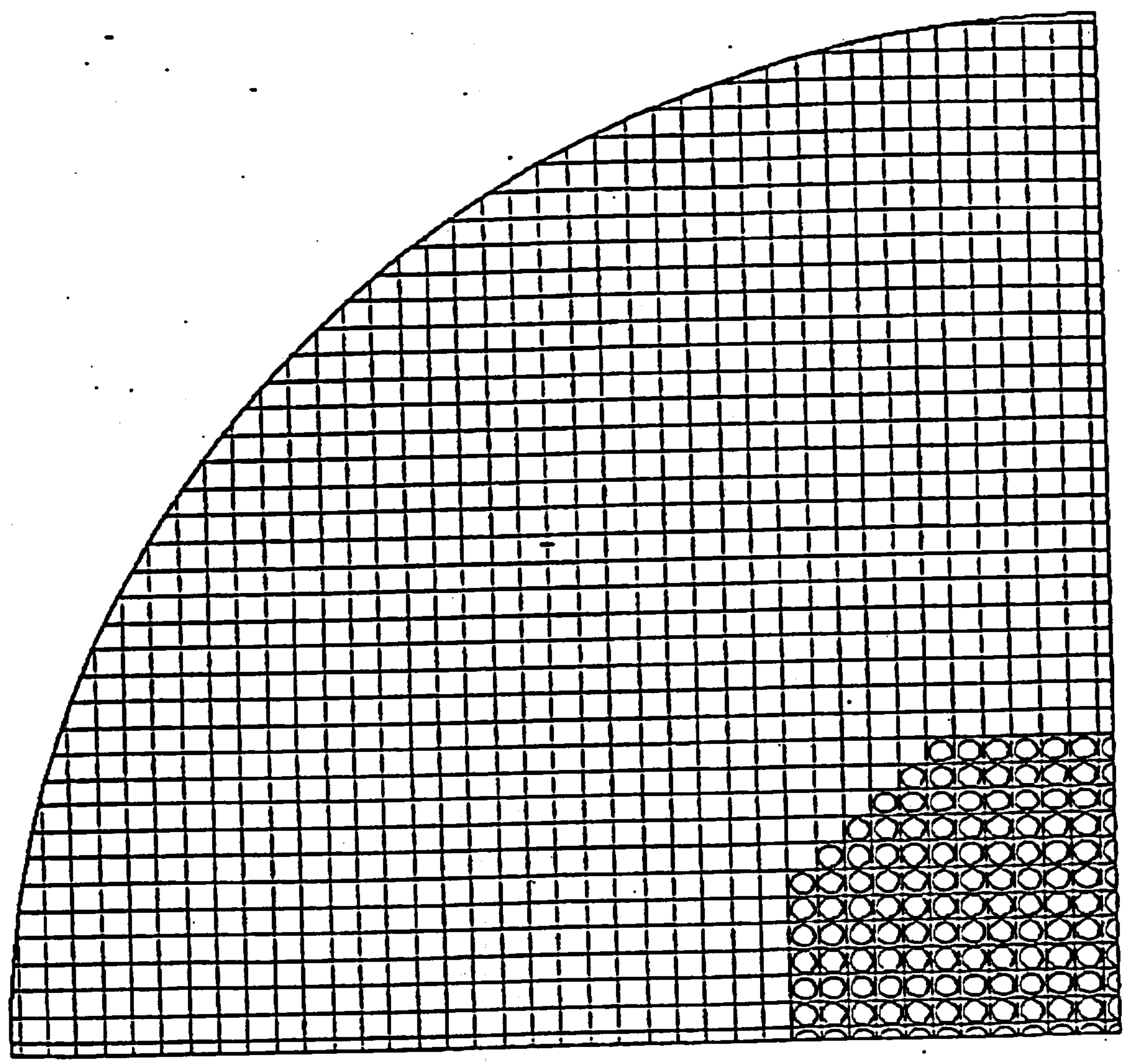

Figure 3.1.2-6 MCNP Plot: EXP22 x-y plane cross-section

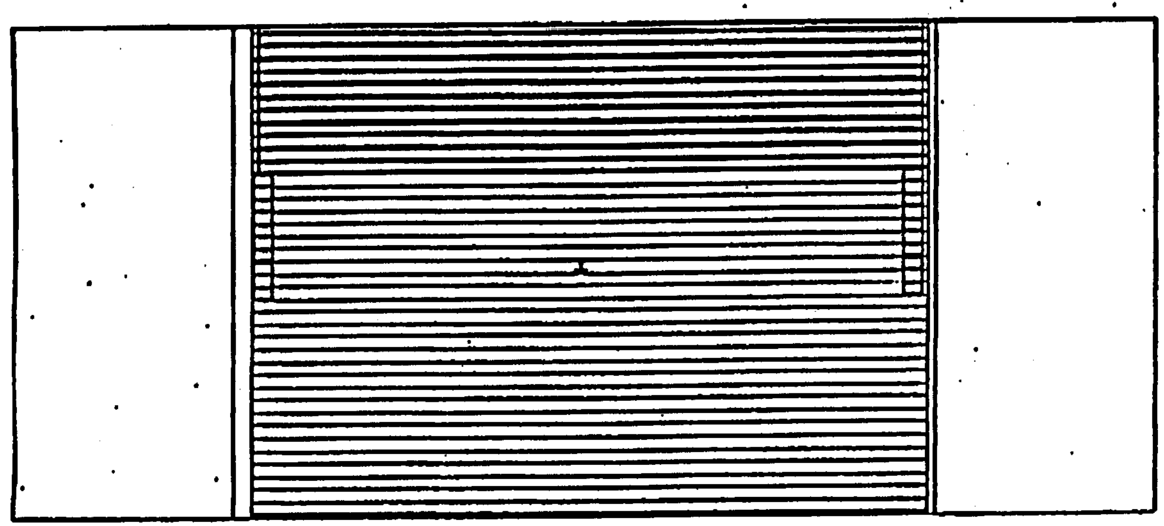

Figure 3.1.2-7 MCNP Plot: EXP22 x-z plane cross-section

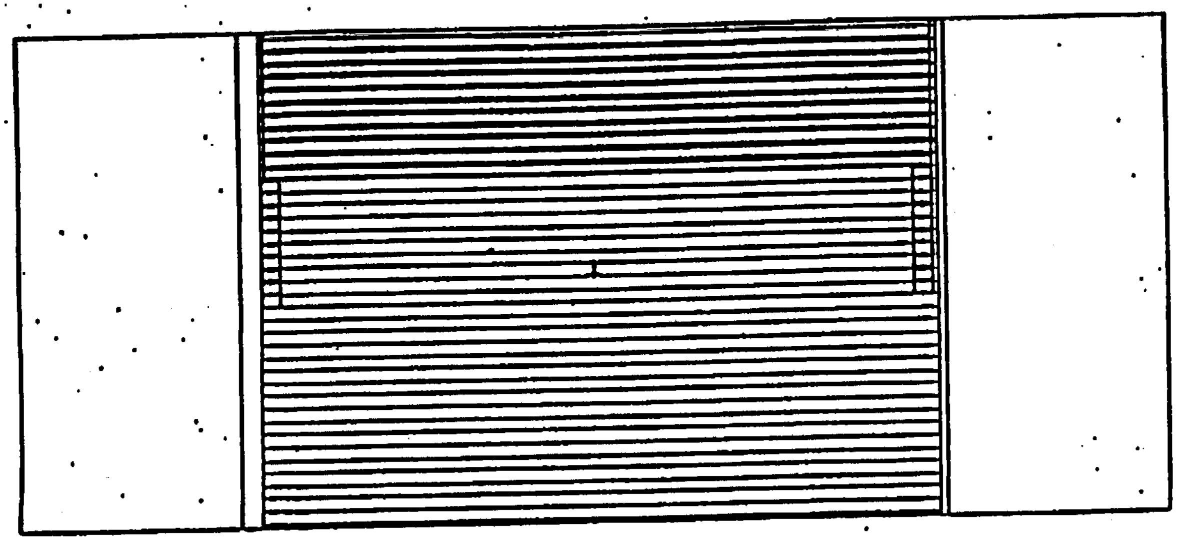

Figure 3.1.2-8 MCNP Plot: EXP22 y-z plane cross-section

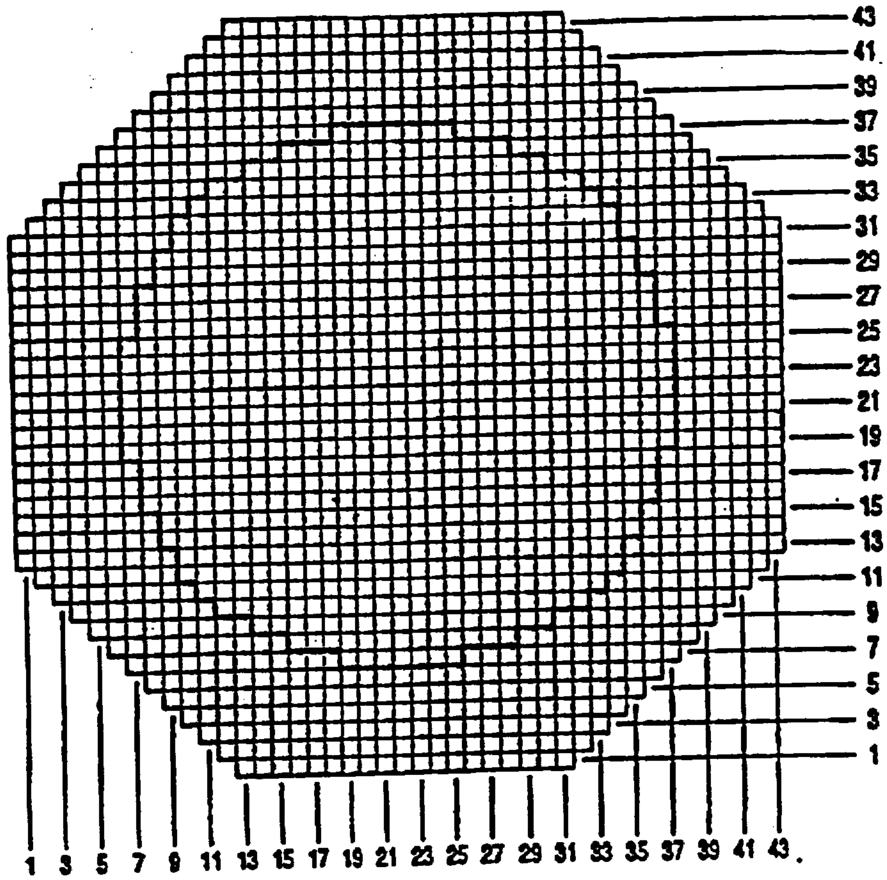

Fig. 31. EPRI 0.70-in. UO_2-2 wt % PuO_2 core, borated (from ref. 30).

Figure 3.1.2-9 EXP23 Core Loading Description

Figure 3.1.2-10 MCNP Input File: EXP23

```
CRITICAL EXPERIMENT NO. 23, 0.71 wt% U-235, 0.700-in. pitch, 680.9 ppmb
C
C   EXPERIMENT DESCRIPTION
C
C   THIS EXPERIMENT CONSISTS OF A WATER MODERATED AND REFLECTED CORE
C   OF 761 PuO2-UO2 FUEL RODS.  THE WATER-TO-FUEL VOLUME RATIO IS 1.195.
C   THE CORE LATTICE HAS A SQUARE PITCH OF 0.7 INCHES OR 1.778 CM.
C   A 0.9525 CM LEAD SHIELD COVERS THE CORE AT THE TOP OF THE FUEL RODS.
C   THE FUEL RODS ARE SUPPORTED BY A 2.8575 CM ALUMINUM PLATE.  THE CORE
C   IS COMPLETELY REFLECTED ON ALL SIDES BY 30 CM OF WATER.
C
C   REFERENCE: EPRI NP-196
C
C   CELL SPECIFICATIONS
C
C   UNIT CELL CONTAINING A FUEL ROD
1  1  -9.54    -1 +5 -9            IMP:N=1  U=1
2  2  -9.54    -1 +4 -5            IMP:N=1  U=1
3  3  4.3333-2  -2 +9              IMP:N=1  U=1
4  3  4.3333-2  -2 +1 -9 +4        IMP:N=1  U=1
5  3  4.3333-2  -2 -4              IMP:N=1  U=1
6  5  -1.0   +2 -11 +12 -13 +14 -8 +7  IMP:N=1  U=1
7  5  -1.0   +2 -11 +12 -13 +14 -6 +3  IMP:N=1  U=1
8  5  -1.0   +2 +8                 IMP:N=1  U=1
9  5  -1.0   +2 -7 +6              IMP:N=1  U=1
10  5  -1.0   +2 -3                IMP:N=1  U=1
11  4  -2.6989  (+11:-12:+13:-14) -8 +7   IMP:N=1  U=1
12  4  -2.6989  (+11:-12:+13:-14) -6 +3   IMP:N=1  U=1
C
C   UNIT CELL CONTAINING ONLY THE SPACER GRIDS
13  5  -1.0   +8                   IMP:N=1  U=2
14  5  -1.0   -11 +12 -13 +14 -8 +7   IMP:N=1  U=2
15  5  -1.0   -7 +6                IMP:N=1  U=2
16  5  -1.0   -11 +12 -13 +14 -6 +3   IMP:N=1  U=2
17  5  -1.0   -3                   IMP:N=1  U=2
18  4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=2
19  4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=2
C
C   ARRAY OF CORE
20  5  -1.0  -15 +16 -17 +18  LAT=1  U=3  IMP:N=1
     FILL 0:42 0:42 0:0
     1 15R 2 5R 3 20R
     1 15R 2 5R 3 20R
     1 15R 2 5R 3 20R
     1 15R 2 5R 3 20R
     1 14R 2 6R 3 20R
```

Figure 3.1.2-10 (continued) MCNP Input File: EXP23

```
     1 14R 2 6R 3 20R
     1 14R 2 6R 3 20R
     1 13R 2 7R 3 20R
     1 13R 2 7R 3 20R
     1 12R 2 8R 3 20R
     1 12R 2 7R 3 21R
     1 11R 2 7R 3 22R
     1 10R 2 7R 3 23R
     1  8R 2 8R 3 24R
     1  6R 2 9R 3 25R
     1 3R 2 11R 3 26R
     2 14R 3 27R
     2 13R 3 28R
     2 12R 3 29R
     2 11R 3 30R
     2 10R 3 31R
     2 9R 3 32R
     3 902R
C
C   GLOBAL CONFIGURATIONS
C
C   WINDOW FOR CORE ARRAY
21  5  -1.0    +19 +21 +22 -20 -10  IMP:N=1  FILL=3
C   LEAD SHIELD
22  6  -11.4   +10 -23 +19 +21 -20  IMP:N=1
C   6061 ALUMINUM PLATE
23  4  -2.6989  -22 +24 +19 +21 -20  IMP:N=1
C   WATER REFLECTOR REGIONS
24  5  -1.0    +23 -25 +19 +21 -20  IMP:N=1
25  5  -1.0    +26 -24 +19 +21 -20  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
26  0          +25:-26:+20:-19:-21  IMP:N=0

C   SURFACE SPECIFICATIONS
1     CZ  0.6415
2     CZ  0.7175
3     PZ  0.3175
4     PZ  0.698
5     PZ  0.898
6     PZ  2.8575
7     PZ  89.535
8     PZ  92.075
9     PZ  92.138
10    PZ  92.964
11    PX  0.73025
12    PX  -0.73025
13    PY  0.73025
```

Figure 3.1.2-10 (continued) MCNP Input File: EXP23

```
14   PY  -0.73025
15   PX  0.889
16   PX  -0.889
17   PY  0.889
18   PY  -0.889
19*   PX  0.0
20   CZ  69.0
21*   PY  0.0
22   PZ  0.0
23   PZ  93.9165
24   PZ  -2.8575
25   PZ  124.0
26   PZ  -33.0

C   MATERIAL SPECIFICATIONS
C
C   PuO2-UO2 FUEL
M1   92234.50C   1.2462-6
     92235.50C   1.4891-4
     92236.50C   2.0943-9
     92238.50C   2.0619-2
     94238.50C   3.885-8
     94239.55C   3.9477-4
     94240.50C   3.3218-5
     94241.50C   1.6023-6
     94242.50C   1.1887-7
     95241.50C   1.5024-6
      8016.50C   4.3763-2
 C   UO2 WITH NATURAL ENRICHMENT
 M2   92234.50C   1.1702-6
      92235.50C   1.5318-4
      92238.50C   2.1121-2
       8016.50C   4.2551-2
 C   ZIRCALOY-2
 M3    8016.50C   -0.12
      24000.50C   -0.10
      26000.55C   -0.10
      40000.50C   -98.23
      50000.35C   -1.40
      28000.50C   -0.05
 C   6061 ALUMINUM
 M4   13027.50C   -96.93
      12000.50C   -1.0
      14000.50C   -0.6
      22000.50C   -0.15
      24000.50C   -0.195
      25055.50C   -0.15
```

Figure 3.1.2-10 (continued) MCNP Input File: EXP23

```
    26000.55C   -0.7
    29000.50C   -0.275
C   WATER WITH 680.9 PPM OF BORON
M5    1001.50C   2.0
     8016.50C   1.0
     5010.50C   2.258135-4
     5011.50C   9.089275-4
MT5   LWTR.01T
C   LEAD
M6   82000.50C   1.0
C
C   CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE   500  1  25  525
KSRC   1.778 1.778 46 3.556 1.778 46 1.778 3.556 46 3.556 3.556 46
     8.89 1.778 46 10.668 1.778 46 8.89 3.556 46 10.668 3.556 46
     16.002 1.778 46 17.78 1.778 46 16.002 3.556 46 17.78 3.556 46
     5.334 7.112 46 5.334 8.89 46 7.112 7.112 46 7.112 8.89 46
     12.446 7.112 46 12.446 8.89 46 14.224 7.112 46 14.224 8.89 46
     1.778 12.446 46 1.778 14.224 46 3.556 12.446 46 3.556 14.224 46
     8.89 12.446 46 8.89 14.224 46 10.668 12.446 46 10.668 14.224 46
     5.335 16.002 46 5.335 17.78 46 7.112 16.002 46 7.112 17.78 46
PRINT
```

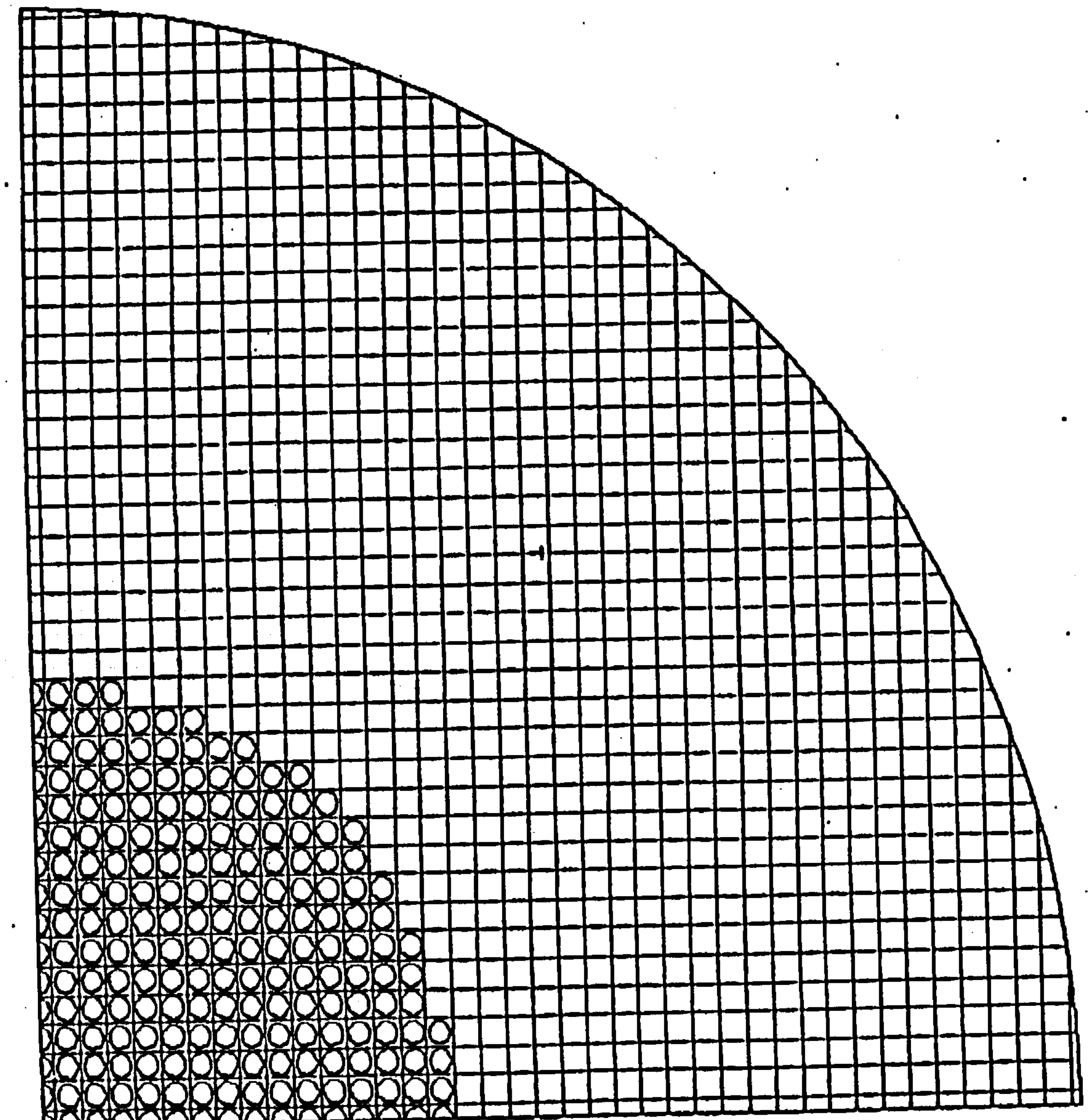

Figure 3.1.2-11 MCNP Plot: EXP23 x-y plane cross-section

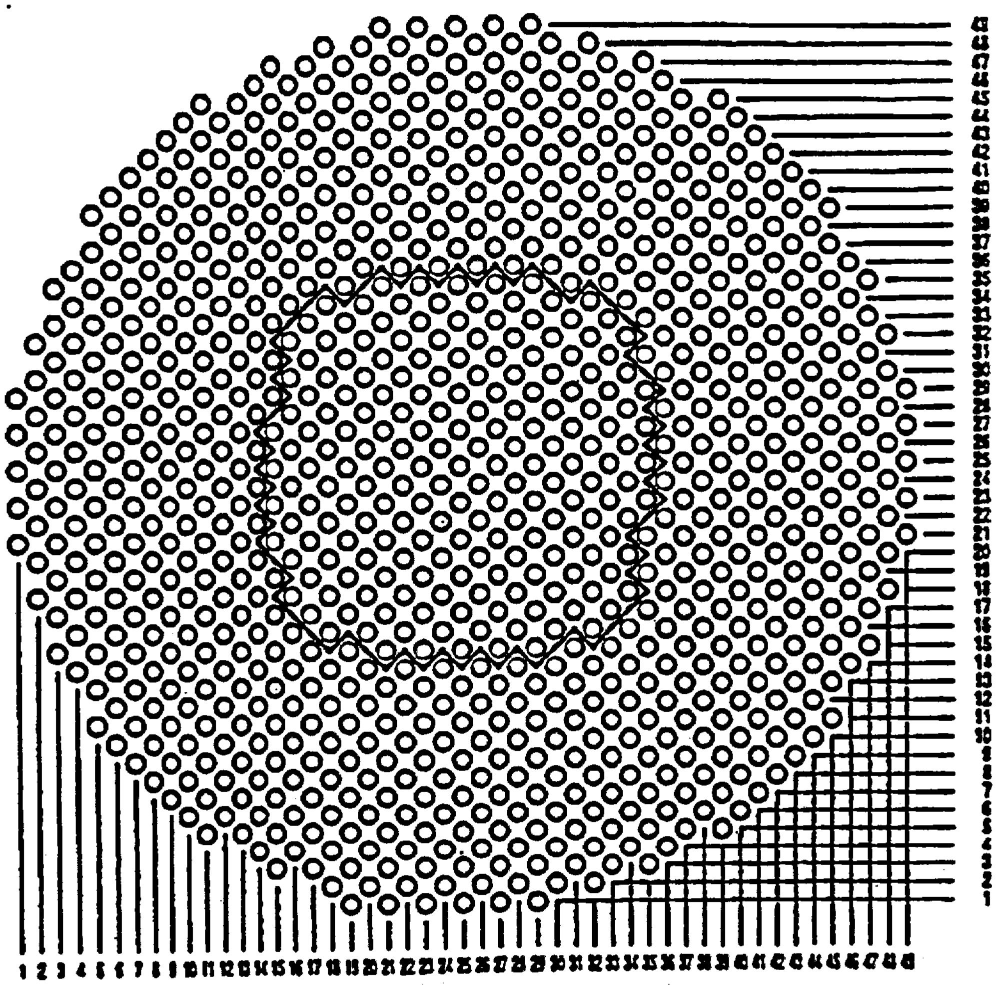

Figure 3.1.2-12 EXP24 Core Loading Description

Figure 3.1.2-13 MCNP Input File: EXP24

```
CRITICAL EXPERIMENT NO. 24a. 0.71 wt% U-235, 0.870-in. pitch, 0 ppmb
C   (RODS ARRANGED AS SHOWN IN FIG. 32 OF ORNL/TM-12295)
C   EXPERIMENT DESCRIPTION
C
C   THIS EXPERIMENT CONSISTS OF A WATER MODERATED AND REFLECTED CORE
C   OF 195 PuO2-UO2 FUEL RODS.  THE WATER-TO-FUEL VOLUME RATIO IS 2.527.
C   THE CORE LATTICE HAS A SQUARE PITCH OF 0.870 INCHES OR 2.210 CM.
C   A 0.9525 CM LEAD SHIELD COVERS THE CORE AT THE TOP OF THE FUEL RODS.
C   THE FUEL RODS ARE SUPPORTED BY A 2.8575 CM ALUMINUM PLATE.  THE CORE
C   IS COMPLETELY REFLECTED ON ALL SIDES BY 30 CM OF WATER.
C
C   REFERENCE: EPRI NP-196
C
C   CELL SPECIFICATIONS
C
C   UNIT CELL CONTAINING A FUEL ROD
1  1  -9.54    -1 +5 -9              IMP:N=1  U=1
2  2  -9.54    -1 +4 -5              IMP:N=1  U=1
3  3  4.3333-2  -2 +9                IMP:N=1  U=1
4  3  4.3333-2  -2 +1 -9 +4          IMP:N=1  U=1
5  3  4.3333-2  -2 -4                IMP:N=1  U=1
6  5  -1.0   +2 -11 +12 -13 +14 -8 +7  IMP:N=1  U=1
7  5  -1.0   +2 -11 +12 -13 +14 -6 +3  IMP:N=1  U=1
8  5  -1.0   +2 +8                   IMP:N=1  U=1
9  5  -1.0   +2 -7 +6                IMP:N=1  U=1
10 5  -1.0   +2 -3                   IMP:N=1  U=1
11 4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=1
12 4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=1
C
C   UNIT CELL CONTAINING ONLY THE SPACER GRIDS
13  5  -1.0   +8                     IMP:N=1  U=2
14  5  -1.0   -11 +12 -13 +14 -8 +7   IMP:N=1  U=2
15  5  -1.0   -7 +6                  IMP:N=1  U=2
16  5  -1.0   -11 +12 -13 +14 -6 +3   IMP:N=1  U=2
17  5  -1.0   -3                     IMP:N=1  U=2
18  4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=2
19  4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=2
C
C   ARRAY OF CORE
20  5  -1.0  -15 +16 -17 +18  LAT=1  U=3  IMP:N=1
     FILL -38:38 -38:38 0:0
     3 1077R  $ROWS 1 TO 14
     3 13R 3 17R 2 10R 3 19R 3 13R  $ROW 15
     3 13R 3 16R 2 14R 3 16R 3 13R
     3 13R 3 13R 2 20R 3 13R 3 13R
     3 13R 3 12R 2 22R 3 12R 3 13R
```

Figure 3.1.2-13 (continued) MCNP Input File: EXP24

```
3 13R 3 9R 2 28R 3 9R 3 13R
3 13R 3 8R 2 30R 3 8R 3 13R  $ROW 20
3 13R 3 7R 2 32R 3 7R 3 13R
3 13R 3 6R 2 34R 3 6R 3 13R
3 13R 3 5R 2 36R 3 5R 3 13R
3 13R 3 4R 2 38R 3 4R 3 13R
3 13R 3 3R 2 40R 3 3R 3 13R  $ROW 25
3 13R 3 4R 2 38R 3 4R 3 13R
3 13R 3 3R 2 40R 3 3R 3 13R
3 13R 3 2R 2 42R 3 2R 3 13R
3 15R 2 11R 2 5R 1 2 1 2 1 2 1 2 1 2 5R 2 11R 3 15R
3 15R 2 11R 2 2R 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2R 2 11R 3 15R  $ROW 30
3 15R 2 11R 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 11R 3 15R
3 14R 2 12R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 12R 3 14R
3 13R 2 12R 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 12R 3 15R
3 13R 2 12R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 12R 3 15R
3 12R 2 13R 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 13R 3 14R $ROW 35
3 12R 2 13R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 13R 3 14R
3 12R 2 13R 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 13R 3 14R
3 12R 2 13R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 13R 3 14R
3 12R 2 13R 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 13R 3 14R
3 12R 2 13R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 13R 3 14R $ROW 40
3 12R 2 13R 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 13R 3 14R
3 12R 2 13R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 13R 3 14R
3 12R 2 13R 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 13R 3 14R
3 13R 2 12R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 12R 3 15R
3 13R 2 12R 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 12R 3 15R $ROW 45
3 13R 2 12R 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 12R 3 15R
3 13R 2 11R 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 11R 3 17R
3 13R 2 11R 2 2R 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2R 2 11R 3 17R
3 13R 2 11R 2 5R 1 2 1 2 1 2 1 2 1 2 5R 2 11R 3 17R
3 13R 3 2R 2 42R 3 2R 3 13R  $ROW 50
3 13R 3 3R 2 40R 3 3R 3 13R
3 13R 3 4R 2 38R 3 4R 3 13R
3 13R 3 3R 2 40R 3 3R 3 13R
3 13R 3 4R 2 38R 3 4R 3 13R
3 13R 3 5R 2 36R 3 5R 3 13R  $ROW 55
3 13R 3 6R 2 34R 3 6R 3 13R
3 13R 3 7R 2 32R 3 7R 3 13R
3 13R 3 8R 2 30R 3 8R 3 13R
3 13R 3 9R 2 28R 3 9R 3 13R
3 13R 3 12R 2 22R 3 12R 3 13R  $ROW 60
3 13R 3 13R 2 20R 3 13R 3 13R
3 13R 3 16R 2 14R 3 16R 3 13R
3 13R 3 17R 2 10R 3 19R 3 13R  $ROW 63
3 1077R  $ROWS 64 TO 77
```

Figure 3.1.2-13 (continued) MCNP Input File: EXP24

```
C
C   GLOBAL CONFIGURATIONS
C
C   WINDOW FOR CORE ARRAY
21  5  -1.0     +22 -20 -10  IMP:N=1  FILL=3
C   LEAD SHIELD
22  6  -11.4    +10 -23 -20  IMP:N=1
C   6061 ALUMINUM PLATE
23  4  -2.6989  -22 +24 -20  IMP:N=1
C   WATER REFLECTOR REGIONS
24  5  -1.0     +23 -25 -20  IMP:N=1
25  5  -1.0     +26 -24 -20  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
26  0           +25:-26:+20  IMP:N=0

C   SURFACE SPECIFICATIONS
1    CZ  0.6415
2    CZ  0.7175
3    PZ  0.3175
4    PZ  0.698
5    PZ  0.898
6    PZ  2.8575
7    PZ  89.535
8    PZ  92.075
9    PZ  92.138
10   PZ  92.964
11   PX  0.74041
12   PX  -0.74041
13   PY  0.74041
14   PY  -0.74041
15   PX  0.78105
16   PX  -0.78105
17   PY  0.78105
18   PY  -0.78105
20   CZ  58.0
22   PZ  0.0
23   PZ  93.9165
24   PZ  -2.8575
25   PZ  124.0
26   PZ  -33.0

C   MATERIAL SPECIFICATIONS
C
C   PuO2-UO2 FUEL
M1   92234.50C   1.2462-6
     92235.50C   1.4891-4
```

Figure 3.1.2-13 (continued) MCNP Input File: EXP24

```
     92236.50C   2.0943-9
     92238.50C   2.0619-2
     94238.50C   3.885-8
     94239.55C   3.9477-4
     94240.50C   3.3218-5
     94241.50C   1.6023-6
     94242.50C   1.1887-7
     95241.50C   1.5024-6
      8016.50C   4.3763-2
C   UO2 WITH NATURAL ENRICHMENT
M2   92234.50C   1.1702-6
     92235.50C   1.5318-4
     92238.50C   2.1121-2
      8016.50C   4.2551-2
C   ZIRCALOY-2
M3    8016.50C   -0.12
     24000.50C   -0.10
     26000.55C   -0.10
     40000.50C   -98.23
     50000.35C   -1.40
     28000.50C   -0.05
C   6061 ALUMINUM
M4   13027.50C   -96.93
     12000.50C   -1.0
     14000.50C   -0.6
     22000.50C   -0.15
     24000.50C   -0.195
     25055.50C   -0.15
     26000.55C   -0.7
     29000.50C   -0.275
C   WATER
M5    8016.50C   1.0
      1001.50C   2.0
MT5   LWTR.01T
C   LEAD
M6   82000.50C   1.0
C
C   CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE   500  1  25  525
KSRC   0 0 46 6.6294 0 46 13.2588 0 46 -6.6294 0 46 -13.2588 0 46
     0 6.6294 46 0 13.2588 46 0 -6.6294 46 0 -13.2588 0 46
     6.6294 6.6294 46 6.6294 13.2588 46 6.6294 -6.6294 46
     6.6294 -13.2588 46 -6.6294 6.6294 46 -6.6294 13.2588 46
     -6.6294 -6.6294 46 -6.6294 -13.2588 46 13.2588 6.6294 46
```

Figure 3.1.2-13 (continued) MCNP Input File: EXP24

```
     13.2588 -6.6294 46 -13.2588 6.6294 46 -13.2588 -6.6294 46
PRINT
```

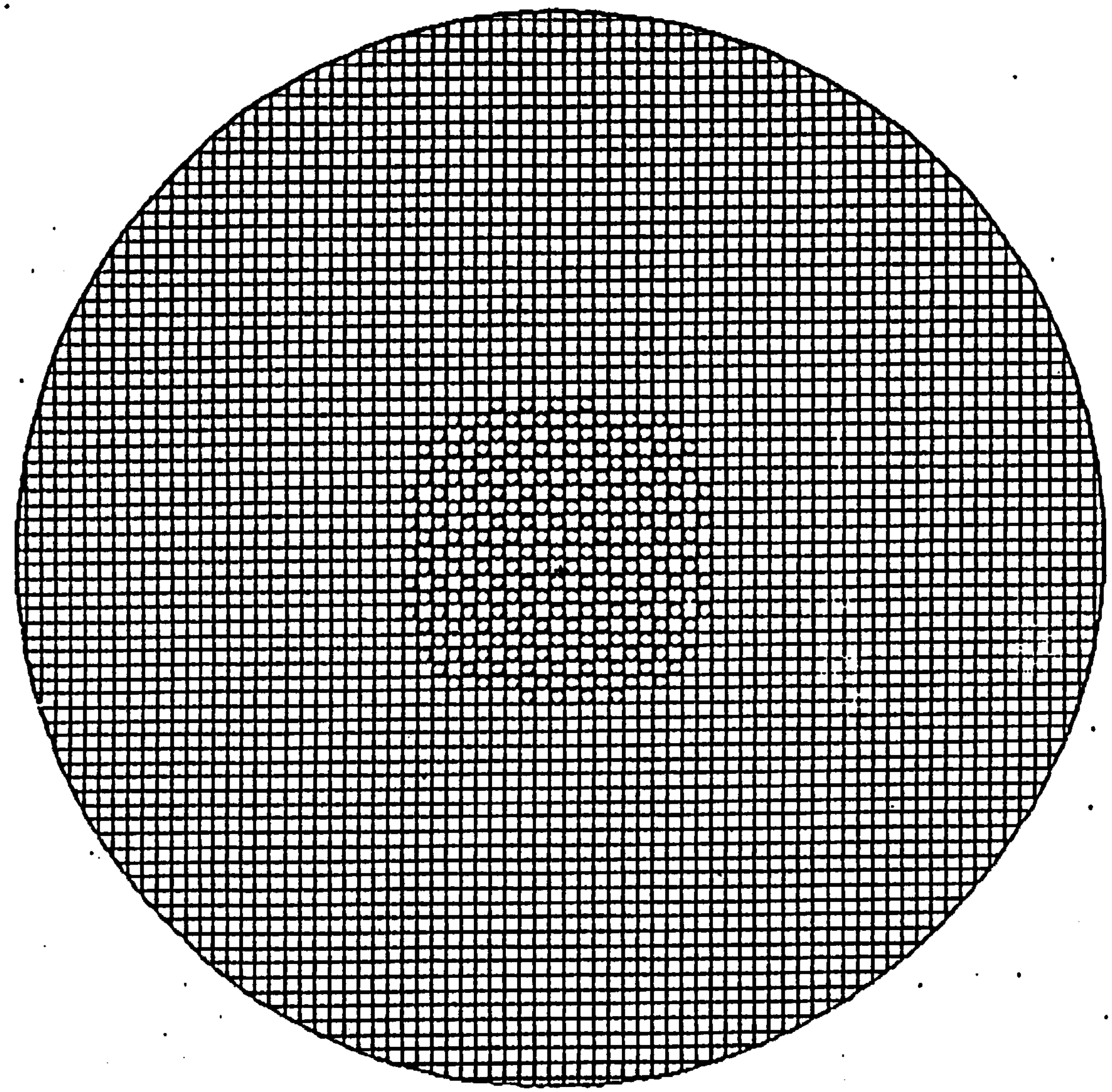

Figure 3.1.2-14 MCNP Plot: EXP24 x-y plane cross-section

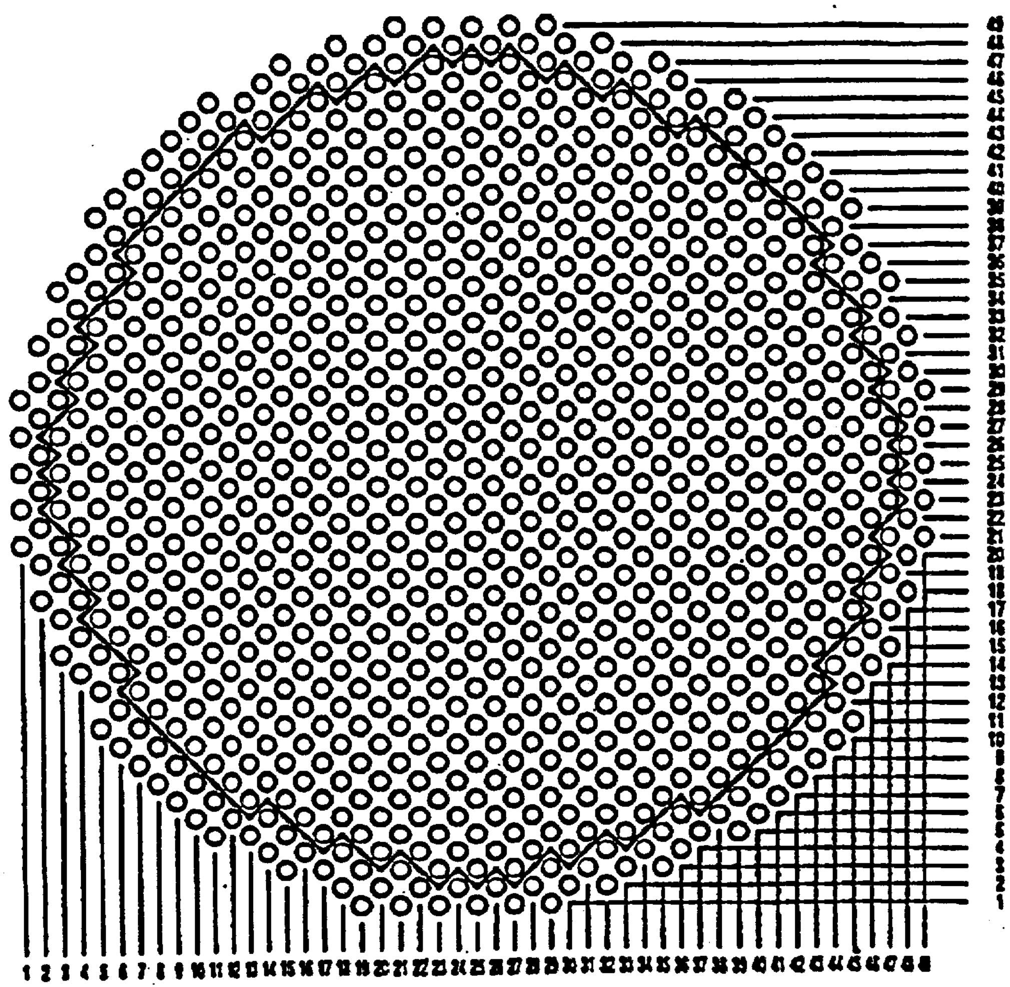

Figure 3.1.2-15 EXP25 Core Loading Description

Figure 3.1.2-16 MCNP Input File: EXP25

```
CRITICAL EXPERIMENT NO. 25, 0.71 wt% U-235, 0.870-in. pitch, 1090.4 ppmb
C
C   EXPERIMENT DESCRIPTION
C
C   THIS EXPERIMENT CONSISTS OF A WATER MODERATED AND REFLECTED CORE
C   OF 761 PuO2-UO2 FUEL RODS.  THE WATER-TO-FUEL VOLUME RATIO IS 2.527.
C   THE CORE LATTICE HAS A SQUARE PITCH OF 0.870 INCHES OR 2.210 CM.
C   A 0.9525 CM LEAD SHIELD COVERS THE CORE AT THE TOP OF THE FUEL RODS.
C   THE FUEL RODS ARE SUPPORTED BY A 2.8575 CM ALUMINUM PLATE.  THE CORE
C   IS COMPLETELY REFLECTED ON ALL SIDES BY 30 CM OF WATER.
C
C   REFERENCE: EPRI NP-196
C
C   CELL SPECIFICATIONS
C
C   UNIT CELL CONTAINING A FUEL ROD
1  1  -9.54     -1 +5 -9                IMP:N=1  U=1
2  2  -9.54     -1 +4 -5                IMP:N=1  U=1
3  3  4.3333-2  -2 +9                   IMP:N=1  U=1
4  3  4.3333-2  -2 +1 -9 +4             IMP:N=1  U=1
5  3  4.3333-2  -2 -4                   IMP:N=1  U=1
6  5  -1.0      +2 -11 +12 -13 +14 -8 +7  IMP:N=1  U=1
7  5  -1.0      +2 -11 +12 -13 +14 -6 +3  IMP:N=1  U=1
8  5  -1.0      +2 +8                   IMP:N=1  U=1
9  5  -1.0      +2 -7 +6                IMP:N=1  U=1
10  5  -1.0     +2 -3                   IMP:N=1  U=1
11  4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=1
12  4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=1
C
C   UNIT CELL CONTAINING ONLY THE SPACER GRIDS
13  5  -1.0     +8                      IMP:N=1  U=2
14  5  -1.0     -11 +12 -13 +14 -8 +7   IMP:N=1  U=2
15  5  -1.0     -7 +6                   IMP:N=1  U=2
16  5  -1.0     -11 +12 -13 +14 -6 +3   IMP:N=1  U=2
17  5  -1.0     -3                      IMP:N=1  U=2
18  4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=2
19  4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=2
C
C   ARRAY OF CORE
20  5  -1.0  -15 +16 -17 +18  LAT=1  U=3  IMP:N=1
    FILL 0:38 0:38 0:0
    1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2  3 13R
    2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2  2 2  3 13R
    1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2  3 13R
    2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2  3 13R
    1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2  2 2 2  3 13R
```

Figure 3.1.2-16 (continued) MCNP Input File: EXP25

```
   2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 3  3 13R
   2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2  2 2 2 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 3 3  3 13R
   2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 3 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 2 3 3  3 13R
   2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2  2 2 2 3 3 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 3 3 3 3  3 13R
   2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 3 3 3 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 2 3 3 3 3  3 13R
   2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 2 3 3 3 3 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 2 3 3 3 3 3 3  3 13R
   2 1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 2 3 3 3 3 3 3 3  3 13R
   1 2 1 2 1 2 1 2 1 2 1 2 1  2 2 2 2 3 3 3 3 3 3 3 3  3 13R
   2 1 2 1 2 1 2 1 2 1  2 2 2 2 2 2 3 3 3 3 3 3 3 3 3  3 13R
   1 2 1 2 1 2 1 2 1  2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3  3 13R
   2 1 2 1 2 1  2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3  3 13R
   1 2 1  2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3  3 13R
   3 623R
C
C   GLOBAL CONFIGURATIONS
C
C   WINDOW FOR CORE ARRAY
21  5  -1.0    +22 -20 -10 +27 +28  IMP:N=1  FILL=3
C   LEAD SHIELD
22  6  -11.4   +10 -23 -20 +27 +28  IMP:N=1
C   6061 ALUMINUM PLATE
23  4  -2.6989  -22 +24 -20 +27 +28  IMP:N=1
C   WATER REFLECTOR REGIONS
24  5  -1.0    +23 -25 -20 +27 +28  IMP:N=1
25  5  -1.0    +26 -24 -20 +27 +28  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
26  0          +25:-26:+20:-27:-28  IMP:N=0

C   SURFACE SPECIFICATIONS
1    CZ  0.6415
2    CZ  0.7175
3    PZ  0.3175
4    PZ  0.698
5    PZ  0.898
6    PZ  2.8575
7    PZ  89.535
8    PZ  92.075
9    PZ  92.138
10   PZ  92.964
11   PX  0.74041
12   PX  -0.74041
```

Figure 3.1.2-16 (continued) MCNP Input File: EXP25

```
13    PY  0.74041
14    PY  -0.74041
15    PX  0.78105
16    PX  -0.78105
17    PY  0.78105
18    PY  -0.78105
20    CZ  58.0
22    PZ  0.0
23    PZ  93.9165
24    PZ  -2.8575
25    PZ  124.0
26    PZ  -33.0
27*    PX  0.0
28*    PY  0.0

C   MATERIAL SPECIFICATIONS
C
C   PuO2-UO2 FUEL
M1    92234.50C    1.2462-6
     92235.50C    1.4891-4
     92236.50C    2.0943-9
     92238.50C    2.0619-2
     94238.50C    3.885-8
     94239.55C    3.9477-4
     94240.50C    3.3218-5
     94241.50C    1.6023-6
     94242.50C    1.1887-7
     95241.50C    1.5024-6
     8016.50C    4.3763-2
C   UO2 WITH NATURAL ENRICHMENT
M2    92234.50C    1.1702-6
     92235.50C    1.5318-4
     92238.50C    2.1121-2
     8016.50C    4.2551-2
C   ZIRCALOY-2
M3    8016.50C    -0.12
     24000.50C    -0.10
     26000.55C    -0.10
     40000.50C    -98.23
     50000.35C    -1.40
     28000.50C    -0.05
C   6061 ALUMINUM
M4    13027.50C    -96.93
     12000.50C    -1.0
     14000.50C    -0.6
     22000.50C    -0.15
     24000.50C    -0.195
```

Figure 3.1.2-16 (continued) MCNP Input File: EXP25

```
    25055.50C   -0.15
    26000.55C   -0.7
    29000.50C   -0.275
C   WATER
M5     1001.50C    2.0
     8016.50C   1.0
     5010.50C    3.616199-4
     5011.50C    1.455565-3
MT5    LWTR.01T
C   LEAD
M6    82000.50C    1.0
C
C    CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE    500  1  25  525
KSRC    3.1242 3.1242 46 3.1242 12.4968 46 3.1242 21.8694 46 3.1242 31.242 46
     7.8105 7.8105 46 7.8105 17.1831 46 7.8105 26.5557 46
     12.4968 3.1242 46 12.4968 12.4968 46 12.4968 21.8694 46
     17.1831 7.8105 46 17.1831 17.1831 46 17.1831 26.5557 46
     21.8694 3.1242 46 21.8694 12.4968 46 21.8694 21.8694 46
     26.5557 7.8105 46 26.5557 17.1831 46 31.242 3.1242 46
PRINT
```

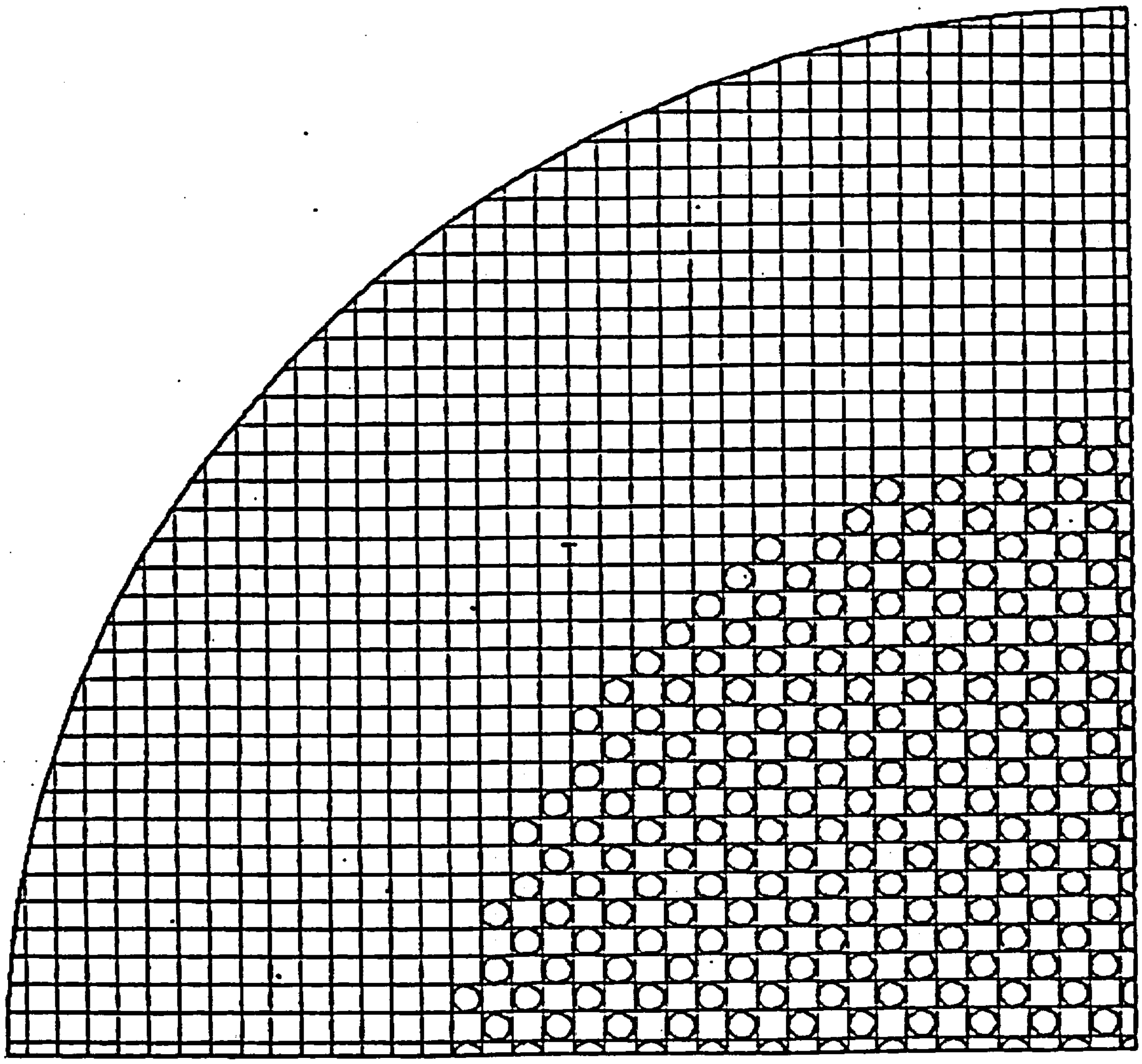

Figure 3.1.2-17 MCNP Plot: EXP25 x-y plane cross-section

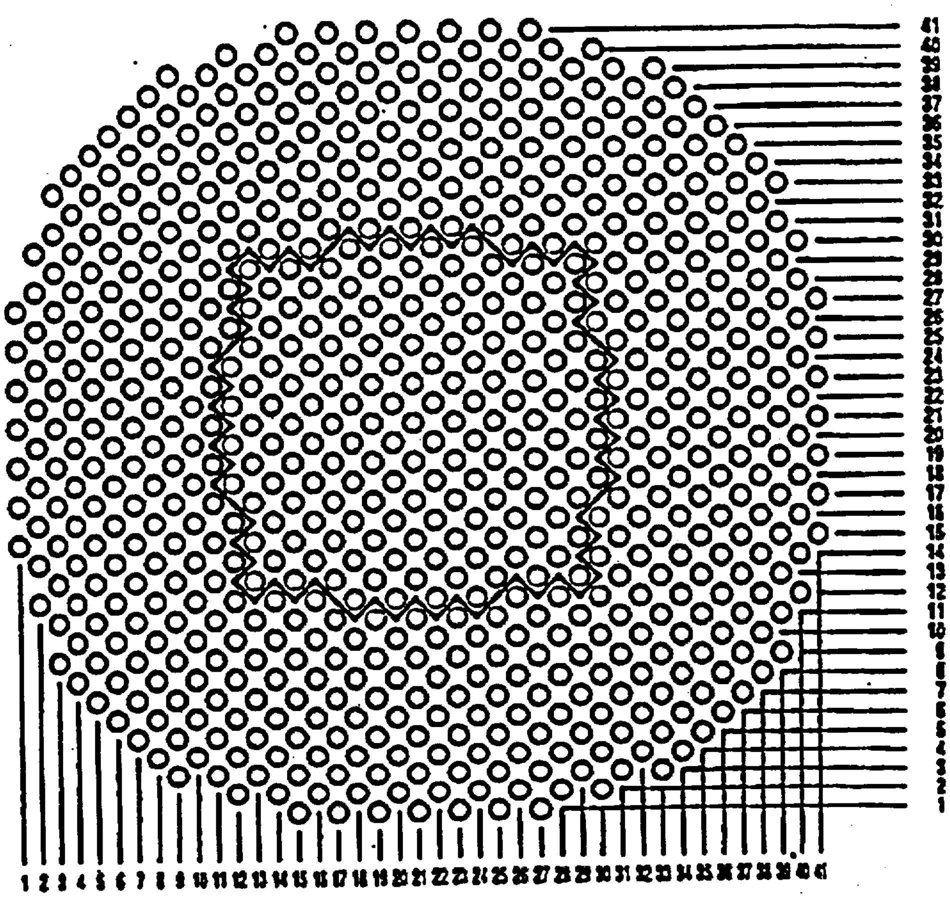

Figure 3.1.2-18 EXP26 Core Loading Description

Figure 3.1.2-19 MCNP Input File: EXP26

```
CRITICAL EXPERIMENT NO. 26, 0.71 wt% U-235, 0.990-in. pitch, 0 ppmb
C
C   EXPERIMENT DESCRIPTION
C
C   THIS EXPERIMENT CONSISTS OF A WATER MODERATED AND REFLECTED CORE
C   OF 160 PuO2-UO2 FUEL RODS.  THE WATER-TO-FUEL VOLUME RATIO IS 3.641.
C   THE CORE LATTICE HAS A SQUARE PITCH OF 0.990 INCHES OR 2.515 CM.
C   A 0.9525 CM LEAD SHIELD COVERS THE CORE AT THE TOP OF THE FUEL RODS.
C   THE FUEL RODS ARE SUPPORTED BY A 2.8575 CM ALUMINUM PLATE.  THE CORE
C   IS COMPLETELY REFLECTED ON ALL SIDES BY 30 CM OF WATER.
C
C   REFERENCE: EPRI NP-196
C
C   CELL SPECIFICATIONS
C
C   UNIT CELL CONTAINING A FUEL ROD
1  1  -9.54     -1 +5 -9                 IMP:N=1  U=1
2  2  -9.54     -1 +4 -5                 IMP:N=1  U=1
3  3  4.3333-2  -2 +9                    IMP:N=1  U=1
4  3  4.3333-2  -2 +1 -9 +4              IMP:N=1  U=1
5  3  4.3333-2  -2 -4                    IMP:N=1  U=1
6  5  -1.0      +2 -11 +12 -13 +14 -8 +7 IMP:N=1  U=1
7  5  -1.0      +2 -11 +12 -13 +14 -6 +3 IMP:N=1  U=1
8  5  -1.0      +2 +8                    IMP:N=1  U=1
9  5  -1.0      +2 -7 +6                 IMP:N=1  U=1
10 5  -1.0      +2 -3                    IMP:N=1  U=1
11 4  -2.6989   (+11:-12:+13:-14) -8 +7  IMP:N=1  U=1
12 4  -2.6989   (+11:-12:+13:-14) -6 +3  IMP:N=1  U=1
C
C   UNIT CELL CONTAINING ONLY THE SPACER GRIDS
13 5  -1.0      +8                       IMP:N=1  U=2
14 5  -1.0      -11 +12 -13 +14 -8 +7    IMP:N=1  U=2
15 5  -1.0      -7 +6                    IMP:N=1  U=2
16 5  -1.0      -11 +12 -13 +14 -6 +3    IMP:N=1  U=2
17 5  -1.0      -3                       IMP:N=1  U=2
18 4  -2.6989   (+11:-12:+13:-14) -8 +7  IMP:N=1  U=2
19 4  -2.6989   (+11:-12:+13:-14) -6 +3  IMP:N=1  U=2
C
C   ARRAY OF CORE
20  5  -1.0  -15 +16 -17 +18  LAT=1  U=3  IMP:N=1
    FILL 0:39 0:39 0:0
    1 2 1 2 1 2 1 2 1 2  2 10R  3 18R
    2 1 2 1 2 1 2 1 2 1  2 10R  3 18R
    1 2 1 2 1 2 1 2 1 2  2 10R  3 18R
    2 1 2 1 2 1 2 1 2 1  2 10R  3 18R
    1 2 1 2 1 2 1 2 1    2 11R  3 18R
```

Figure 3.1.2-19 (continued) MCNP Input File: EXP26

```
2 1 2 1 2 1 2 1 2   2 11R  3 18R
1 2 1 2 1 2 1 2 1   2 11R  3 18R
2 1 2 1 2 1 2 1 2   2 10R  3  3 18R
1 2 1 2 1 2 1 2 1   2 10R  3  3 18R
2 1 2 1        2 15R  3  3 18R
2 18R  3 3  3 18R
2 18R  3 3  3 18R
2 18R  3 3  3 18R
2 17R  3 2R  3 18R
2 16R  3 3R  3 18R
2 15R  3 4R  3 18R
2 14R  3 5R  3 18R
2 13R  3 6R  3 18R
2 12R  3 7R  3 18R
2 9R  3 10R  3 18R
2 6R  3 13R  3 18R
3 759R
C
C   GLOBAL CONFIGURATIONS
C
C   WINDOW FOR CORE ARRAY
21  5  -1.0   +19 +21 +22 -20 -10  IMP:N=1  FILL=3
C   LEAD SHIELD
22  6  -11.4   +10 -23 +19 +21 -20  IMP:N=1
C   6061 ALUMINUM PLATE
23  4  -2.6989  -22 +24 +19 +21 -20  IMP:N=1
C   WATER REFLECTOR REGIONS
24  5  -1.0    +23 -25 +19 +21 -20  IMP:N=1
25  5  -1.0    +26 -24 +19 +21 -20  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
26  0        +25:-26:+20:-19:-21  IMP:N=0

C   SURFACE SPECIFICATIONS
1    CZ  0.6415
2    CZ  0.7175
3    PZ  0.3175
4    PZ  0.698
5    PZ  0.898
6    PZ  2.8575
7    PZ  89.535
8    PZ  92.075
9    PZ  92.138
10   PZ  92.964
11   PX  0.73025
12   PX  -0.73025
13   PY  0.73025
14   PY  -0.73025
```

Figure 3.1.2-19 (continued) MCNP Input File: EXP26

```
15    PX  0.889
16    PX  -0.889
17    PY  0.889
18    PY  -0.889
19*    PX  0.0
20    CZ  69.0
21*    PY  0.0
22    PZ  0.0
23    PZ  93.9165
24    PZ  -2.8575
25    PZ  124.0
26    PZ  -33.0

C   MATERIAL SPECIFICATIONS
C
C   PuO2-UO2 FUEL
M1    92234.50C    1.2462-6
      92235.50C    1.4891-4
      92236.50C    2.0943-9
      92238.50C    2.0619-2
      94238.50C    3.885-8
      94239.55C    3.9477-4
      94240.50C    3.3218-5
      94241.50C    1.6023-6
      94242.50C    1.1887-7
      95241.50C    1.5024-6
      8016.50C    4.3763-2
C   UO2 WITH NATURAL ENRICHMENT
M2    92234.50C    1.1702-6
      92235.50C    1.5318-4
      92238.50C    2.1121-2
      8016.50C    4.2551-2
C   ZIRCALOY-2
M3    8016.50C    -0.12
      24000.50C    -0.10
      26000.55C    -0.10
      40000.50C    -98.23
      50000.35C    -1.40
      28000.50C    -0.05
C   6061 ALUMINUM
M4    13027.50C    -96.93
      12000.50C    -1.0
      14000.50C    -0.6
      22000.50C    -0.15
      24000.50C    -0.195
      25055.50C    -0.15
      26000.55C    -0.7
```

Figure 3.12-19 (continued) MCNP Input File: EXP26

```
    29000.50C   -0.275
C   WATER
M5    8016.50C    1.0
      1001.50C    2.0
MT5   LWTR.01T
C   LEAD
M6   82000.50C    1.0
C
C   CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE    500  1  25  525
KSRC   1.778 1.778 46 3.556 1.778 46 1.778 3.556 46 3.556 3.556 46
       8.89 1.778 46 10.668 1.778 46 8.89 3.556 46 10.668 3.556 46
       16.002 1.778 46 17.78 1.778 46 16.002 3.556 46 17.78 3.556 46
       5.334 7.112 46 5.334 8.89 46 7.112 7.112 46 7.112 8.89 46
       12.446 7.112 46 12.446 8.89 46 14.224 7.112 46 14.224 8.89 46
       1.778 12.446 46 1.778 14.224 46 3.556 12.446 46 3.556 14.224 46
       8.89 12.446 46 8.89 14.224 46 10.668 12.446 46 10.668 14.224 46
       5.335 16.002 46 5.335 17.78 46 7.112 16.002 46 7.112 17.78 46
 PRINT
```

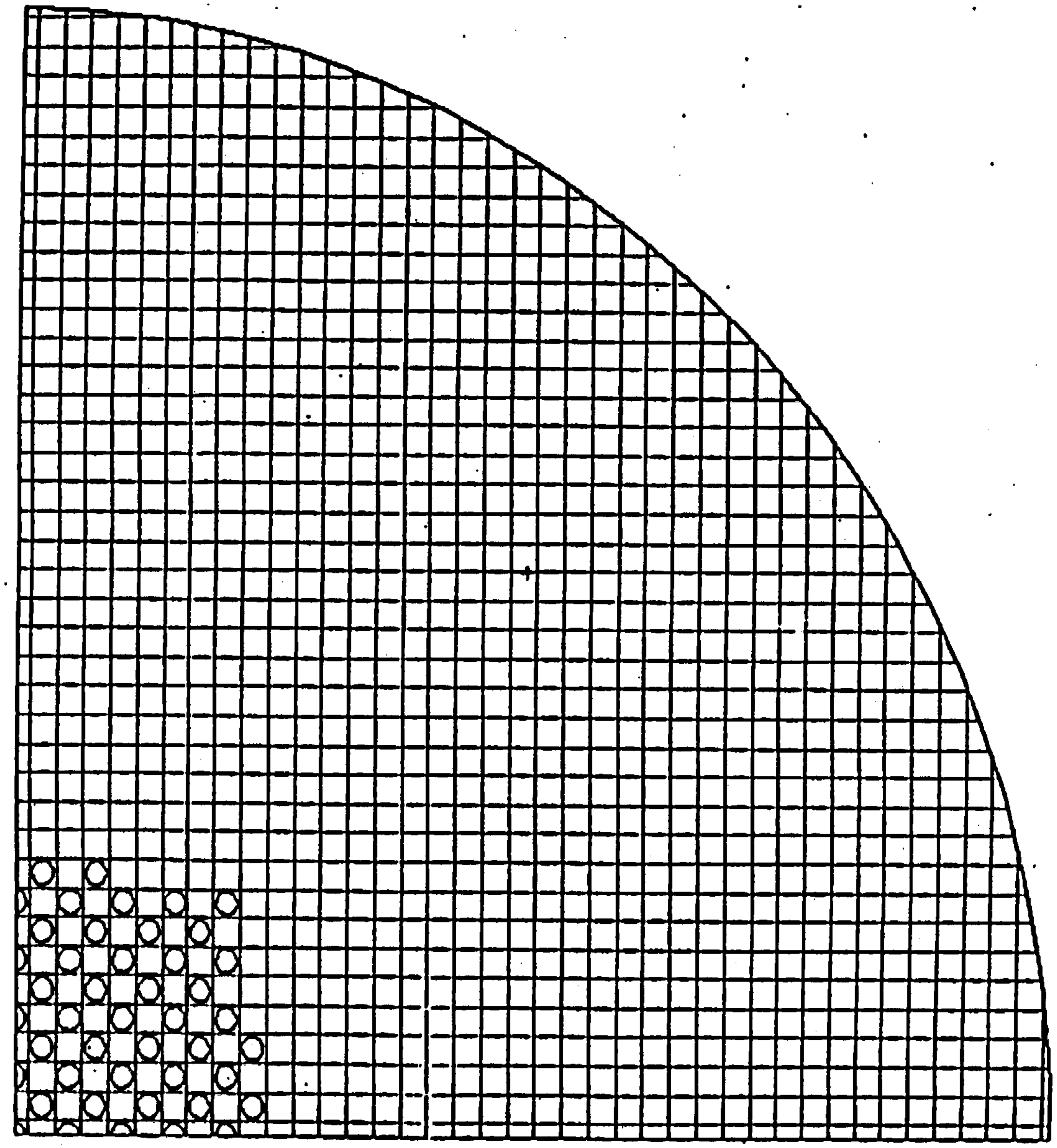

Figure 3.1.2-20 MCNP Plot: EXP26 x-y plane cross-section

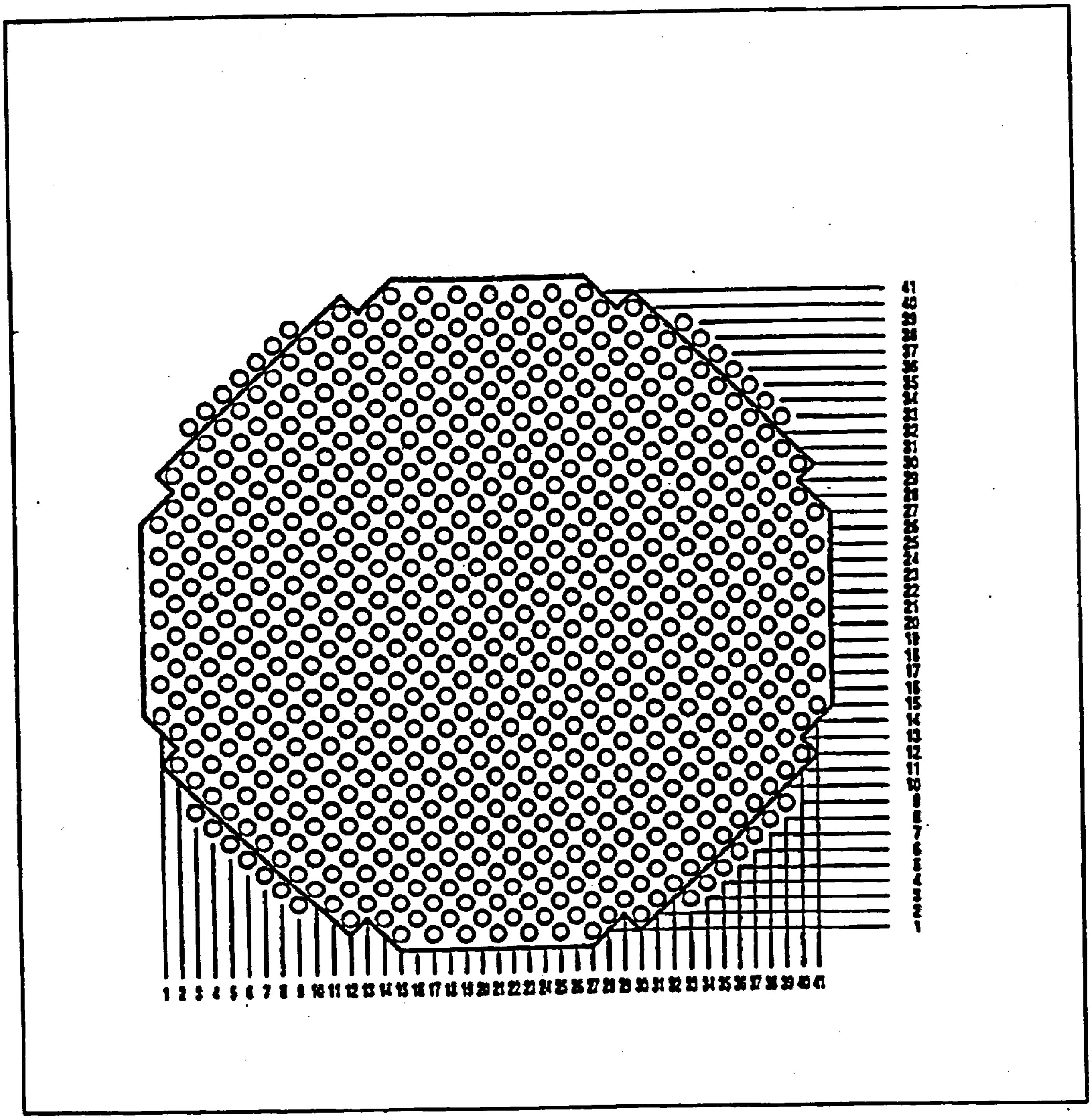

Figure 3.1.2-21 EXP27 Core Loading Description

Figure 3.1.2-22 MCNP Input File: EXP27

```
CRITICAL EXPERIMENT NO. 27, 0.71 wt% U-235, 0.990-in. pitch, 767.2 ppmb
C
C   EXPERIMENT DESCRIPTION
C
C   THIS EXPERIMENT CONSISTS OF A WATER MODERATED AND REFLECTED CORE
C   OF 689 PuO2-UO2 FUEL RODS.  THE WATER-TO-FUEL VOLUME RATIO IS 3.641.
C   THE CORE LATTICE HAS A SQUARE PITCH OF 0.990 INCHES OR 2.515 CM.
C   A 0.9525 CM LEAD SHIELD COVERS THE CORE AT THE TOP OF THE FUEL RODS.
C   THE FUEL RODS ARE SUPPORTED BY A 2.8575 CM ALUMINUM PLATE.  THE CORE
C   IS COMPLETELY REFLECTED ON ALL SIDES BY 30 CM OF WATER.
C
C   REFERENCE: EPRI NP-196
C
C   CELL SPECIFICATIONS
C
C   UNIT CELL CONTAINING A FUEL ROD
1  1  -9.54    -1 +5 -9              IMP:N=1  U=1
2  2  -9.54    -1 +4 -5              IMP:N=1  U=1
3  3  4.3333-2  -2 +9                IMP:N=1  U=1
4  3  4.3333-2  -2 +1 -9 +4          IMP:N=1  U=1
5  3  4.3333-2  -2 -4                IMP:N=1  U=1
6  5  -1.0     +2 -11 +12 -13 +14 -8 +7  IMP:N=1  U=1
7  5  -1.0     +2 -11 +12 -13 +14 -6 +3  IMP:N=1  U=1
8  5  -1.0     +2 +8                 IMP:N=1  U=1
9  5  -1.0     +2 -7 +6              IMP:N=1  U=1
10 5  -1.0     +2 -3                 IMP:N=1  U=1
11 4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=1
12 4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=1
C
C   UNIT CELL CONTAINING ONLY THE SPACER GRIDS
13 5  -1.0   +8                  IMP:N=1  U=2
14 5  -1.0   -11 +12 -13 +14 -8 +7   IMP:N=1  U=2
15 5  -1.0   -7 +6               IMP:N=1  U=2
16 5  -1.0   -11 +12 -13 +14 -6 +3   IMP:N=1  U=2
17 5  -1.0   -3                  IMP:N=1  U=2
18 4  -2.6989  (+11:-12:+13:-14) -8 +7  IMP:N=1  U=2
19 4  -2.6989  (+11:-12:+13:-14) -6 +3  IMP:N=1  U=2
C
C   ARRAY OF CORE
20  5  -1.0  -15 +16 -17 +18  LAT=1  U=3  IMP:N=1
    FILL 0:39 0:39 0:0
    1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 3 18R
    2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 18R
    1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 3 18R
    2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 18R
    1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 3 18R
```

Figure 3.1.2-22 (continued) MCNP Input File: EXP27

```
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 3 18R
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 3 18R
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 3 3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 3 18R
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 3 3 3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 3 3 3 18R
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 2 3 2R 3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 3 3R  3 18R
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 3 4R    3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 3 5R      3 18R
 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 3 6R        3 18R
 1 2 1 2 1 2 1 2 1 2 1 2 2 3 7R              3 18R
 2 1 2 1 2 1 2 1 2 1 2 3 9R                  3 18R
 1 2 1 2 1 2 1 2 3 12R                       3 18R
 3 759R
C
C   GLOBAL CONFIGURATIONS
C
C   WINDOW FOR CORE ARRAY
21  5  -1.0     +19 +21 +22 -20 -10  IMP:N=1  FILL=3
C   LEAD SHIELD
22  6  -11.4    +10 -23 +19 +21 -20  IMP:N=1
C   6061 ALUMINUM PLATE
23  4  -2.6989  -22 +24 +19 +21 -20  IMP:N=1
C   WATER REFLECTOR REGIONS
24  5  -1.0     +23 -25 +19 +21 -20  IMP:N=1
25  5  -1.0     +26 -24 +19 +21 -20  IMP:N=1
C   ZERO IMPORTANCE REST OF WORLD
26  0           +25:-26:+20:-19:-21  IMP:N=0

C   SURFACE SPECIFICATIONS
1    CZ  0.6415
2    CZ  0.7175
3    PZ  0.3175
4    PZ  0.698
5    PZ  0.898
6    PZ  2.8575
7    PZ  89.535
8    PZ  92.075
9    PZ  92.138
10   PZ  92.964
11   PX  0.73025
12   PX  -0.73025
13   PY  0.73025
14   PY  -0.73025
```

Figure 3.1.2-22 (continued) MCNP Input File: EXP27

```
15   PX  0.889
16   PX  -0.889
17   PY  0.889
18   PY  -0.889
19*   PX  0.0
20   CZ  69.0
21*   PY  0.0
22   PZ  0.0
23   PZ  93.9165
24   PZ  -2.8575
25   PZ  124.0
26   PZ  -33.0

C   MATERIAL SPECIFICATIONS
C
C   PuO2-UO2 FUEL
M1   92234.50C   1.2462-6
     92235.50C   1.4891-4
     92236.50C   2.0943-9
     92238.50C   2.0619-2
     94238.50C   3.885-8
     94239.55C   3.9477-4
     94240.50C   3.3218-5
     94241.50C   1.6023-6
     94242.50C   1.1887-7
     95241.50C   1.5024-6
      8016.50C   4.3763-2
C   UO2 WITH NATURAL ENRICHMENT
M2   92234.50C   1.1702-6
     92235.50C   1.5318-4
     92238.50C   2.1121-2
      8016.50C   4.2551-2
C   ZIRCALOY-2
M3    8016.50C   -0.12
     24000.50C   -0.10
     26000.55C   -0.10
     40000.50C   -98.23
     50000.35C   -1.40
     28000.50C   -0.05
C   6061 ALUMINUM
M4   13027.50C   -96.93
     12000.50C   -1.0
     14000.50C   -0.6
     22000.50C   -0.15
     24000.50C   -0.195
     25055.50C   -0.15
     26000.55C   -0.7
```

Figure 3.1.2-22 (continued) MCNP Input File: EXP27

```
    29000.50C   -0.275
C   WATER WITH 680.9 PPM OF BORON
M5    1001.50C   2.0
     8016.50C   1.0
     5010.50C   2.54434-4
     5011.50C   1.02413-3
MT5   LWTR.01T
C   LEAD
M6   82000.50C   1.0
C
C   CONTROL CARD SPECIFICATIONS
C
MODE N
KCODE   500  1  25  525
KSRC   1.778 1.778 46 3.556 1.778 46 1.778 3.556 46 3.556 3.556 46
     8.89 1.778 46 10.668 1.778 46 8.89 3.556 46 10.668 3.556 46
     16.002 1.778 46 17.78 1.778 46 16.002 3.556 46 17.78 3.556 46
     5.334 7.112 46 5.334 8.89 46 7.112 7.112 46 7.112 8.89 46
     12.446 7.112 46 12.446 8.89 46 14.224 7.112 46 14.224 8.89 46
     1.778 12.446 46 1.778 14.224 46 3.556 12.446 46 3.556 14.224 46
     8.89 12.446 46 8.89 14.224 46 10.668 12.446 46 10.668 14.224 46
     5.335 16.002 46 5.335 17.78 46 7.112 16.002 46 7.112 17.78 46
     1.778 1.778 .7 3.556 1.778 .7 1.778 3.556 .7 3.556 3.556 .7
     8.89 1.778 .7 10.668 1.778 .7 8.89 3.556 .7 10.668 3.556 .7
     16.002 1.778 .7 17.78 1.778 .7 16.002 3.556 .7 17.78 3.556 .7
     5.334 7.112 .7 5.334 8.89 .7 7.112 7.112 .7 7.112 8.89 .7
     12.446 7.112 .7 12.446 8.89 .7 14.224 7.112 .7 14.224 8.89 .7
     1.778 12.446 .7 1.778 14.224 .7 3.556 12.446 .7 3.556 14.224 .7
     8.89 12.446 .7 8.89 14.224 .7 10.668 12.446 .7 10.668 14.224 .7
     5.335 16.002 .7 5.335 17.78 .7 7.112 16.002 .7 7.112 17.78 .7
 PRINT
```

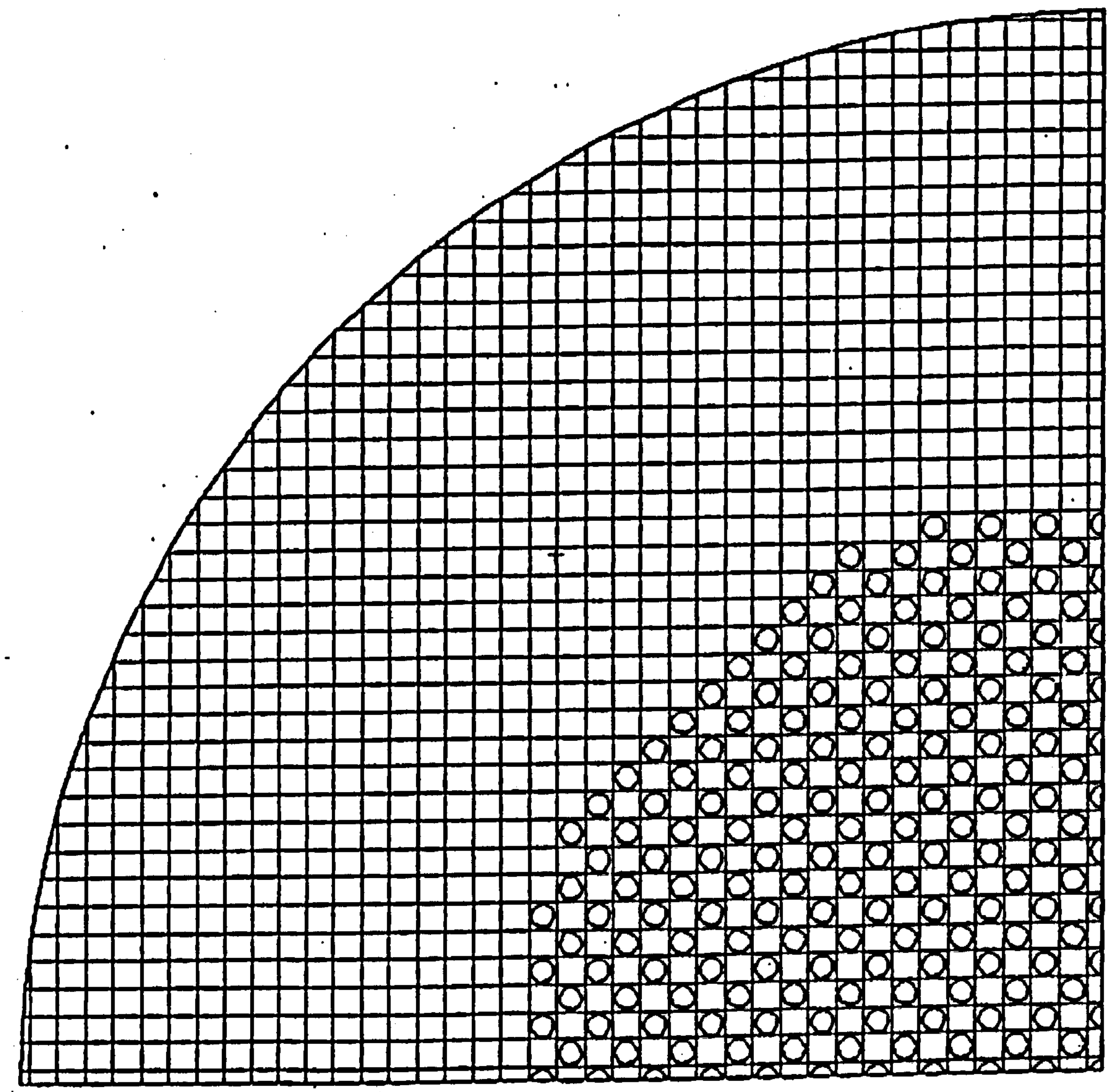

Figure 3.1.2-23 MCNP Plot: EXP27 x-y plane cross-section

3.1.3 Results of Validation for the HP 9000 Workstation

The results of the validation benchmark test cases on the QUICHE HP 9000/C160 workstation are tabulated in Table 3.1.3-1. Results are also provided for the same benchmark test cases run on a HP 9000/700 series workstation designated "ROSEBUD" to confirm correct operation using both operating systems and CPUs. The multiplication factor results from MCNP4A represent the combined average of three MCNP4A estimated multiplication factors: collision, absorption, and track length. The combined results of the ten benchmark test cases obtained from the QUICHE HP 9000/C160 workstation produce an average multiplication factor of 1.0025 $\pm$ 0.0042. The combined results of the ten benchmark test cases obtained from the ROSEBUD HP 9000/700 workstation produce an average multiplication factor of 1.0028 $\pm$ 0.0039. Differences in multiplication factors between operating systems and CPUs (HP 9000/C160 vs. HP 9000/700) for the same experiments are within 1σ statistical uncertainty. The ten benchmark test cases are well established critical experiments which all have a reactivity of 1.000. Thus, the average value of the multiplication factor for each set of ten benchmark cases is sufficiently close to one to indicate that the MCNP4A code package is functioning properly. In addition, each of the individual benchmark cases were run on each HP 9000 workstation (HODGE: 700667, OPUS: 102878, PORTNOY: 700669, MILO: 105062, OLIVER: 700314, DALLAS: 110689, and ROSEBUD: 700315) in the WPDD to verify correct network installation.

Based on the MCNP4A multiplication factor results for the ten benchmark test cases, the MCNP4A code package installed at the NFS mount point located on the QUICHE HP 9000/C160 workstation and run on any HP 9000 workstation in the WPDD is determined to be operating correctly for applications involving criticality and shielding analyses supporting WPDD activities.

TABLE 3.1.3-1
MCNP4A RESULTS (K_{eff}) FOR BENCHMARK CASES ON HP 9000 WORKSTATIONS

Case ID	HP9000/C160-QUICHE	HP 9000/700-ROSEBUD
EXP1	0.9991 (0.0013)	0.9991 (0.0013)
EXP2	0.9986 (0.0013)	1.0005 (0.0013)
EXP22	0.9966 (0.0015)	0.9968 (0.0014)
EXP23	1.0018 (0.0015)	1.0018 (0.0016)
EXP24	1.0066 (0.0015)	1.0066 (0.0015)
EXP25	1.0050 (0.0015)	1.0050 (0.0015)
EXP26	1.0086 (0.0014)	1.0086 (0.0014)
EXP27	1.0073 (0.0014)	1.0073 (0.0014)
EXP3	1.0018 (0.0013)	1.0003 (0.0013)
EXP4	0.9993 (0.0013)	1.0019 (0.0014)
Average	1.0025 ± 0.0042	1.0028 ± 0.0039

*Standard deviation in parentheses.

3.2 Results of MCNP4A Validation Cases For PC

The ten critical benchmark cases described in Sections 3.1.1 and 3.1.2 were tested on the GATEWAY2000 P5-90 computer, using the same input files as listed in the referenced sections. However, the MCNP4A code package installed on the GATEWAY2000 P5-90 only uses the cross section library based on ENDF/B-V.

Table 3.2-1 provides the MCNP4A criticality results for benchmark test cases run on the GATEWAY2000 P5-90 platform. The criticality results from the HP 9000 workstations are also included for comparison purposes. The results represent the combined average of the three estimators used in MCNP4A: collision, absorption, and track length. The criticality results are sufficiently close to one and within 2σ statistical uncertainty between the three computer platforms.

Based on the MCNP4A multiplication factor results for the ten benchmark test cases, the MCNP4A code package installed on the GATEWAY2000 P5-90 PC is determined to be operating correctly for applications involving criticality and shielding analyses supporting WPDD activities.

TABLE 3.2-1
MCNP4A RESULTS (K_{eff}) FOR CRITICALITY BENCHMARK CASES ON HP AND PC PLATFORMS

Case ID	GATEWAY2000 PC	HP9000/C160-QUICHE	HP9000/700-ROSEBUD
EXP1	1.0017 (0.0013)	0.9991 (0.0013)	0.9991 (0.0013)
EXP2	1.0007 (0.0012)	0.9986 (0.0013)	1.0005 (0.0013)
EXP22	0.9987 (0.0015)	0.9966 (0.0015)	0.9968 (0.0014)
EXP23	0.9990 (0.0015)	1.0018 (0.0015)	1.0018 (0.0016)
EXP24	1.0043 (0.0014)	1.0066 (0.0015)	1.0066 (0.0015)
EXP25	1.0079 (0.0015)	1.0050 (0.0015)	1.0050 (0.0015)
EXP26	1.0056 (0.0015)	1.0086 (0.0014)	1.0086 (0.0014)
EXP27	1.0091 (0.0015)	1.0073 (0.0014)	1.0073 (0.0014)
EXP3	0.9978 (0.0013)	1.0018 (0.0013)	1.0003 (0.0013)
EXP4	1.0003 (0.0013)	0.9993(0.0013)	1.0019 (0.0014)
Average	1.0025 ± 0.0040	1.0025 ± 0.0042	1.0028 ± 0.0039

*Standard deviation in parentheses.

3.3 ENDF/B-VI Cross Section Library Installation Test

The original generation and testing of the ENDF/B-VI cross sections by LANL is documented in the report "ENDF/B-VI DATA for MCNP" and included in the MCNPDAT6 manual (Ref. 2). A description and summary of results for a number of benchmark test cases are provided in Reference 1. Seventeen representative benchmark test cases from Reference 2 were selected and run. The benchmark test case input files are listed in sections 3.3.1-17. The input files for these cases were taken from References 8 and 9. The original results obtained by LANL and the results from the rerun of these cases on the QUICHE HP 9000/C160 workstation and PORTNOY HP 9000/700 workstation are listed in Table 3.3-1. In addition, each of the individual cross section benchmark test cases were run on each HP 9000 workstation (HODGE: 700667, OPUS: 102878, PORTNOY: 700669, MILO: 105062, OLIVER: 700314, DALLAS: 110689, and ROSEBUD: 700315) in the WPDD to verify correct network installation.

Comparison of the LANL results with those run on the QUICHE HP 9000/C160 workstation and the PORTNOY HP 9000/700 workstation indicate that the ENDF/B-VI cross sections have been successfully installed and provide the same results within the statistics of the calculations. All cases fall within 3σ (standard deviation) of each other.

Table 3.3-1 MCNP4A RESULTS (K_{eff}) FOR MCNPDAT6 (ENDF/B-VI CROSS SECTION LIBRARY) INSTALLATION TEST CASES

Case Description	LANL Results	HP 9000/C160 QUICHE	HP 9000/700 PORTNOY
Godiva: 93.71% U-235 Enriched Bare Sphere	0.9953 (0.0011)	0.9940 (0.0010)	0.9940 (0.0010)
Jezebel: 95.5% Pu-239 Enriched Bare Sphere	1.0023 (0.0022)	1.0057 (0.0017)	1.0057(0.0017)
Jezebel: 80% Pu-239 Enriched Bare Sphere	1.0097 (0.0012)	1.0073 (0.0012)	1.0073 (0.0012)
Uranium Cylinder, 10.9% U-235 Enriched	0.9998 (0.0005)	0.9997 (0.0005)	0.9997 (0.0005)
Graphite-Tamped 93.9% U-235 Enriched Sphere	0.9900 (0.0010)	0.9908 (0.0009)	0.9908 (0.0009)
3 X 3 Array of 95.5% Pu-239 Enriched rods	0.9992 (0.0015)	0.9992 (0.0013)	0.9992 (0.0013)
KENO 1	0.9936 (0.0009)	0.9951 (0.0008)	0.9951 (0.0008)
KENO 3	1.0002 (0.0011)	0.9986 (0.0010)	0.9988 (0.0010)
KENO 6	0.7426 (0.0007)	0.7426 (0.0007)	0.7426 (0.0007)
KENO 7	0.9954 (0.0008)	0.9951 (0.0008)	0.9951 (0.0008)
KENO 12	0.9994 (0.0013)	1.0019 (0.0011)	1.0019 (0.0011)
KENO 13	0.9914 (0.0008)	0.9924 (0.0008)	0.9924 (0.0008)
KENO 14	0.9969 (0.0008)	0.9972 (0.0009)	0.9972 (0.0009)

Case Description	LANL Results	HP 9000/C160 QUICHE	HP 9000/700 PORTNOY
KENO 15	1.0003 (0.0011)	1.0005 (0.0011)	1.0005 (0.0011)
KENO 16	0.9924 (0.0009)	0.9920 (0.0010)	0.9920 (0.0010)
KENO 18	1.0308 (0.0013)	1.0298 (0.0014)	1.0284 (0.0013)
KENO 20	0.9981 (0.0015)	0.9998 (0.0014)	0.9998 (0.0014)

3.3.1 Cross Section Validation Test Case 1

```
GODIVA
1  1 -18.7400 -1 IMP:N=1
2  0 1 IMP:N=0

1  SO 8.741000

M1  92235.60C -93.7100 92238.60C -5.27 92234.60C -1.02
KCODE 3000 1.0 60 150
KSRC 0. 0. 0.
PRINT
```

3.3.2 Cross Section Installation Test Case 2

```
JEZEBEL 4.5% ENRICHED Pu-240
1  1 -15.61 -1 IMP:N=1
2  0 1 IMP:N=0

1  SO 6.385

M1  94239.60C -95.5 94240.60C -4.5
KCODE 3000 1.0 80 110
KSRC 0. 0. 0.
PRINT
```

3.3.3 Cross Section Installation Test Case 3

```
JEZEBEL 20% ENRICHED Pu-240
1  1 -15.73 -1 IMP:N=1
2  0 1 IMP:N=0

1  SO 6.660
```

```
M1  94239.60C -80 94240.60C -20
KCODE 3000 1.0 60 150
KSRC 0. 0. 0.
PRINT
```

3.3.4 Cross Section Installation Test Case 4

```
URANIUM CYLINDER 10.90% ENRICHED
1   1 -18.63 -1 2 -3 IMP:N=1
2   0 -4 #1 IMP:N=1
3   0 4 IMP:N=0

1   CY 26.65
2   PY 0
3   PY 119.392
4   SO 130

M1  92235.60C -10.9 92238.60C -89.1
KCODE 9000 1 25 40
SDEF  AXS 0 1 0 POS 0 60 0 EXT D1 RAD D2
SI1  55
SI2  0.1 26
PRINT
```

3.3.5 Cross Section Installation Test Case 5

```
GRAPHITE REFLECTED URANIUM SPHERE 93.9% ENRICHED
1 1 -18.6  -1  IMP:N=1
2 2 -1.67  1  -2  IMP:N=1
3 0  2  IMP:N=0

1   SO 7.39840
2   SO 12.49840
3   SO 55

M1  92235.60C  -93.5
      92238.60C  -6.5
M2  6000.60C  -99.5
    26054.60C -0.019 26056.60C -0.312 26057.60C -0.007
    26058.60C -0.001  16032.60C  -0.16
MT2  GRPH.01T
KCODE 3000 1.0 30 50
SDEF AXS 0 1 0 POS 0 0 0 EXT D1 RAD D2
SI1  6
SI2  6
PRINT
```

3.3.6 Cross Section Installation Test Case 6

```
3X3X3  PLUTONIUM ARRAY
1     5 -2.710 -1 2 5 -27 IMP:N=1 U=-1
2     2 -0.5400 3 -4 -38 IMP:N=1
3     5 -2.375 4 -44 -38 IMP:N=1
4     6 -4.800 -2 5 -6 IMP:N=1 U=-1
5     1 -2.5000 6 -7 -8 9 IMP:N=1 U=-1
6     3 -0.001 6 -7 -9 IMP:N=1 U=-1
7     1 -2.5000 -8 7 -10 IMP:N=1 U=-1
8     2 -7.870 -8 10 -11 IMP:N=1 U=-1
9     7 -19.6 -12 11 -14 IMP:N=1 U=-1
10    5 -2.710 12 -13 11 -14 IMP:N=1 U=-1
11    4 -2.640 -8 14 -15 IMP:N=1 U=-1
12    1 -2.5000 -8 9 15 -16 IMP:N=1 U=-1
13    3 -0.001 8 -2 -16 14 IMP:N=1 U=-1
14    3 -0.001 13 -2 -14 11 IMP:N=1 U=-1
15    3 -0.001 8 -2 -11 6 IMP:N=1 U=-1
16    3 -0.001 -9 15 -16 IMP:N=1 U=-1
17    0   37 IMP:N=0
19    3 -0.001 -37 #2 #3 #41 #51 #52 #53 #54 #55 #56 #57 #58 IMP:N=1
20    1 -2.5000 -8 16 -17 IMP:N=1 U=-1
21    2 -7.870 -8 17 -18 IMP:N=1 U=-1
22    7 -19.6 -12 18 -19 IMP:N=1 U=-1
23    4 -2.640 -8 19 -20 IMP:N=1 U=-1
24    3 -0.001 -9 20 -21 IMP:N=1 U=-1
25    1 -2.5000 -8 21 -22 IMP:N=1 U=-1
26    2 -7.870 -8 22 -23  IMP:N=1 U=-1
27    7 -19.6 -12 23 -24 IMP:N=1 U=-1
28    4 -2.640 -8 24 -25 IMP:N=1 U=-1
29    3 -0.001 -9 25 -26 IMP:N=1 U=-1
30    6 -4.810 -2 26 -27 IMP:N=1 U=-1
32    5 -2.710 -13 12 -19 18 IMP:N=1 U=-1
33    1 -2.500 -8 9 20 -21 IMP:N=1 U=-1
34    5 -2.710 -13 12 -24 23 IMP:N=1 U=-1
35    1 -2.500 -8 9 25 -26 IMP:N=1 U=-1
36    3 -0.001 8 -2 -26 24 IMP:N=1 U=-1
37    3 -0.001 13 -2 23 -24 IMP:N=1 U=-1
38    3 -0.001 8 -2 -23 19 IMP:N=1 U=-1
39    3 -0.001 13 -2 -19 18 IMP:N=1 U=-1
40    3 -0.001 8 -2 -18 16 IMP:N=1 U=-1
41    0 -42 -43 44 FILL=1  IMP:N=1
42    0 (1:27:-5) U=1 IMP:N=1
51    LIKE 41 BUT TRCL=1
52    LIKE 41 BUT TRCL=2
53    LIKE 41 BUT TRCL=3
54    LIKE 41 BUT TRCL=4
55    LIKE 41 BUT TRCL=5
56    LIKE 41 BUT TRCL=6
57    LIKE 41 BUT TRCL=7
58    LIKE 41 BUT TRCL=8

1     C/Y  3.609  3.609  3.609
```

```
2    C/Y  3.609  3.609  3.425
3    PY 0.0
4    PY 30.0
5    PY 32.540
6    PY 40.795
7    PY 47.725
8    C/Y  3.609  3.609  3.326
9    C/Y  3.609  3.609  3.104
10   PY 48.360
11   PY 48.381
12   C/Y  3.60900  3.609  3.26250
13   C/Y  3.60900  3.609  3.29950
14   PY 53.014
15   PY 53.580
16   PY 55.425
38   C/Y  3.609  3.609  80
37   SO  500
17   PY  56.060
18   PY  56.081
19   PY  60.714
20   PY  61.280
21   PY 63.125
22   PY 63.760
23   PY 63.781
24   PY 67.714
25   PY 68.2800
26   PY 70.125
27   PY 78.380
42   C/Y  3.609  3.609  3.6100
43   PY  78.3810
44   PY  32.539

TR1  9.6  0.0  0.0
TR2  19.2  0.0  0.0
TR3  0.0  0.0  9.6
TR4  9.6  0.0  9.6
TR5  19.2  0.0  9.6
TR6  0.0  0.0  19.2
TR7  9.6  0.0  19.2
TR8  19.2  0.0  19.2
M3   7014.60C -0.78  8016.60C -0.21  18000.35C -0.01 $ Air
M1   24050.60C -8.3474-5  24052.60C -1.6740-3      $ Al for inner spacer
     24053.60C -1.9345-4  24054.60C -4.9068-5
     26054.60C -3.9892-4  26056.60C -6.4309-3
     26057.60C -1.4987-4  26058.60C -2.0335-5
     29063.60C -0.0017  29065.60C -0.0008
     12000.60C -0.010  25055.60C -0.0015  14000.60C -0.006
     22000.60C -0.0015  13027.60C -0.9670
M2   6000.60C -0.0008 25055.60C -0.0037  15031.60C  -0.00015  $ Steel w/holes
     14000.60C -0.0001 16032.60C -0.00025 50000.35C -0.0030
     26054.60C -0.0565  26056.60C -0.9113  26057.60C -0.0212
     26058.60C -0.0029
M5   29063.60C -0.0017  29065.60C -0.0008        $ Al for can sides & container
```

```
    26054.60C -3.9892-4 26056.60C -6.4309-3 26057.60C -1.4987-4
    26058.60C -2.0333-5 12000.60C -0.0105
    25055.60C -0.0125 14000.60C -0.003 13027.60C -0.9630
M4  24050.60C  -4.1737-5 24052.60C -8.3700-4 24053.60C -9.6726-5
    24054.60C  -2.4534-5 29063.60C -1.7125-3 29065.60C -7.8751-4
    26054.60C -3.9892-4 26056.60C -6.4309-3 26057.60C -1.4987-4
    26058.60C -2.0333-5
    12000.60C -0.01025 25055.60C -0.007 14000.60C -0.0045
    22000.60C -0.00075 13027.60C -0.9645          $ Al for can top
M7  94239.60C  -0.9356                  $ Pu metal
    94240.60C  -0.0597
    94241.60C  -0.0046
    94242.60C  -0.0001
M6  6000.60C -0.0003 25055.60C -0.005 15031.60C -0.00005 $ Al/Steel Mix
    14000.60C -0.0033 16032.60C -0.00009 50000.35C -0.0011
    26054.60C -2.0254-2 26056.60C -3.2650-1 26057.60C -7.6093-3
    26058.60C -1.0324-3
    24050.60C -2.9216-5 24052.60C -5.8590-4 24053.60C -6.7708-5
    24054.60C -1.7174-5  29063.60C -1.9180-2 29065.60C -8.8202-3
    12000.60C -0.0097 13027.60C -0.5945032
KCODE  3000  0.5  60  150
C   KSRC   3.6 50. 3.6  3.6 58. 3.6  3.6 65. 3.6  20 50. 3.6  20 65. 20
SDEF  AXS= 0 1 0 POS=13.2 58.0 13.2 EXT=D1  RAD=D2
SI1  9
SI2  0.001   16
PRINT
```

3.3.7 Cross Section Installation Test Case 7

```
E5MT.1: CONVERTED FROM KENO FILE K.1; CONTINUOUS ENERGY; ENDF/B-5
C    8 BARE CYlINDERS OF U-METAl
C
C    CELL  CARDS
C
 1  1  4.80368E-2 -7 -8 9          IMP:N=1 U=-1
 2  0         #1             IMP:N=1 U=1
 3  0         -1  2 -3  4  -5  6   IMP:N=1 U=2 LAT=1
    FILL= 0:1 0:1 0:1 1 1 1 1 1 1 1 1
 4  0         -11 12 -13  14  -15 16  IMP:N=1     FILL=2
 5  0          #4             IMP:N=0

C    SURFACE  CARDS
C
C    PARALLELPIPED
 1  PX  0.0
 2  PX -13.74
 3  PY  0.0
 4  PY -13.74
 5  PZ  0.0
 6  PZ -13.01
```

```
C    CYLINDER
  7  C/Z -6.87 -6.87 5.748
  8  PZ  -1.1225
  9  PZ  -11.8875
C    PARALLELPIPED (SHRINK DIMENSIONS SLIGHTLY TO AVOID FILL TROUBLE)
  11  PX  13.7399
  12  PX -13.7399
  13  PY  13.7399
  14  PY -13.7399
  15  PZ  13.0099
  16  PZ -13.0099

C    DATA  CARDS
C
MODE  N                    $ TRANSPORT NEUTRONS ONLY
C
C    MATERIAL CARDS; ENDF/B-5 DATA
  M1  92235.60C  0.932631      $ U-235
      92238.60C  0.055328      $ U-238
      92234.60C  0.010049      $ U-234
      92236.60C  0.001992      $ U-236
C
C    S(ALPHA, BETA):  NOT APPLICABLE
C
C
C
C    DEFAULT ENERGY BINS; HANSEN-ROACH STRUCTURE
  E0  1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
      1.7E-2 0.1 0.4 0.9  1.4  3.0  20.0
C
C    TALLIES
  F4:N  1                  $ AVE FLUX IN CELL 1
C
C  CRITICALITY CARDS
KCODE  3000 1.0 20 200 4500 0
C
C  UNIFORM VOLUME SOURCE IN FISSILE CELLS
C  UNIFORMLY DISTRIBUTED VOLUME SOURCE IN EACH CYLINDER
C  YOU HAVE TO SET UP DISTRIBUTIONS FROM WHICH TO CHOOSE:
C  CELL, ENERGY, RADIUS(FROM AXIS), AND Z DISPLACEMENT (FROM POS).
C  SINCE THE CYLINDER IS IN A REPEATED STRUCTURE, BUT ALWAYS
C  CALLED CELL 1, YOU MOST SPECIFY THE PATH OF CELLS WHICH UNIQUELY
C  DEFINES THE CYLINDER YOU WANT.  THE PATH BEGINS WITH THE OUTERMOST
C  CELL AND WORKS DOWN.  WHEN CELL 3 IS REACHED, THE LATTICE POSITION
C  MUST ALSO BE GIVEN.
C
SDEF  CEL=D1 ERG=D2 RAD=D3  EXT=D4  POS=-6.87 -6.87 -6.505  AXS=0 0 1
C
SI1  L  4:3(1  1 0):1        $ PATH:  /CELL4/CELL3/LATTICE(1,1,0)/CELL1
        4:3(1  0 0):1        $ ETC.
        4:3(0  1 0):1        $ THIS ORDERING CHOSEN TO WATCH
        4:3(0  0 0):1        $ SAMPLING IN E5CE.2
        4:3(1  1 1):1
```

```
     4:3(1 0 1):1
     4:3(0 1 1):1
     4:3(0 0 1):1
SP1  1 1 1 1 1 1 1 1        $ EQUAL PROBABILITY FOR ALL PATHS ABOVE
C
SP2  -3                    $ WATT FISSION SPECTRUM
C
SI3  0.0  5.748             $ RADIAL DISTRIBUTION
SP3  -21 1                 $ P(X) = CONST*ABS(X)
C
SI4  -5.3825 5.3825          $ AXIAL DISTRIBUTION
SP4  -21 0                 $ P(X) = CONST
C
PRDMP J J 1 J               $ WRITE MCTAL FILE
C
PRINT                      $ FULL OUTPUT
```

3.3.8 Cross Section Installation Test Case 8

```
E5MT.3: CONVERTED FROM KENO FILE K.3; CONTINUOUS ENERGY; ENDF/B-5
 C  UNIVERSES OF PARAFFIN WITH CONSTANT IMPORTANCE SURROUNDING CORE
 C
 C  CELL CARDS
 C
 C  LATTICE WITH CYLINDERS OF U FUEL
 1  1 0.0480368 -7 -8 9        IMP:N=1  U=1     $ U CYLINDER
 2  0       #1           IMP:N=1  U=1     $ OUTSIDE
 3  0       -1 2 -3 4 -5 6   IMP:N=1  U=2 LAT=1 $ 2X2X2 LATTICE
    FILL=0:1 0:1 0:1  1 1 1 1 1 1 1 1         $ FILLING U'S
 4  2 0.122282  #3             IMP:N=1  U=2     $ OUTSIDE
 C
 C  CONCENTRIC BOXES OF CONSTANT IMPORTANCE
 10  0       -11 12 -13 14 -15 16 IMP:N=1   U=10 FILL=2
 11  2 0.122282  #10          IMP:N=1   U=10
 20  0       -21 22 -23 24 -25 26  IMP:N=1   U=20 FILL=10
 21  2 0.122282  #20          IMP:N=1   U=20
 30  0       -31 32 -33 34 -35 36  IMP:N=1   U=30 FILL=20
 31  2 0.122282  #30          IMP:N=1   U=30
 40  0       -41 42 -43 44 -45 46  IMP:N=1   U=40 FILL=30
 41  2 0.122282  #40          IMP:N=1   U=40
 50  0       -51 52 -53 54 -55 56  IMP:N=1   U=50 FILL=40
 51  2 0.122282  #50          IMP:N=1   U=50
 60  0       -61 62 -63 64 -65 66  IMP:N=1        FILL=50
 61  0       #60           IMP:N=0

  C  SURFACE CARDS
  C
  C  PARALLELPIPED
  1  PX  0.0
  2  PX  -23.48
  3  PY  0.0
```

```
4  PY -23.48
5  PZ 0.0
6  PZ -22.75
C  CYLINDER
7  C/Z -11.74 -11.74 5.748
8  PZ -5.9925
9  PZ -16.7575
C  PARALLELPIPED (DIMENSIONS SHRUNK BY 0.001 TO AVOID FILL PROBLEMS)
11  PX 23.479
12  PX -23.479
13  PY 23.479
14  PY -23.479
15  PZ 22.749
16  PZ -22.749
C  PARALLELPIPED
21  PX 26.48
22  PX -26.48
23  PY 26.48
24  PY -26.48
25  PZ 25.75
26  PZ -25.75
C  PARALLELPIPED
31  PX 29.48
32  PX -29.48
33  PY 29.48
34  PY -29.48
35  PZ 28.75
36  PZ -28.75
C  PARALLELPIPED
41  PX 32.48
42  PX -32.48
43  PY 32.48
44  PY -32.48
45  PZ 31.75
46  PZ -31.75
C  PARALLELPIPED
51   PX 35.48
52   PX -35.48
53   PY 35.48
54   PY -35.48
55   PZ 34.75
56   PZ -34.75
C  PARALLELPIPED
61   PX 38.72
62   PX -38.72
63   PY 38.72
64   PY -38.72
65   PZ 37.99
66   PZ -37.99

C  DATA  CARDS
C
MODE   N              $ TRANSPORT NEUTRONS ONLY
```

```
C
C  MATERIAL  CARDS;  ENDF/B-5 DATA
M1 92235.60C 0.932631       $U-235
   92238.60C 0.055328      $U-238
   92234.60C 0.010049      $U-234
   92236.60C 0.001992      $U-236
C PARAFFIN
M2  1001.60C 0.675324      $H ( IN PARAFFIN )
    6000.60C 0.324676      $C ( IN PARAFFIN )
C
C  S(ALPHA, BETA)
MT2   POLY.01T
C
C  DEFAULT ENERGY BINS; HANSON-ROACH STRUCTURE
E0  1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5
    1.0E-4 5.5E-4 3.0E-3 1.7E-2 0.1 0.4 0.9 1.4 3.0 20.0
C
C  TALLIES
F4:N    1    $ TALLY THE AVE FLUX IN CELL 1
C
C  CRITICALITY CARDS
KCODE 3000  1.0  20  200  4500  0
C
SDEF  CEL=D1 ERG=D2 RAD=D3  EXT=D4  POS=-11.74 -11.74 -11.375  AXS=0 0 1
C
SI1  L 60:50:40:30:20:10:3(0 0 0):1  $ PATH:  /CELL6O/CELL5O/ ... /CELL1
       60:50:40:30:20:10:3(1 0 0):1  $ PATH TO CELL 1 THRU LATTICE(1,0,0)
       60:60:40:30:20:10:3(1 1 0):1  $ PATH TO CELL 1 THRU LATTICE(1,1,0)
       60:50:40:30:20:10:3(0 1 0):1  $ ETC.
       60:50:40:30:20:10:3(0 0 1):1
       60:50:40:30:20:10:3(1 0 1):1
       60:50:40:30:20:10:3(0 1 1):1
       60:50:40:30:20:10:3(1 1 1):1
SP1    1 1 1 1 1 1 1 1           $ EQUAL PROBABILITY FOR ALL PATHS ABOVE
C
SP2   -3                        $ WATT FISSION SPECTRUM
C
SI3      0.0  5.748              $ RADIAL DISTRIBUTION
SP3  -21   1                    $ P(X) = CONST*ABS(X)
C
SI4     -5.3825  6.3825            $ AXIAL DISTRIBUTION
SP4  -21   0                    $ P(X) = CONST
C
PRDMP   J J 1 J                   $ WRITE MCTAL FILE
C
PRINT                           $ FULL OUTPUT
```

3.3.9 Cross Section Installation Test Case 9

```
E5MT.6: CONVERTED FROM KENO FILE K-6; CONTINUOUS ENERGY; ENDF/B-5
C
C  CELL  CARDS
C
1   1 4.80368E-2 -7 -8 9         IMP:N=1
2   0       (-1 2 -3 4 -5 6) #1 IMP:N=1
3   0       1: -2: 3: -4: 5: -6  IMP:N=0

C  SURFACE CARDS
C
C  PARALLELPIPED
1  PX  6.87
2  PX -6.87
3  PY  6.87
4  PY -6.87
5  PZ  6.505
6  PZ -6.505
C  CYLINDER
7  CZ  5.748
8  PZ  5.3825
9  PZ -5.3825

C  DATA  CARDS
C
MODE  N                       $ TRANSPORT NEUTRONS ONLY
C
C  MATERIAL CARDS  ENDF/B-5 DATA
C  SAME COMPOSITION AS MCUP.1
M1  92235.60C 0.932631            $ U-235
    92238.60C 0.055328           $ U-238
    92234.60C 0.010049           $ U-234
    92236.60C 0.001992           $ U-236
C
C  S(ALPHA, BETA):  NOT APPLICABLE
C
C
C  DEFAULT ENERGY BINS; HANSEN-ROACH STRUCTURE
E0   1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
     1.7E-2 0.1 0.4 0.9 1.4 3.0 20.0
C
C  TALLIES
F4:N  1                     $ AVE FLUX IN CELL 1
C
C  CRITICALITY CARDS
KCODE  3000 1.0 20 200 4600 0
C
SDEF  CEL=1 POS=0 0 0 AXS=0 0 1 RAD=D1 EXT=D2 ERG=D3
C
SI1   0.0 5.748               $ BE SURE THIS ENCLOSES CELL 1
C
SI2  -5.3825  5.3825            $ BE SURE THIS ENCLOSES CALL 1
```

```
C
SP3  -3                    $ WATT FISSION SPECTRUM
C
PRDMP  J J 1 J             $ WRITE MCTAL FILE
C
PRINT                      $ FULL OUTPUT
```

3.3.10 Cross Section Installation Test Case 10

```
E5MT.7: CONVERTED FROM KENO FILE K.7; CONTINUOUS ENERGY; ENDF/B-5 DATA
C   REFLECTION ON 3 SIDES
C
C   CELL CARDS
C
1   1 4.80368E-2 -7 -8 9          IMP:N=1
2   0        (-1 2 -3 4 -5 6) #1  IMP:N=1
3   0        1: -2: 3: -4: 5: -6  IMP:N=0

C   SURFACE CARDS
C
C   PARALLELPIPED
C
*1   PX 6.87             $ REFLECTING  SURFACE
2   PX -6.87
*3   PY 6.87             $ REFLECTING  SURFACE
4   PY -6.87
*5   PZ 6.505            $ REFLECTING  SURFACE
6   PZ -6.505
C   CYLINDER
7   CZ  5.748
8   PZ  5.3825
9   PZ -5.3825
C   ENCLOSING SPHERE
10  SO  11.0

C   DATA CARDS
C
MODE  N                  $ TRANSPORT NEUTRONS ONLY
C
C
C   MATERIAL CARDS  ENDF/B-6 DATA
C   SAME COMPOSITION AS MCNP.1
M1   92235.60C 0.932631        $ U-235
     92238.60C 0.055328        $ U-238
     92234.60C 0.010049        $ U-234
     92236.60C 0.001992        $ U-236
C
C   S(ALPHA, BETA):  NOT APPLICABLE
C
C
C   DEFAULT ENERGY BINS
```

```
E0   0.025E-6 1.0E-6 1.0E-4 1.0E-2 1.0E-1 5.0E-1 1.0 2.0 4.0 10.0 14.0 20.0
C
C   TALLIES
F4:N 1                    $ AVE FLUX IN CELL 1
C
C   CRITICALITY CARDS
KCODE 3000 1.0 20 200 4500 0
C
SDEF CEL=1 POS=0 0 0 AXS=0 0 1 RAD=D1 EXT=D2 ERG=D3
C
SI1  0.0 5.748            $ BE SURE THIS ENCLOSES CELL 1
C
SI2  -5.3825 5.3825       $ BE SURE THIS ENCLOSES CELL 1
C
SP3  -3                   $ WATT FISSION SPECTRUM
C
PRDMP J J 1 J             $ WRITE MCTAL FILE
C
PRINT                     $ FULL OUTPUT
```

3.3.11 Cross Section Installation Test Case 11

```
E5MT.12: CONVERTED FROM KENO FILE K.12; CONT ENERGY; ENDF/B-5
 C
 C  CELL  CARDS
 C
 1   1 0.0480295   -7 -8  9      IMP:N=1
 2   2 0.09806472 -17 -18 19     IMP:N=1 U=1
 3   3 0.106657    17: 18:-19    IMP:N=1 U=1
 4   0            -27 -28 29     IMP:N=1 FILL=1
 C
 11  LIKE 1 BUT  TRCL=(0.00 13.18  0.00)
 14  LIKE 4 BUT  TRCL=(0.00 21.75  0.00)
 C
 21  LIKE 1 BUT  TRCL=(0.00  0.00 12.45)
 24  LIKE 4 BUT  TRCL=(0.00  0.00 20.48)
 C
 31  LIKE 1 BUT  TRCL=(0.00 13.18 12.45)
 34  LIKE 4 BUT  TRCL=(0.00 21.75 20.48)
 C
 40  0 -30 #1 #4 #11 #14 #21 #24 #31 #34 IMP:N=1 $ BTWN CYLINDER & SPHERE
 C
 50  0  30                       IMP:N=0  $ OUTSIDE OF SPHERE

 C  SURFACE CARDS
 C
 C  FINITE CYLINDERS
 7  C/Z   -6.59 -6.59 5.748
 8  PZ    -0.8425               $ 5.3825 ABOVE MIDPLANE
 9  PZ    -11.6076              $ 5.3825 BELOW MIDPLANE
 C
```

```
17 C/Z   10.875 -10.875 9.525
18 PZ   -1.35              $ 8.89 ABOVE MIDPLANE
19 PZ   -19.13             $ 8.89 BELOW MIDPLANE
C
27 C/Z   10.875 -10.875 10.16
28 PZ   -0.715             $ 9.525 ABOVE MIDPLANE
29 PZ   -19.765            $ 9.525 BELOW MIDPLANE
C
30 SO    35.0              $ ENCLOSING SPHERE

C DATA CARDS
C
MODE N                     $ TRANSPORT NEUTRONS ONLY
C
C MATERIAL CARDS; ENDF/B-5 DATA
M1 92238.60C  0.067198
  92235.60C  0.932802
C URANYL NITRATE
M2  1001.60C 0.592466
    7014.60C 0.020143
    8016.60C 0.376557
   92235.60C 0.010041
   92238.60C 0.000792
C PLEXIGLAS
M3  6000.60C 0.333330
    1001.60C 0.533336
    8016.60C 0.133334
C
C S(ALPHA, BETA)
MT2 LWTR.01T
C DEFAULT ENERGY BINS; HANSON-ROACH STRUCTURE
E0  1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
    1.7E-2 0.1 0.4 0.9 1.4 3.0 20.0
C
C TALLIES
C
F4:N 1                     $ AVE FLUX IN CELL 1
C
C CRITICALITY CARDS
KCODE 3000 1.0 20 200 4500 0
C
C UNIFORM VOLUME SOURCE IN FISSILE CELLS
C
SDEF CEL=D1 ERG=D2 RAD=FCEL D3 EXT=FCEL D4
    POS=FCEL D5 AXS=0 0 1
C
SI1 L 1 11 21 31           $CELLS
     4:2 14:2 24:2 34:2    $PATH TO CELL 2
SP1  V                     $PROB PROPORTIONAL TO VOLUME
C
SP2 -3                     $WATT FISSION SPECTRUM
C
DS3 S 31 31 31 31          $RADIAL DISTRIB NUMBERS BASED ON CEL
```

```
     32 32 32 32          $CORRESPOND TO SI1 CARD
SI31  0.0 5.748           $RADIAL LIMITS: SOURCE IN CELL 1
SP31 -21  1               $P(X) = CONST*ABS(X)
SI32  0.0 9.525           $RADIAL LIMITS: SOURCE IN CELL 2
SP32 -21  1               $P(X) = CONST*ABS(X)
C
DS4 S 41 41 41 41         $RADIAL DISTRIB NUMBERS BASED ON CEL
      42 42 42 42         $CORRESPOND TO SI1 CARD
SI41  -5.3825 5.3825      $AXIAL LIMITS: SOURCE IN CELL 1
SP41 -21 0                $P(X) = CONST
SI42  -8.89  8.89         $AXIAL LIMITS: SOURCE IN CELL 2
SP42 -21 0                $P(X) = CONST
C
DS5 L -6.59 -6.59 -6.225       $POS VARIABLE BASED ON CEL
     -6.59 6.59 -6.225         $CORRESPOND TO SI1 CARD
     -6.59 -6.59 6.225
     -6.59 6.59 6.225
     10.875 -10.875 -10.24     $WHEN PATH IS GIVEN (SEE SI1)
     10.875 -10.875 -10.24     $THE POSITION OF THE
     10.875 -10.875 -10.24     $UNTRANSLATED CELL IS GIVEN, SO
     10.875 -10.875 -10.24     $POS IS THE SAME EACH TIME
C
PRDMP J J 1 J                  $WRITE MCTAL FILE
C
PRINT
```

3.3.12 Cross Section Installation Test Case 12

```
E5MT.13: CONVERTED FROM KENO FILE K.13; CONTINUOUS ENERGY; ENDF/B-5
 C  2 OFFSET CUBES OF ENRICHED U-235 SURROUNDED BY A CYLINDRICAL
 C  ANNULUS OF ENRICHED U-235
 C
 C  CELL CARDS
 C
 1   1 4.80368E-2 -1 2 -3  4 -5 6 IMP:N=1 TRCL=(-0.2566 -6.35 0.00)
 2   1 4.80368E-2 -1 2 -3  4 -7 6 IMP:N=1 TRCL=(-12.4434 -6.35 7.62)
 3   1 4.80368E-2 -12 -13  6 11   IMP:N=1 $ ANNULUS
 4   0        -11 -13  6 #1 #2  IMP:N=1 $ BTWN BOXES AND CYLINDER
 5   0           (12: 13:-6) #2  IMP:N=0 $ OUTSIDE

 C  SURFACE CARDS
 C
 C  PLANES
 1   PX 12.7
 2   PX 0.0
 3   PY -12.7
 4   PY 0.0
 5   PZ 7.62
 6   PZ 0.0
 7   PZ 11.176
```

```
C  CYLINDERS
11  CZ  13.97
12  CZ  19.05
13  PZ  16.18

C  DATA CARDS
C
MODE   N                    $ TRANSPORT NEUTRONS ONLY
C
C  MATERIAL CARDS; ENDF/B-5 DATA
M1  92235.60C  0.932631
    92238.60C  0.055328
    92234.60C  0.010049
    92236.60C  0.001992
C
C  S(ALPHA, BETA): NOT APPLICABLE
C
C  DEFAULT ENERGY BINS; HANSEN-ROACH STRUCTURE
E0   1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
     1.7E-2 0.1 0.4 0.9 1.4 3.0 20.0
C
C  TALLIES
F4:N   1                    $ AVE FLUX IN CELL 1
C
C  CRITICALITY CARDS
KCODE  3000 1.0 20 200 4500 0
KSRC  6.35 0.0 3.81  -6.35 0.0 13.2        $ POINT IN EACH BLOCK
C
PRDMP J J 1 J               $ WRITE MCTAL FILE
C
PRINT                       $ FULL OUTPUT
```

3.3.13 Cross Section Installation Test Case 13

```
E5MT.14: CONVERTED FROM KENO FILE K.14; CONTINUOUS ENERGY; ENDF/B-5
C
C    CELL CARDS
C
1    1 4.80362E-2 -1 -8  9          IMP:N=1
2    0          1 -8  9 -2          IMP:N=1
3    1 4.80362E-2 -3 -8  9  2       IMP:N=1
4    0          3:  8:-9            IMP:N=0

C    SURFACE CARDS
C
C    CYLINDER
1    C/Z 5.08 0.0  8.89
2    CZ  13.97
3    CZ  19.05
C    PLANES
8    PZ  10.109
```

```
9     PZ 0.0

C     DATA CARDS
C
MODE   N                          $ TRANSPORT NEUTRONS ONLY
C
C     MATERIAL CARDS  ENDF/B-5 DATA
M1    92235.60C 0.932631              $ U-235
      92238.60C 0.055328              $ U-238
      92234.60C 0.010049              $ U-234
      92236.60C 0.001992              $ U-236
C
C     S(ALPHA, BETA):  NOT APPLICABLE
C
C
C     DEFAULT ENERGY BINS; HANSEN-ROACH STRUCTURE
E0    1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
      1.7E-2 0.1 0.4 0.9 1.4 3.0 20.0
C
C     TALLIES
F4:N   1                          $ AVE FLUX IN CELL 1
C
C     CRITICALITY CARDS
KCODE  3000 1.0 20 200 4500 0
C
SDEF   CEL=D1  POS=FCEL D2  EXT=FCEL D3  RAD=FCEL D4  ERG=D5 AXS=0 0 1
C
SI1    L 1  3                     $ CELLS
SP1    V                          $ PROB PROPORTIONAL TO VOLUME
C
DS2    T 1  5.08 0.0 0.0              $ POS FOR CEL=1
         3  0.0  0.0 0.0          $ POS FOR CEL=2
C
DS3    S  31 32                    $ EXT DISTRIB NUMBERS BASED ON CEL
SI31      0.0  10.109               $ AXIAL RANGE ABOUT POS
SP31   -21 0                      $ P(Z)  CONST
SI32      0.0  10.109               $ AXIAL RANGE ABOUT POS
SP32   -21 0                      $ P(Z)   CONST
C
DS4    S  41 42                    $ RAD DISTRIB NUMBERS BASED ON CEL
SI41      0.0    8.89              $ RADIAL RANGE ABOUT POS
SP41   -21 1                       $ P(R) = CONST*ABS(R)
SI42      13.97  19.05               $ RADIAL RANGE ABOUT POS
SP42   -21 1                       $ P(R) = CONST*ABS(R)
C
SP5    -3
C
PRDMP J  J  1  J                     $ WRITE MCTAL FILE
C
PRINT                              $ FULL OUTPUT
```

3.3.14 Cross Section Installation Test Case 14

```
E5MT.15: CONVERTED FROM KENO FILE K.15; CONTINUOUS ENERGY; ENDF/B-5
C
C  CELL  CARDS
C
1  1   0.04817212  -5              IMP:N=1
2  2   0.106657    1 -2 3 -4       IMP:N=1
3  3   0.100113    6 -7 -8 #1 #2   IMP:N=1
4  0               #3 #2 #1        IMP:N=0

C  SURFACE CARDS
1  PZ  -7.092175
2  PZ  -4.552185
3  CZ   4.1275
4  CZ   12.7
5  SZ   0.538475 6.5537
6  PZ  -22.092175
7  PZ   22.092175
8  CZ   32.97

C  DATA  CARDS
C
MODE N
KCODE 3000 1.0 20 200 4500 0
SDEF CEL=1 ERG=D1 RAD=D2 POS=0.0 0.0 0.538475
C
SP1 -3
C
SI2  0.0 6.56
SP2 -21  2
C
C   CONTINUOUS   ENDF/B-V
C
M1   92234.60C  0.01177258      $ U-234
     92235.60C  0.97656128      $ U-235
     92236.60C  0.0019912319    $ U-236
     92238.60C  0.009674906     $ U-238
C  PLEXIGLAS
M2   1001.60C  0.5333358     $ H
     6000.60C  0.3333302     $ C
     8016.60C  0.13333396    $ O
C  WATER
M3   1001.60C  0.666667      $ H
     8016.60C  0.333333      $ O
C
C  S(ALPHA,  BETA)
MT3 LWTR.01T
C
PRDMP J J 1 J            $ WRITE MCTAL FILE
C
PRINT                    $ FULL OUTPUT
```

3.3.15 Cross Section Installation Test Case 15

```
E5MT 16: CONVERTED FROM KENO FILE K.16; CONTINUOUS ENERGY; ENDF/B-5
C   UO2F2 INFINITE SLAB
C
C   CELL CARDS
C
1   1 0.09872456 (-1 2 -3 4 -5 6)          IMP:N=1
2   2 0.07044000 (-11 12 -3 4 -5 6) ( 1: -2 ) IMP:N=1
3   3 0.1      (-21 22 -3 4 -5 6) (11: -12) IMP:N=1
4   0        (21:-22: 3:-4: 5:-6)        IMP:N=0

C   SURFACE CARDS
C
C   PLANES
1   PX 2.479
2   PX -2.479
*3  PY 100.0
*4  PY -100.0
*5  PZ 100.0
*6  PZ -100.0
C
11  PX 3.749
12  PX -3.749
C
*21 PX 17.479
*22 PX -17.479

C   DATA CARDS
C
MODE N                      $ TRANSPORT NEUTRONS ONLY
C
C   MATERIAL CARDS; ENDF/B-5 DATA
C   UO2F2 SOLN
M1  92235.60C 0.013999
    92238.60C 0.001008
    9019.60C 0.030013
    8016.60C 0.338315
    1001.60C 0.616665
C   PYREX
M2  13027.60C 0.007524
    5010.60C 0.012967 5011.60C 0.052195 $ NATURAL BORON
    8016.60C 0.637706
    14000.60C 0.255821
    11023.60C 0.033788
C   BORATED UO2F2 SOLN
M3  5010.60C 0.002943 5011.60C 0.011846 $ NATURAL BORON
    92235.60C 0.013792
    92238.60C 0.0009935
    9019.60C 0.029569
    8016.60C 0.333312
    1001.60C 0.607545
C
```

```
C   S(ALPHA, BETA)
MT1  LWTR.01T
MT3  LWTR.01T
C
C   DEFAULT ENERGY BINS; HANSEN-ROACH STRUCTURE
E0   1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
     1.7E-2 0.1 0.4 0.9 1.4 3.0 20.0
C
C   TALLIES
F4:N  1                    $ AVE FLUX IN CELL 1
C
C   CRITICALITY CARDS
KCODE  3000 1.0 20 200 4500 0
C
KSRC    0.0  0.0 0.0          $ POINT IN MATERIAL 1
     -10.61 0.0 0.0          $ POINT IN MATERIAL 3
      10.61 0.0 0.0          $ POINT IN MATERIAL 3
C
PRDMP J J 1 J                $ WRITE MCTAL FILE
C
PRINT                        $ FULL OUTPUT
```

3.3.16 Cross Section Installation Test Case 16

```
E5MT.18:  CONVERTED FROM KENO FILE K.18;  CONTINUOUS  ENERGY;  ENDF/B-5
C
C   CELL CARDS
C
1    1 0.0981986  1 -2 -3              IMP:N=1  U=1
2    0          1 -4 -3 #1             IMP:N=1  U=1
3    2 0.106657   5 -6 -7 #1 #2        IMP:N=1  U=1
4    4 0.100113 -9  -5:6:7             IMP:N=1  U=1
5    0          14 -15 16 -17 18  -19  IMP:N=1  U=3 LAT=1
     FILL=-1:1 -1:1 -1:1
     1 1 1  1 1 1  1 1 1
     1 1 1  1 1 1  1 1 1
     1 1 1  1 1 1  1 1 1
6    0          20 -21 22 -23  24  -25  IMP:N=1 FILL=3
7    3 0.122268   30 -31 32 -33  34  -35 (-20:21:-22:23:-24:25) IMP:N=1
8    5 0.100113   30 -31 32 -33  44  -34         IMP:N=1
9    0          (-30:31:-32:33:-44:35)       IMP:N=0

C   SURFACE CARDS
C
C   URANYL-NITRATE CYLINDER
1   PZ   -8.7804
2   PZ   8.7804
3   CZ   9.52
C
C   VOID CYLINDER - USED TO ACCOUNT FOR THE FACT THAT THE PLEXIGLAS
```

```
C          CYLINDER IS NOT COMPLETELY FULL.
4  PZ   8.9896
C
C  PLEXIGLAS CYLINDER
5  PZ  -9.4204
6  PZ   9.6296
7  CZ  10.16
C
C  WATER FILLED CUBOID THAT CONTAINS THE CYLINDERS
14  PX  -18.45
15  PX   18.45
16  PY  -18.45
17  PY   18.45
18  PZ  -17.6854
19  PZ   17.8946
C
C  CUBOID THAT CONTAINS ALL THE OTHER CUBOIDS
20  PX  -55.3499
21  PX   55.3499
22  PY  -55.3499
23  PY   55.3499
24  PZ  -52.9199
25  PZ   52.9199
C
C  CUBOID THAT CONTAINS THE PARAFFIN
30  PX  -70.591
31  PX   70.591
32  PY  -70.591
33  PY   70.591
34  PZ  -68.6100999
35  PZ   68.6100999
C
C  SLAB OF WATER - ON THE NEGATIVE Z FACE
44  PZ  -99.09

C  DATA    CARDS
C
MODE N
C
C   MATERIAL  #1  -  AQUEOUS  URANYL  NITRATE
C   MATERIAL  #2  -  PLEXIGLAS
C   MATERIAL  #3  -  PARAFFIN
C   MATERIAL  #4  -  WATER, VERY  LOW  DENSITY (WATER VAPOR)
C   MATERIAL  #5  -  WATER, NORMAL DENSITY
C
C   CONTINUOUS   ENDF/B-V
C
M1   92238.60C  0.00079085         $ U-238
     92235.60C  0.01002407         $ U-235
      8016.60C  0.37766319         $ O
      7014.60C  0.02010823         $ N
      1001.60C  0.59141367         $ H
MT1   LWTR.01T
```

```
C
M2    1001.60C  0.5333358          $ H
      6000.60C  0.3333302          $ C
      8016.60C  0.13333396         $ O
C
M3    1001.60C  0.67532797         $ H
      6000.60C  0.32467203         $ C
MT3   POLY.01T
C
M4    1001.60C  0.66666667         $ H
      8016.60C  0.33333333         $ O
MT4   LWTR.01T
C
M5    1001.60C  0.66666667         $ H
      8016.60C  0.33333333         $ O
MT5   LWTR.01T
C
KCODE 3000 1.0 20 200 4500 0
SDEF CEL=D1 ERG=D2 RAD=D3 EXT=D4 POS=0.0 0.0 0.0 AXS=0 0 1
C
C  PATH TO EACH OF 27 SOURCE CELLS
SI1  L 6:5( 1  1  1):1  6:5(-1 -1  0):1  6:5(-1 -1  1):1
     6:5(-1  0 -1):1  6:5(-1  0  0):1  6:5(-1  0  1):1
     6:5(-1  1 -1):1  6:5(-1  1  0):1  6:5(-1  1  1):1
     6:5( 0 -1 -1):1  6:5( 0 -1  0):1  6:5( 0 -1  1):1
     6:5( 0  0 -1):1  6:5( 0  0  0):1  6:5( 0  0  1):1
     6:5( 0  1 -1):1  6:5( 0  1  0):1  6:5( 0  1  1):1
     6:5( 1 -1 -1):1  6:5( 1 -1  0):1  6:5( 1 -1  1):1
     6:5( 1  0 -1):1  6:5( 1  0  0):1  6:5( 1  0  1):1
     6:5( 1  1 -1):1  6:5( 1  1  0):1  6:5( 1  1  1):1
SP1   1 1 1  1 1 1  1 1 1        $ EQUAL PROBABILITY FOR ALL PATHS ABOVE
      1 1 1  1 1 1  1 1 1
      1 1 1  1 1 1  1 1 1
SP2  -3                          $ WATT FISSION SPECTRUM
C
SI3    0.0   9.52                $ RADIAL DISTRIBUTION
SP3  -21  1                      $ P(X) = CONST*ABS(Z)
C
SI4    -8.7804    8.7804         $ AXIAL  DISTRIBUTION
SP4  -21  0                      $ P(X) = CONST
C
PRDMP  J J 1 J                   $ WRITE MCTAL FILE
PRINT
```

3.3.17 Cross Section Installation Test Case 17

```
E5MT.20: CONVERTED FROM KENO FILE K.20; CONTINUOUS ENERGY; ENDF/B-5
C
C   CELL CARDS
C
C   ALUMINUM CAN WITH URANYL NITRATE
```

```
1   1 0.0982616  -17 -18 19        IMP:N=1 U=1
2   2 0.060242   17: 18:-19        IMP:N=1 U=1
3   0            -27 -28 29        IMP:N=1 FILL=1
C   MAKE A TRIANGULAR ARRAY OF THE ABOVE CANS
13  LIKE 3  BUT  TRCL=( 21.006  0.000  0.000)
23  LIKE 3  BUT  TRCL=(-21.006  0.000  0.000)
33  LIKE 3  BUT  TRCL=( 10.503  18.192  0.000)
43  LIKE 3  BUT  TRCL=(-10.503  18.192  0.000)
53  LIKE 3  BUT  TRCL=( 10.503 -18.192  0.000)
63  LIKE 3  BUT  TRCL=(-10.503 -18.192  0.000)
C   ENCLOSE THE ARRAY IN A BOX
101  0   -1 2 -3  4  -5  6  #3  #13  #23 #33 #43 #53 #63   IMP:N=1   $ BTWN
102  0    1:-2:  3:-4:  5:-6                          IMP:N=0   $ OUTSIDE

C   SURFACE CARDS
C
1   PX  50.0
2   PX  -50.0
3   PY  50.0
4   PY  -50.0
5   PZ  50.0
6   PZ  -0.152
C   FINITE CYLINDERS
17  CZ  10.16
18  PZ  18.288
19  PZ  0.0
C
27  CZ  10.312
28  PZ  18.288
29  PZ  -0.152

C   DATA CARDS
C
MODE N                          $ TRANSPORT NEUTRONS ONLY
C
C   MATERIAL CARDS; ENDF/B-5 DATA
C   URANYL FLUORIDE
M1   92235.60C 0.014017          $ U-235
     92238.60C 0.001010          $ U-238
      8016.60C 0.338342          $ O
      9019.60C 0.030053          $ F
      1001.60C 0.616578          $ H
M2   13027.60C 1.0               $ AL CAN
C
C   S(ALPHA, BETA)
MT1  LWTR.01T
C
C  DEFAULT ENERGY BINS; HANSON-ROACH STRUCTURE
E0  1.0E-7 4.0E-7 1.0E-6 3.0E-6 1.0E-5 3.0E-5 1.0E-4 5.5E-4 3.0E-3
    1.7E-2 0.1 0.4  0.9  1.4  3.0  20.0
C
C  TALLIES
F4:N  1                        $ AVE FLUX IN CELL 1
```

```
C
C  CRITICALITY CARDS
KCODE  3000 1.0 20 200 4500 0
C
C  UNIFORMLY DISTRIBUTED VOLUME SOURCE IN EACH CYLINDER.
C  YOU HAVE TO SET UP DISTRIBUTIONS FROM WHICH TO CHOOSE:
C  CELL, ENERGY, RADIUS (FROM AXS), AND Z DISPLACEMENT (FROM POS).
C  SINCE THE CYLINDER IS IN A REPEATED STRUCTURE, BUT ALWAYS
C  HAS THE SAME CELL NUMBER, YOU MUST SPECIFY THE PATH OF CELLS
C  WHICH UNIQUELY DEFINES THE CYLINDER YOU WANT.  THE PATH BEGINS
C  WITH THE OUTERMOST CELL AND WORKS DOWN.
C
SDEF  CEL=D1  ERG=D2  RAD=D3  EXT=D4  POS=0.0 0.0 9.144  AXS=0 0 1
C
SI1  L  3:1               $ PATH:  /CELL13/CELL1
     13:1                 $ ETC.
     23:1
     33:1
     43:1
     53:1
     63:1
SP1     1 1 1 1 1 1 1     $ EQUAL PROB FOR ALL THE ABOVE
C
SP2  -3                   $ WATT FISSION SPECTRUM
C
SI3     0.0 10.16         $ RADIAL LIMITS
SP3  -21  1               $ P(X) = CONST*ABS(X)
C
SI4  -9.144 9.144         $ AXIAL LIMITS
SP4  -21  0               $ P(X) = CONST
C
PRDMP  J J 1 J            $ WRITE MCTAL FILE
C
PRINT                     $ FULL OUTPUT
```

3.3.18 Results Of Cross Section Installation Tests

During the original generation and testing of MCNPDAT6 package based on the ENDF/B-VI cross section library, results calculated using this library were compared with the results for a number of other data libraries for infinite medium simulations of all nuclides. In addition, a number of experimental benchmarks consisting of pulsed sphere experiments, iron benchmark experiments, and criticality experiments were run. The cases listed in Reference 2 are adequate for validating MCNPDAT6 (ENDF/B-VI cross section library) for use with MCNP4A. The benchmark test cases listed in Table 3.3-1 are a subset of those listed in Reference 2 and demonstrate that the validation can be extended to the HP 9000 series workstations. The output from these benchmark test cases (including mirrored input) is archived on electronic media, MI: 30006-M03-002.

Based on the result comparisons of these specific test cases, the operation of the MCNP4A code package using the MCNPDAT6 library (ENDF/B-VI based cross section library) on the QUICHE HP 9000/C160 workstation and any other HP 9000 series workstation located at the WPDD was determined to be satisfactory. No limitations on the use of the MCNPDAT6 package or ENDF/B-VI cross sections with MCNP4A are noted.

4.0 RECOMMENDATIONS

The installation of the MCNP4A code package and the ENDF/B-VI based cross section library was reviewed and found to have been accomplished according to the instructions provided by the developer. The test cases required for installation verification and code validation have been executed and found to satisfy the acceptance criterion for numerical results. Additional benchmark test cases have been successfully run to validate the proper operation of MCNP4A as well as to verify the proper installation of the ENDF/B-VI based cross section library update. Thus, the MCNP4A code package installation was shown to be satisfactory and complete in all aspects.

Based upon the sufficient fulfillment of installation requirements as set forth by the developer, and the acceptance of the MCNP4A code by the NRC, it is recommended that the MCNP4A code be approved for use in work that is subject to QARD requirements.

As noted above in section 3.1.3 for the HP 9000 series workstations, this validation document pertains to both the HP 9000/700 and the HP 9000/C160 workstations using the UNIX operating systems V9.07 and V10.2. The HP 9000 workstations (both C160s and 700s) are connected to the QUICHE MCNP4A code package installation via a NFS mount. Numerous benchmark test cases have been run on all HP 9000 workstations in this configuration at the WPDD and results have been sufficiently similar for this validation document. For the PC version, this validation document pertains to the PC platform using the WINDOWS 3.11/MS-DOS 6.22 operating system. This validation document is valid for other PCS with the same operating system, if they produce the same results for the test problems.

There are no MCNP4A software components that could not be validated as indicated by this SQR. The MCNP4A code package operating on the GATEWAY2000 P5-90 uses the ENDF/B-V based cross section library and is not validated for the ENDF/B-VI based library.

5.0 ATTACHMENTS

Attachment I: Software Acquisition Correspondence

Attachment II: Installation Information/Notes

Attachment III: MCNP4A Directory And File Listing

Attachment IV: MCNP4A New Appendix G For Manual

Attachment V: README2 For ENDF60

Attachment VI: XSDIR Cross Section Library File

Attachment I: Software Acquisition Correspondence

This attachment contains a copy of the CRWMS/M&O requisition requesting the MCNP4A package from RSIC and a copy of the RSIC letter that accompanied the package.

PMA NO. 103543

CRWMS/M&O | **Property Movement Authorization**

Please check appropriate location identifier:

☐ VA - Virginia ☐ DC - District of Columbia ☐ NC - North Carolina ☒ LV - Las Vegas

This form must be completed for all custodian or location changes of M&O number tagged property. If the change involves moving the property outside its current facility, a separate Property Removal Authorization (PRA) must also be completed. SEE INSTRUCTIONS ON THE REVERSE SIDE OF THIS FORM.

PROPERTY TAG	ITEM DESCRIPTION	NEW LOCATION (Bldg./Room)	NEW CCC
510294	Solwina V 3.54- (RSIC)	527	
510295	~~MCNP4A~~ MCNP4A (RSIC)		
	CJW 05/21/96		
	User Restapes (2)		

Jim Low
CURRENT CUSTODIAN NAME

CURRENT CUSTODIAN SIGNATURE DATE 4/15/94

PROPERTY RECEIPT AND CUSTODIAN ACCEPTANCE

I acknowledge receipt of the property listed above and accept responsibility for protecting, controlling, and accounting for these items at all times. I agree that each item assigned to my custody will be properly transferred and/or returned to Property Control when I no longer have a business need for them (e.g. termination, job change, or transfer). I agree to promptly report any loss, damage, destruction, or theft of any property in my custody and understand that I may be charged for any repair or replacement costs for these items due to my neglect. I further understand that anyone who knowingly converts for personal use, or the use of another, anything of value belonging to the United States Government may be subject to a maximum penalty of a $10,000 fine, or ten years imprisonment, or both (Public Law 772, 80th Congress).

Dan Thomas
NEW CUSTODIAN NAME

NEW CUSTODIAN SIGNATURE DATE 4/15/94

CCC MANAGER

CCC MANAGER SIGNATURE DATE

SSG USE ONLY	PROPERTY CONTROL USE ONLY
CPU NUMBER:	RECEIVED:
The ADP equipment listed above has been inspected and is authorized for movement.	COMMENTS:
SSG SIGNATURE DATE	PROPERTY CONTROL DATE

```
                          Page 1 of 3
                                 ID#             :   C00200ALLCP02
1 DC 6150 (150MB)                RSIC#           :   CCC 200
1 8mm (2.3GB)                    CODE PKG NAME   :   MCNP4A
1 4mm (8.0GB)                    COMPUTER        :   Cray,IBM,VAX
29 3.5" (1.44MB) diskettes                           Unix workstations
90mb or 150mb Bernoulli disk                         PC 386 and higher
QIC-80/QIC-40 data cartridge     PACKAGED        :   06/30/83
  (250mb or 120mb)               RECENT UPDATE   :   02/22/94
IMPORTANT: The cross sections (diskettes 13-29; subdirectory 'xsection'
           for UNIX systems) are based on ENDF/B-IV. Recommended
           ENDF/B-V cross sections are restricted and available as
           DLC105C/MCNPDAT. Call RSIC at 615-574-6176 for the latter.
           FAX: 615-574-6182    E-MAIL: pdc@ornl.gov
*************************************************************************
DESCRIPTION  of diskettes.
*************************************************************************
REQUIRED: at least 8 megabytes of memory, 150 megabytes of hard disk
1. Diskette 1
   C00200   LIS   - this listing of all files in MCNP.
   README   DOS   - Instructions to install MCNP on DOS systems.
   README   UNX   - Instructions to install MCNP on UNIX systems
   README   VMS   - Instructions to install MCNP on VAX/VMS systems.
   README   RSI   - important information on how RSIC compressed files.
   README         - general installation instructions.
   INSTALL        - general installation command file for UNIX systems.
   INSTALL  DOS   - installation command file for DOS.
   INSTALL  VMS   - installation command file for VAX/VMS
   INSTALL  FIX   - corrections to INSTALL file
   MCSETUP.FOR    - program required in installing MCNP (FORTRAN 77 source).
   ID       EXE   - compressed file containing MCNP.ID, MAKXSF.ID, PRPR.ID.
   RUNPROB  BAT   - DOS command to run all 25 sample problems.
   LINKMCNP BAT   - DOS command to compile and link MCNP.
   LINKMAKX BAT   - DOS command to compile and link MAKXSF.
   LINKPRPR BAT   - DOS command to compile and link PRPR.
   XSDIR          - cross section directory, required by MAKXSF.
   SPECS          - list of cross sections to be converted by MAKXSF.
   F77L3     EER  - error text file required by the Lahey runtime.
   INPDOS    EXE  - compressed file of 25 MCNP sample problems for DOS.
   INP       EXE  - compressed file of 25 MCNP problems for all computers.
   INPVMS    EXE  - compressed file of 25 MCNP sample problems for VAX/VMS.
   RUNPROB        - command file to run 25 problems for UNIX systems.
   RUNPROBX       - command file to run 25 problems for UNIX with PVX.
   DIFFTIME C     - C dummy subroutine for Sun workstations.
   F77L3     OPT  - Lahey F77L3-EM/32 compiler options.
   MCTL      <DIR>- subdirectory of compressed MCNP tally output files.

2. Contents of diskette 2
   MCNPDOS.EXE    - compressed file containing MCNP executable program
                    (compiled and linked at RSIC with MDAS=1000000)
   PRPRDOS.EXE    - compressed file containing PRPR.EXE.
   MAKXSDOS.EXE   - compressed file containing MAKXSF.EXE.

3. Contents of diskettes 3-8.
   LIB1.EXE LIB2.EXE LIB3.EXE LIB4.EXE LIB5.EXE LIB6.EXE
   The above files are compressed and comprise the TESTLIB1 cross section
   library to be used with the sample problems. Insert each diskette in
   drive A and type A:\LIB1, A:\LIB2, A:\LIB3, A:\LIB4, A:\LIB5, A:\LIB6.
 . After decompression, do the following:
   copy LIB1+LIB1+LIB3+LIB4+LIB5+LIB6 TESTLIB1

4. Diskettes 9-12 are hardware specific. Extract only what you need.
   Contents of diskette 9.
   OUTPDOS.EXE -compressed file of 25 MCNP sample output for DOS.
   OUTPAIX.EXE -compressed file of 25 MCNP sample output for AIX.

5. Contents of diskette 10.
   OUTPSUN.EXE -compressed file of 25 MCNP sample output for SUN.
   OUTPDEC.EXE -compressed file of 25 MCNP sample output for DEC workstations.
*************************************************************************
Notes: 1. Version 4A replaces all versions of MCNP.
       2. MCNP4A was tested at RSIC on:
          a.  an IBM RISC 6000 Model 550 under AIX 3.2 and XL FORTRAN Version 2.3
          b.  on a Sun Sparcstation 2 under Solaris 2.3 and Sun FORTRAN 2.0
          c.  on a PC 486/33 DOS 6.0 and Lahey FORTRAN F77L3-EM/32 Version 5.10
          d.  on the VAX 6000 under VAX/VMS A5.5-2 and VAX FORTRAN.
```

```
                              Page 2 of 3
                                     ID#            :  C00200ALLCP02
 1 DC 6150 (150MB)                   RSIC#          :  CCC 200
 1 8mm (2.3GB)                       CODE PKG NAME  :  MCNP4A
 1 4mm (8.0GB)                       COMPUTER       :  Cray,IBM,VAX
 29 3.5" (1.44MB) diskettes                            Unix workstations
 90mb or 150mb Bernoulli disk                          PC 386 and higher
 QIC-80/QIC-40 data cartridge        PACKAGED       :  06/30/83
      (250mb or 120mb)               RECENT UPDATE  :  02/22/94
****************************************************************************
DESCRIPTION  of diskettes.
****************************************************************************
6. Contents of diskette 11.
   OUTPHP.EXE  -compressed file of 25 MCNP sample output for HP.
   OUTPSGI.EXE -compressed file of 25 MCNP sample output for SGI.

7. Contents of diskette 12.
   OUTPUCOS.EXE -compressed file of 25 MCNP sample output for Cray/UNICOS.
   OUTPVMS.EXE  -compressed file of 25 MCNP sample output for VAX/VMS.

*****Diskettes 13-29 comprise the cross sections for neutrons, photons,
*****electrons, etc..These are the standard cross sections for running MCNP.
*****Recommended cross sections are in the RSIC package DLC-105.
8. Contents of diskettes 13-18.
   SPECS     - input file to MAKXSF specific to cross sections below.
   XSDIR1    - cross section directory input to MAKXSF.
   XSLIST    - summary listing of nuclides in the MCNP package.
   ENDL851   - ENDL85 based continuous energy neutron cross sections.
               This file is in compressed form in diskettes 13-18.
               ENDL85A.EXE, ENDL85B.EXE, ENDL85C.EXE
               ENDL85D.EXE, ENDL85E.EXE, ENDL85F.EXE
               Uncompress the above files, then
               copy ENDL85A+ENDL85B+ENDL85C+ENDL85D+ENDL85E+ENDL85F ENDL851

9. Contents of diskettes 19-21.
   BMCCS1    - 69 tables from ENDF/B, ENDL and LANL continuous energy
               neutron evaluations.
               This file is in compressed form in diskettes 19-21.
               BMCCSA.EXE, BMCCSB.EXE, BMCCSD.EXE
               Uncompress the above files, then
               copy BMCCSA+BMCCSB+BMCCSC BMCCS1

9. Contents of diskettes 22-25.
   TMCCS1    - 42 tables from ENDF/B thermal neutrons.
               This file is in compressed form in diskettes 22-25.
               TMCCSA.EXE, TMCCSB.EXE, TMCCSC.EXE, TMCCSD.EXE
               Uncompress the above files, then
               copy TMCCSA+TMCCSB+TMCCSC+TMCCSD TMCCS1
10. Contents of diskettes 25-27.
   D91       - 99 tables from ENDF/B, ENDL and LANL discrete reaction
               neutron evaluations.
               This file is in compressed form in diskettes 25-27.
               Uncompress the above files, then
               copy D9A+D9B+D9C D91
11. Contents of diskettes 25-27.
   MCPLIB1   - 94 tables based on DLC-7E and Storm/Israel photons.
               Uncompress MCPLIB.EXE to get MCPLIB1.
   531DOS1   - 18 tables from ENDF/B-V neutron dosimetry tape 531.
               Uncompress 531DOS.EXE to get 531DOS1.
   LLLDOS1   - 374 tables from Livermore ACTL neutron dosimetry.
               Uncompress LLLDOS.EXE to get LLLDOS1.
   THERXS1   - thermal data for SMITH, LMETH, HORTHO, DPARA and DORTHO.
               Uncompress THERXS.EXE to get THERXS1.
   EL1       - electron cross sections.
               Uncompress EL.EXE to get EL1.
12. Contents of diskette 29.
   532DOS1   - 43 tables from ENDF/B-V neutron dosimetry activation tape 532.
               Uncompress 532DOS.EXE to get 532DOS1.
```

```
                              Page 3 of 3
                                            ID#             :   C00200ALLCP02
1 DC 6150 (150MB)                           RSIC#           :   CCC 200
1 8mm (2.3GB)                               CODE PKG NAME   :   MCNP4A
1 4mm (8.0GB)                               COMPUTER        :   Cray,IBM,VAX
25 3.5" (1.44MB) diskettes                                      Unix workstations
90mb or 150mb Bernoulli disk                                    PC 386 and higher
QIC-80/QIC-40 data cartridge                PACKAGED        :   06/30/83
     (250mb or 120mb)                       RECENT UPDATE   :   02/22/94
**************************************************************************
DESCRIPTION  of files on cartridge tape.
**************************************************************************
To extract the files:
1.  tar -xvf /dev/rmt0           (your tape device may be different)
2.  uncompress c00200allCPC2.tar
3.  tar -xvf   c00200allCP02.tar
    C00200.LIS        - this listing of all files in MCNP.
    README.DOS        - Instructions to install MCNP on DOS systems.
    README.UNIX       - Instructions to install MCNP on UNIX systems
    README.VMS        - Instructions to install MCNP on VAX/VMS systems.
    README            - general installation instructions.
    install           - general installation command file for UNIX systems.
    install.dos       - installation command file for DOS.
    install.vms       - installation command file for VAX/VMS
    install.fix       - corrections to INSTALL file
    mcsetup.for       - program required in installing MCNP (FORTRAN 77 source).
    ID       EXE      - compressed file containing MCNP.ID, MAKXSF.ID, PRPR.ID.
    prpr.id           - FORTRAN 77 pre-processor PRPR needed to create
                        MCNP and MAKXSF FORTRAN 77 sources.
    mcnpf.id          - MCNP source file to be processed by PRPR.
    makxs.id          - MAKXSF source file to be processed by PRPR.
    mcnpc.id          - MCNP C source to be processed by PRPR.
    difftime.c        - dummy C subroutine for Sun systems (may not need).
    runprob           - UNIX script file to run 25 MCNP sample problems.
    runprobmt         - UNIX script file to run 25 MCNP sample problems under PVM.
    runprob.vms       - VAX/VMS command file to run 25 MCNP sample problems.
    xsdir             - cross section directory, required by MAKXSF.
    specs             - list of cross sections to be converted by MAKXSF.
    testlib1          - cross section library used for 25 MCNP sample problems.
    ----------------------------------------------------------------------
      The following test files are in tar format. Extract 'tar -xvf test...'
    testinp.tar       - 25 MCNP sample problems in 'tar' format.
    testinp.vms       - 25 MCNP sample problems for VAX/VMS.
    testmctl.aix      - 25 MCNP tally ouput files for AIX.
    testmctl.dec      - 25 MCNP tally ouput files for DEC.
    testmctl.hp       - 25 MCNP tally ouput files for HP.
    testmctl.sgi      - 25 MCNP tally ouput files for SGI.
    testmctl.sun      - 25 MCNP tally ouput files for SUN.
    testmctl.ucos     - 25 MCNP tally ouput files for Cray/UNICOS.
    testmctl.vms      - 25 MCNP tally ouput files for VAX/VMS.
    testoutp.aix      - 25 MCNP outp ouput files for AIX.
    testoutp.dec      - 25 MCNP outp ouput files for DEC.
    testoutp.hp       - 25 MCNP outp ouput files for HP.
    testoutp.sgi      - 25 MCNP outp ouput files for SGI.
    testoutp.sun      - 25 MCNP outp ouput files for SUN.
    testoutp.ucos     - 25 MCNP outp ouput files for Cray/UNICOS.
    testoutp.vms      - 25 MCNP outp ouput files for VAX/VMS.
    ----------------------------------------------------------------------
    DOS               - subdirectory of DOS specific files.
                        Contents of DOS subdirectory:
    README.RSI         - important information to uncompress DOS files.
    INPDOS.EXE         - compressed DOS file of 25 MCNP sample problems.
    MCTLDOS.EXE        - compressed DOS file of 25 MCNP sample tally output.
    OUTPDOS.EXE        - compressed DOS file of 25 MCNP sample output.
    f7713.eer          - error text file required by Lahey compiler at runtime.
    linkmcnp.bat       - DOS command to compile and link MCNP.
    linkmakxs.bat      - DOS command to compile and link MAKXSF.
    linkprpr.bat       - DOS command to compile and link PRPR.
    makxsf.exe         - executable MAKXSF program for DOS.
    mcnp.exe           - executable MCNP for DOS (compiled with MDAS=1000000)
    prpr.exe           - executable PRPR program.
    runprob.bat        - command file to run 25 MCNP sample problems.
    XSECTION           - subdirectory of standard MCNP cross sections
                         based on ENDF/B-IV. Files in this directory:
                         specs, xsdir1, xslist, endl851, bmccs1, tmccs1, e91,
                         mcplib1, 531dos1, 532dos1, 111dos1, therxs1, el1
```

```
                                       ID#:             P00242MFMWS01
Transmitted in tar format on one       RSIC #:          PSR-242
?" 6150 or 8 mm (2.3gb) tape.          CODE PKG NAME:   SABRINA Version 3.54
                                       COMPUTER:        IBM, SUN, DEC, APOLLO
                                                        Hewlett Packard,
                                                        Silicon Graphics
                                                        workstations
                                                        VAX running ULTRIX
                                                        CRAY running UNICOS
                                       PACKAGED:        4/01/87
                                       RECENT UPDATE:   11/04/93
**************************************************************************
Description
**************************************************************************

Requires about 10 megabytes of hard disk space.
Load the tape into appropriate drive (example: /dev/rmt0) and do
tar -xvf /dev/rmt0 *
ls -l

You will get a file psr242mfmws01.tar.Z (name may be different)
uncompress psr242mfmws01.tar
tar -xvf psr242mfmws01.tar

1.  README          - important installation instructions.
2.  examples.tar    - SABRINA examples, see file named MANIFEST for description.
                      To extract files:
                      tar -xvf examples.tar
3.  sabhelp         - listing of SABRINA commands.
4.  sources3.54.tar - SABRINA FORTRAN 77 and ANSI C sources.
                      To extract:   tar -xvf sources3.54.tar
5.  new_man.tar.Z   - SABRINA manual in postscript format; requires a
                      postscript printer. You do not need this file
                      to load SABRINA.
                      To extract files:
                      mkdir man
                      cd man
                      uncompress new_man.tar.Z
                      tar -xvf new_man.tar
6.  LISTFILES       - this listing.
**************************************************************************
Notes: The November 1993 update was the initial release of SABRINA 3.54
       and was a complete replacement of the RSIC package.
       SABRINA was tested at RSIC on an IBM RISC 6000 Model 550 under
       AIX 3.2, using the xlf FORTRAN compiler Version 2.3;  SABRINA
       was also tested on a Sun Sparcstation 2 under SunOS 4.2, and
       SUN FORTRAN 1.4, OPENWIN Version 3.
```

Attachment II: Installation Information/Notes

This attachment contains a copy of the installation instructions contained in the "README." and "README.UNIX" files of the code package. No difficulties were encountered with the installation by the installer. A separate section is included in this Attachment on installation of the MCNP4A code with the DLC105C ENDF/B-V cross section data files on the PC platform. This section follows the README and README.UNIX sections for the HP version.

README

DISTRIBUTION FILES

The following files should be present with the MCNP 4A distribution:

FILE	DESCRIPTION
Readme	This file.
INSTALL	Installation controller. Named INSTALL.SYS for non-UNIX systems (e.g., VMS and DOS).
INSTALL.FIX	Installation fix file.
MCSETUP.FOR	Setup FORTRAN code.
PRPR.ID	FORTRAN preprocessor code.
MAKXS.ID	Cross-section processor source code.
MCNPC.ID	MCNP C source code (used on UNIX systems only).
MCNPF.ID	MCNP FORTRAN source code.
RUNPROB	Script file for MCNP verification. Named RUNPROB.SYS for non-UNIX systems.
TESTINP.TAR	Compressed input files for MCNP verification. Named TESTINP.SYS for non-UNIX systems.
TESTMCTL.SYS	Compressed tally output files for MCNP verification.
TESTOUTP.SYS	Compressed MCNP output files for MCNP verification.
XSDIR	Cross-section directory for MCNP verification.
TESTLIB1	Cross-section data for MCNP verification.

Substitute the appropriate system identifier from the following table for the "SYS" suffix.

SYSTEM	IDENTIFIER	SYSTEM	IDENTIFIER
Cray UNICOS	ucos	DEC ULTIRX	dec
Sun SunOS	sun	PC DOS	dos
IBM RS/6000 AIX	aix	Sun Solaris	sun
HP-9000 HPUX	hp	SGI IRIX	sgi
VAX VMS	vms		

The INSTALL.FIX file is used to implement corrections to either the MCNP source or the MAKEMCNP script. The latter is important for future changes/bugs in compilers and/or operating systems. The format of this file is provided within INSTALL.FIX, and more details can be found in Appendix C of the MCNP manual. The MCSETUP utility is a user friendly interface for creating system dependent files. The remaining files in the first group are MCNP related source code, and the second group of files are used for MCNP verification (i.e. running the 25 MCNP test problems).

For DOS systems, two additional utilities have been included: the file compare utility FC.EXE and the archive utility PKXARC.COM.

Software Requirements:

(1) A FORTRAN 77 compiler. The supported compiler for each system is listed in the 1.1 MCSETUP menu (see below).

(2) On Unix systems, a C compiler is recommended and a Bourne-shell command interpreter is required to execute the installation scripts. If the X-Window graphics are to be used, an ANSI C library must be available.

Hardware Requirements:

	Minimum	Recommended
RAM	2 Mbytes	16 Mbytes
Disk Space	50 Mbytes	100 Mbytes

GETTING STARTED

On VMS systems, add the following line in your LOGIN.COM file to enable argument passing on the MCNP execution line:

MCNP :== $MCNP_DISK:[MCNP_PATH]MCNP.EXE

where MCNP_DISK and MCNP_PATH are the disk and directory path to be used for the MCNP installation. To update this change, log back in or type @LOGIN.

On all systems, initiate the installation controller with the following commands:

COMMANDS	COMMENT
chmod a+x install ./install SYS	UNIX systems - SYS keyword given in the table above.
COPY INSTALL.VMS INSTALL.COM @INSTALL	VMS systems
COPY INSTALL.DOS INSTALL.BAT INSTALL	DOS systems

The MCSETUP utility is initiated first. Simply alter the main menu according to the MCNP options you desire. Note the following:

(1) Section 1.1 of the main menu SHOULD BE ALTERED FIRST. This sets the appropriate computer system which in turn selects suitable defaults for the remaining options.

(2) Default responses are included within barckets, []. (i.e., a <CR> will produce the default response) and additional options are included within parentheses.

(3) If the dynamic memory option is turned "off", an appropriate value for the MDAS parameter should be set (default is mdas=4000000). In general MDAS should be greater than 100000 and less than (R-2)/4 * 1000000. where R is your available RAM in Mbytes.

(4) More information on the setup options is available in the MCNP manual. If you are unsure as to graphics libraries available on your system or their location, contact your system administrator. Default library names and directory paths are supplied by the MCSETUP utility; however these may not be applicable to your system. A FATAL error message is displayed if needed libraries could not be located. Included in

this message is the expected library name and path.

When done altering the main menu, use the PROCESS command to continue the installation. The MCSETUP utility creates three system dependent files: the PRPR C patch file (PATCHC, for UNIX systems only), the PRPR FORTRAN patch file (PATCHF), and the MAKEMCNP script. MCSETUP also creates an ANSWER file which contains the MCSETUP input for future installations. This file reflects all options chosen during the initial installation and can be used in future installations by

COMMAND(S)	COMMENT
./install SYS < answer	UNIX systems
ASSIGN ANSWER.DAT SYSSCOMMAND @INSTALL	VMS systems
INSTALL ANSWER	DOS systems

Next, the installation controller initiates the MAKEMCNP script which creates the MCNP executable. System differences can result in compilation errors (e.g., unsatisfied externals). If this occurs, contact MCNP@LANL.GOV regarding a fix. In most cases a two line fix can be added to your INSTALL.FIX file to rectify the situation (the INSTALL.FIX file included with the distribution contains examples of such fixes).

The last section of the installation controller performs MCNP verification by running the 25 MCNP test problems. If this step is to be omitted, rename the RUNPROB file with some other name (e.g., RUNPROB.ORG).

On most dedicated systems, compilation time is roughly 15-30 minutes and verification an additional 20-40 minutes.

UPON COMPLETION

A successful compilation generates an MCNP executable, called mcnp on UNIX systems and MCNP.EXE on VMS and DOS sytems. The MCNP FORTRAN source will be placed in the flib directory on UNIX systems or called MCNP.FOR on VMS and DOS systems. Likewise for the object code. A normal completion results in the following message:

Installation complete - see Readme file.

A log of the installation process is written to the INSTALL.LOG file. An abnormal completion results in one of the following messages:

SETUP ERROR OR USER ABORT.
COMPILATION ERROR - see INSTALL.LOG file.
VERIFICATION ERROR - see INSTALL.LOG file.

The cause of the error can be found in the INSTALL.LOG file.

Upon completion of MCNP verification, 25 difm?? files will exist containing the MCNP tally differences between your runs and the standard. Similarly, the 25 difo?? files will contain the MCNP output file differences between your runs and the standard. Exact tracking is required for MCNP verification, thus significant differences (i.e. other than round-off in the last digit) may prove to be serious (e.g. compiler bugs, etc.). In such cases the INSTALL.LOG file should be reviewed to ensure that the 25 test problems ran successfully.

KNOWN PROBLEMS

---

(1) On Sun Solaris systems. a compiler bug results in a loss of output. A fix is contained in the INSTALL.FIX file. Simply un-comment this fix (lines 29-31) before installing MCNP (be careful what column each line begins on after removing the comments - the *d command should be in column 1 and "return" starts in column 7).

(2) Many UNIX systems have been found to be missing an ANSI C compiler/library and result in an unsatisfied external for DIFFTIME, used in the X-window MCNP C functions. Once such a library has been located, it can be included via the INSTALL.FIX file (see lines 47-48 for an example).

(3) Inquiries related to other installation problems can be sent to MCNP@LANL.GOV.

README.UNIX

RSIC CODE PACKAGE CCC-200/MCNP4A
Instructions for UNIX systems.

February 1994 Bernadette L. Kirk
RSIC
615-574-6176
615-574-6182 FAX
blk@ornl.gov

****
These notes are not absolute and are not meant to replace the MCNP manual. Please familiarize yourself with the manual to avoid delays. VAX/VMS users can follow the steps below, using VAX commands (not all commands will apply).
****

Hardware requirements: 150 megabytes hard disk
8 megabytes or more of memory
Software requirements: UNIX operating system or VAX/VMS
FORTRAN 77 compiler
ANSI C compiler for UNIX systems

1. Create an MCNP subdirectory.
```
mkdir mcnp4a
cd mcnp4a
uncompress ccc200allcp02.tar.Z
tar -xvf ccc200allcp02.tar
```

2. Change the access mode of the script file 'runprob'.
```
chmod a+x runprob
```

3. Now install MCNP4A. You need to follow the instructions in the README file at this point. If you want to run the sample problems separately from the installation, rename 'runprob' before you run the install script. Then consider the 'Note on MAKXSF' below.
```
chmod a+x install
./install SYS
```

where SYS is described in the README file.

Note on MAKXSF:

To cut down on running time, it is better to convert the cross section library 'testlib1' into binary form.

Program 'makxsf' requires the 'specs' file and 'xsdir1' file and the cross section data 'testlib1'.

```
cp  xsdir xsdir1
mv xsdir xsdir.old
makxsf
```

c. The output from makxsf consists of the files: xsdir2, testliba, testlibb, testlibc (the latter are binary files). Copy the new cross section directory xsdir2 to xsdir (note the old one is saved as xsdir.old).

```
cp xsdir2 xsdir
chmod a+x runprob
runprob
```

On an IBM RISC 6000, Model 550, the problems took about 45 minutes and double that if TESTLIB1 is used with no conversion.

INSTALLATION OF MCNP4A AND DLC105C ON PC

BACKGROUND

MCNP4A distributed by RSIC is intended for use without restrictions. This version contains the ENDF/B-IV cross section data. Distribution of the ENDF/B-V data to foreign users is prohibited. All the ENDF/B-V data are provided in a separate package called DLC105C. It is necessary to attach DLC105C to MCNP4A in order to use the ENDF/B-V data.

DESCRIPTION OF MCNP4A PACKAGE

MCNP4A is version 4A of the MCNP code system created on 10/01/93. The README.RSI file in MCNP4A was written in February 1994, and revised on April 21, 1994. The MCNP4A package includes a total of 29 3.5" floppy disks as described below:

Disk 1: MCNP, PRPR and MAKXSF source files, INSTALL and RUNPROB batch files, README files, and miscellaneous files for FORTRAN source code setup, cross section file directory, and output files for MCNP verification

Disk 2: Executable files to extract MCNP.EXE, PRPR.EXE and MAKXSF.EXE

Disk 3: Executable file LIB1 to extract the test cross section library

Disk 4: Executable file LIB2 to extract the test cross section library

Disk 5: Executable file LIB3 to extract the test cross section library

Disk 6: Executable file LIB4 to extract the test cross section library

Disk 7: Executable file LIB5 to extract the test cross section library

Disk 8: Executable file LIB6 to extract the test cross section library

Disk 9: Executable file OUTPDOS.EXE to extract DOS output files for verification problems

Disk 10: Output files for other computer systems (SUN and DEC)

Disk 11: Output files for other computer systems (HP and Silicon Graphics workstations)

Disk 12: Output files for other computer systems (CRAY and VAX)

Disk 13: SPECS, XSDIR1, XSLIST, and ENDL85A.EXE files. SPECS and XSDIR1 are required to convert the cross section data from Type 1 (ASCII) to Type 2 (binary) by MAKXSF. XSLIST is a text file listing the cross section data files available by element. ENDL85A.EXE extracts the ENDL85A cross section data file.

Disk 14: ENDL85B.EXE to extract ENDL85B file (Type 1 data)

Disk 15: ENDL85C.EXE

Disk 16: ENDL85D.EXE

Disk 17: ENDL85E.EXE

Disk 18: ENDL85F.EXE

Disk 19: BMCCSA.EXE to extract BMCCSA file (Type 1 data)

Disk 20: BMCCSB.EXE

Disk 21: BMCCSC.EXE

Disk 22: TMCCSA.EXE to extract TMCCSA file (Type 1 data)

Disk 23: TMCCSB.EXE

Disk 24: TMCCSC.EXE

Disk 25: TMCCSD.EXE, and D9A.EXE to extract D9A file (Type 1 data)

Disk 26: D9B.EXE

Disk 27: D9C.EXE

Disk 28: MCPLIB.EXE, LLLDOS.EXE, THERXS.EXE, EL.EXE, and 531DOS.EXE to produce MCPLIB1, LLLDOS1, THERXS1, EL1 and 531DOS1 data files (Type 1)

Disk 29: 532DOS.EXE to produce 532DOS1 data file (Type 1)

DESCRIPTION OF DLC105C PACKAGE

The DLC105C package contains Type 2 (binary) data library associated with ENDF/B-V. The package contains an information file named DLC105C.DOC. which was last updated on September 10. 1992. The data files currently reside on the hard disk drive (C:) under the \MCNP\DLC105C\ subdirectory. including the following:

NEWXS2
NEWXSD2
RMCCS2
RMCCSA2
DRMCCS2
ENDF5P2
ENDF5U2
ENDF5T2
DRE52
MGXSNP2
EPRIXS2
XSDIR.SUN

Note that the digit 2 appears at the end of each data file to indicate Type 2 data. XSDIR.SUN provided in this package is for the SUN workstation. Modifications to XSDIR.SUN are required for the PC version.

FULL INSTALLATION PROCEDURE

The full installation of MCNP4A includes compilation of the source code, and verification of the test problems in the MCNP4A package. The compilation requires Lahey FORTRAN F77L-EM/32 Version 5.10 or higher compiler residing in the \F77L3 directory. The hardware requirements are 150 MB hard disk. 8 or more MB RAM. and PC-386 or higher. The step-by-step installation procedure is given below:

1. Create MCNP4A directory on hard disk (C: assumed), and copy Disk 1 files on drive A.

```
print a:readme.rsi          (print information on diskettes, if wanted)
print a:readme              (print Los Alamos installation instructions, if wanted)
c:                          (working drive)
cd\                         (change to root directory)
md mcnp4a                   (make MCNP4A directory)
cd mcnp4a                   (change directory to MCNP4A)
a:id                        (extract MCNP, PRPR and MAKXSF source codes)
copy a:*.bat                (copy all batch files from a:)
copy a:\mctl\mctldos.exe    (compressed MCNP tally output files)
```

```
copy a:inpdos.exe             (compressed input files for 25 test problems)
copy a:xsdir                  (copy cross section directory file used for test problems)
copy a:specs                  (file needed by MAKXSF for test library)
copy a:install.dos install.bat (command file to install MCNP4A)
copy a:install.fix            (installation fix file useful for future)
copy a:mcsetup.for            (FORTRAN 77 setup source needed for installation)
```

2. Copy the cross section library for the test problems to file TESTLIB1. Insert Disks 3-8.

```
a:lib1                        (extract file LIB1)
a:lib2                        (extract file LIB2)
a:lib3                        (extract file LIB3)
a:lib4                        (extract file LIB4)
a:lib5                        (extract file LIB5)
a:lib6                        (extract file LIB6)
copy lib1+lib2+lib3+lib4+lib5+lib6 testlib1     (merge files to testlib1)
```

TESTLIB1 is a Type 1 data library. During the installation process, INSTALL.BAT will convert it to a Type 2 library named TESTLIB2. The use of Type 2 data generally cuts the MCNP running time by half, as compared to Type 1 data.

3. Insert Disk 9 in drive A to copy DOS output files.

```
copy a:outpdos.exe            (compressed DOS output files for test problems)
```

4. Install and verify MCNP4A.

```
copy \f77l3\bin\run386.exe    (copy the Lahey compiler to the MCNP4A directory)
\f77l3\bin\fig3               (check F77L3 settings)
install                       (compile, and install MCNP4A. Run 25 test problems.)
```

Before installation of MCNP4A, it is necessary to run \F77L3\BIN\FIG3 to check the Lahey F77L3 settings to be consistent with the options used at RSIC to compile the FORTRAN sources. The RSIC options are listed below for reference:

OPTION	DESCRIPTION	OPTION	DESCRIPTION
/n0	- Standard FORTRAN 77 IMPLICIT	/L	- Line-number traceback table
/n2	- Generate 387 constants and code	/P	- Protect constant arguments
/n4	- No 80486 optimizations	/Q1	- Limit NDP stack entries
/n7	- Optimize inter-statement	/nQ2	- No protected-mode RPC
/nA2	- No allocatable array checking	/nQ3	- No real-mode RPC

/nB - No Bounds checking	/ R - Remember local variables
/nC - Ignore nonstandard usage	/nS - No SOLD file created
/nC1 - INTEGER constants 4 bytes	/nT - INTEGER*4, LOGICAL*4 default
/ D - DIRECT files without headers	/nV - Not VAX interpretation
/nH - No Hardcopy source listing	/ W - Display Warning messages
/nI - No Interface checking	/nX - No Xref listing
/nK - Generate 80x87 code	/ Z1 - Production optimiZations

The INSTALL program consists of three parts executed in sequence: setup, compilation, and verification. During the setup stage, the computer system setting must be PC DOS (No. 7 designated by MCNP4A). Additional settings that may be changed include:

Parameter MDAS (size for dynamically allocated storage): Default setting=4000000

Parameter DATAPATH: Default=c:\mcnp\xs. Recommended=c:\mcnp4a

Upon completion of setup and compilation, the INSTALL program continues to perform verification of MCNP4A by executing 25 test problems. Up to this point, the code is good for the test problems only. Additional steps as described below are required to complete the installation in order to run actual problems.

5. Insert Disk 13.

copy a:specs	(copy file SPECS for use by MAKXSF)
copy a:xsdir1	(copy file XSDIR1 for use by MAKXSF)
copy a:xslist	(copy file XSLIST)
a:endl85a	(extract file ENDL85A)

6. Insert Disk 14.

a:endl85b	(extract file ENDL85B)

7. Insert Disk 15.

a:endl85c	(extract file ENDL85C)

8. Insert Disk 16.

a:endl85d	(extract file ENDL85D)

9. Insert Disk 17.

a:endl85e (extract file ENDL85E)

10. Insert Disk 18.

a:endl85f (extract file ENDL85F)

11. Insert Disk 19.

a:bmccsa (extract file BMCCSA)

12. Insert Disk 20.

a:bmccsb (extract file BMCCSB)

13. Insert Disk 21.

a:bmccsc (extract file BMCCSC)

14. Insert Disk 22.

a:tmccsa (extract file TMCCSA)

15. Insert Disk 23.

a:tmccsb (extract file TMCCSB)

16. Insert Disk 24.

a:tmccsc (extract file TMCCSC)

17. Insert Disk 25.

a:tmccsd (extract file TMCCSD)
a:d9a (extract file D9A)

18. Insert Disk 26.

a:d9b (extract file D9B)

19. Insert Disk 27.

a:d9c (extract file D9C)

20. Insert Disk 28.

```
a:mcplib        (produce MCPLIB1)
a:llldos        (produce LLLDOS1)
a:therxs        (produce THERXS1)
a:el            (produce EL1)
a:531dos        (produce 531DOS1)
```

21. Insert Disk 29.

```
a:532dos        (produce 532DOS1)
```

22. Convert cross section data from Type 1 to Type 2.

```
copy endl85a+endl85b+endl85c+endl85d+endl85e+endl85f  endl851
copy bmccsa+bmccsb+bmccsc  bmccs1
copy tmccsa+tmccsb+tmccsc+tmccsd  tmccs1
copy d9a+d9b+d9c  d91
makxsf                  (convert from Type 1 to Type 2 data)
copy xsdir2  xsdir      (create xsdir for use in running MCNP4A)
```

MAKXSF uses files SPECS and XSDIR1 copied from Disk 13, and creates MCPLIB2, EL2, ENDL852, BMCCS2, TMCCS2, LLLDOS2, 531DOS2, 532DOS2, THERXS2, D92, XSDIR2, and TPRINT. Read file TPRINT to check if MAKXSF is successfully run. If not, remove all the files created by MAKXSF before re-running. After conversion, all Type 1 data files may be deleted.

The above procedures complete installation of MCNP4A for use with the ENDF/B-IV cross section data. The following additional procedures will attach the DLC105C data package to MCNP4A to include the ENDF/B-V data.

23. Modify XSDIR.SUN in the \MCNP\DLC105C\ subdirectory.

```
cd c:\mcnp\dlc105c      (change directory to \MCNP\DLC105C)
copy xsdir.sun  xsdir   (create XSDIR for editing)
edit xsdir              (modify XSDIR)
```

Edit file XSDIR to remove all c:\mcnp\dlc105c\ and c:\mcnp\xslibe\ subdirectory names.

24. Copy all files in \MCNP\DLC105C to the MCNP4A directory.

```
cd\
cd mcnp4a                    (change directory to MCNP4A)
ren xsdir xsdir.4a           (rename XSDIR created above to XSDIR.4A)
copy c:\mcnp\dlc105c\*.*     (copy all files in \MCNP\DLC105C subdirectory)
del xsdir.sun                (delete XSDIR.SUN which is not needed)
```

The full installation is now complete. MCNP4A can be used to run shielding and criticality problems using the ENDF/B-IV and/or ENDF/B-V cross section data.

INSTALLATION WITHOUT COMPILATION AND VERIFICATION

The MCNP4A package includes file MCNP.EXE, which is ready for running actual problems. It should be noted that this executable file was produced using MDAS=1000000. This setting is satisfactory for most of photon problems, but may be inadequate for large neutron and photon coupled problems.

The following procedures install MCNP4A without recompiling the source code or running the test problems for verification:

1. Insert Disk 1.

```
c:                  (working drive)
cd\                 (change to root directory)
cd mcnp4a           (change to MCNP4A directory)
copy a:\f77l3.eer   (required for using the executable MCNP, PRPR & MAKXSF)
```

2. Insert Disk 2.

```
a:mcnpdos           (extract MCNP.EXE)
a:prprdos           (extract PRPR.EXE)
a:makxsdos          (extract MAKXSF.EXE)
```

3. Perform Steps 5 through 24 in the full installation procedure.

MCNP4A EXECUTION

Use the following command to execute MCNP4A:

```
cd mcnp4a
mcnp inp=(input file name in the MCNP4A directory)
```

The code automatically produces an output file named OUTP, which can be renamed for easy identification. In addition, a run dump file named RUNTPE is created. OUTP and RUNTPE can be deleted when no longer needed.

To check the input setup and plot the 2-D geometry of the model for viewing on screen, the ip options shall be used as follows:

mcnp inp=(input file) ip

REFERENCES

1. RSIC Computer Code Collection, "MCNP 4A - Monte Carlo N-Particle Transport Code System," CCC-200, Oak Ridge National Laboratory, January 1995.

2. RSIC Data Library Collection, "MCNP Standard Neutron Cross Section Data Library Based in Part on ENDF/B-V," DLC105C/PC, Oak Ridge National Laboratory, December 1992.

Attachment III: MCNP4A Directory And File Listing

The following files are required for execution of the MCNP4A code system. These have been placed under the control of the appropriate systems administrator to provide write protection for these files.

MCNP4A - MCNP executable version 4A for the HP 9000 series, 1323008 bytes, 09/22/94.

MCNP - MCNP executable version 4A for the GATEWAY P5-90 PC, 1,582,026 bytes. 04/15/96

MAKXSF - executable to convert cross section file from ASCII to binary format for the HP 9000 series, 135168 bytes, 09/21/94. For the GATEWAY P5-90 PC: 326,054 bytes. 04/15/96.

PRPR - executable for source to create machine dependent FORTRAN source code for MCNP4A and MAKXSF for the HP 9000/700 series, 40960 bytes, 09/21/94.

HP 9000 DIRECTORY LISTING

This attachment contains a listing of the MCNP4A executable and library files contained in subdirectory /opt/neut/mcnp on the QUICHE HP 9000 workstation. These files were created during the installation process. Upon approval of this SQR all files other than those controlled by the systems administrator and selected test case input files will be removed after they have been electronically archived. This is done to conserve storage on the workstation.

```
quiche:/opt/neut/mcnp
total 2636
-rw-r--r--    1 root   sys    8899      Mar  7 16:00 README
-rw-r--r--    1 root   sys    2430      Mar  7 16:00 README.UNIX
drwxr-xr-x    3 root   sys    2048      Apr 14 09:06 lib
-rwxr-xr-x    1 root   sys    1323008   Mar  7 16:03 mcnp

quiche:/opt/neut/mcnp/lib
total 239426
-rw-r--r--    1 root   sys    305152    Mar  7 16:00 531DOS2
-rw-r--r--    1 root   sys    874496    Mar  7 16:00 532DOS2
-rwxr-xr-x    1 root   sys    3483      Mar  7 16:00 532dos
-rwxr-xr-x    1 root   sys    4014080   Mar  7 16:01 BMCCS2
-rwxr-xr-x    1 root   sys    2514944   Mar  7 16:01 D92
-rw-r--r--    1 root   sys    2705408   Mar  7 16:01 DRE52
-rw-r--r--    1 root   sys    5117952   Mar  7 16:01 DRMCCS2
-rw-r--r--    1 root   sys    770048    Mar  7 16:01 EL2
-rw-r--r--    1 root   sys    3665920   Mar  7 16:01 ENDF5T2
-rw-r--r--    1 root   sys    5937152   Mar  7 16:01 ENDF5U2
-rwxr-xr-x    1 root   sys    6000640   Mar  7 16:01 ENDL852
-rw-r--r--    1 root   sys    1687552   Mar  7 16:01 LLLDOS2
-rw-r--r--    1 root   sys    440320    Mar  7 16:01 MCPLIB2
-rw-r--r--    1 root   sys    1628160   Mar  7 16:01 MGXSNP2
-rw-r--r--    1 root   sys    47752     Mar  7 16:01 NEW1D
-rw-r--r--    1 root   sys    1812480   Mar  7 16:01 NEWXS2
-rw-r--r--    1 root   sys    716800    Mar  7 16:01 NEWXSD2
-rw-r--r--    1 root   sys    15975     Mar  7 16:03 README.ENDFBVI
```

-rw-r--r--	1 root	sys	8265728	Mar 7 16:01	RMCCS2
-rw-r--r--	1 root	sys	3532800	Mar 7 16:01	RMCCSA2
-rw-r--r--	1 root	sys	90112	Mar 7 16:01	THERXS2
-rw-r--r--	1 root	sys	2416640	Mar 7 16:01	TMCCS2
-rw-r--r--	1 root	sys	1362797	Mar 7 16:01	W184XS
-rw-r--r--	1 root	sys	5947392	Mar 7 16:02	endf5p2
-rw-r--r--	1 root	sys	36685824	Mar 7 16:04	endfbvi2
-rw-r--r--	1 root	sys	2320384	Mar 7 16:02	eprixs2
drwxr-xr-x	2 root	sys	1024	Apr 14 07:50	evold
-rw-r--r--	1 root	sys	1259520	Mar 7 16:02	kidman2
-rw-r--r--	1 root	sys	577536	Mar 7 16:03	mcplib22
-r--r--r--	1 root	sys	21346524	Apr 3 12:42	testlib1
-rw-r--r--	1 root	sys	168682	Mar 7 16:03	xsdir
-r--r--r--	1 root	sys	19856	Apr 3 12:42	xsdirtst

quiche:opt/neut/mcnp/lib/evold
total 122192

-r--r--r--	1 root	sys	305152	Apr 13 17:26	531DOS2
-r--r--r--	1 root	sys	874496	Apr 13 17:31	532DOS2
-r-xr-xr-x	1 root	sys	4014080	Apr 13 17:31	BMCCS2
-r-xr-xr-x	1 root	sys	2514944	Apr 13 17:31	D92
-r--r--r--	1 root	sys	2705408	Apr 13 17:27	DRE52
-r--r--r--	1 root	sys	5117952	Apr 13 17:28	DRMCCS2
-r--r--r--	1 root	sys	770048	Apr 13 17:25	EL2
-r--r--r--	1 root	sys	5947392	Apr 13 20:27	ENDF5P2
-r--r--r--	1 root	sys	3665920	Apr 13 17:28	ENDF5T2
-r--r--r--	1 root	sys	5937152	Apr 13 17:28	ENDF5U2
-r-xr-xr-x	1 root	sys	6000640	Apr 13 17:30	ENDL852
-r--r--r--	1 root	sys	1687552	Apr 13 17:27	LLLDOS2
-r--r--r--	1 root	sys	440320	Apr 13 17:25	MCPLIB2
-r--r--r--	1 root	sys	1628160	Apr 13 17:26	MGXSNP2
-r--r--r--	1 root	sys	1812480	Apr 13 17:26	NEWXS2
-r--r--r--	1 root	sys	716800	Apr 13 17:29	NEWXSD2
-r--r--r--	1 root	sys	8265728	Apr 13 17:29	RMCCS2
-r--r--r--	1 root	sys	3532800	Apr 13 17:29	RMCCSA2
-r--r--r--	1 root	sys	90112	Apr 13 17:32	THERXS2
-r--r--r--	1 root	sys	2416640	Apr 13 17:26	TMCCS2
-r--r--r--	1 root	sys	2320384	Apr 13 17:33	eprixs2
-r--r--r--	1 root	sys	1259520	Apr 13 17:32	kidman2
-rw-r--r--	1 root	sys	139883	Apr 14 07:49	xsdir.eV
-rw-r--r--	1 root	sys	139883	Apr 13 17:23	xsdir.endfbv

GATEWAY2000 P5-90 DIRECTORY LISTING

A listing of the MCNP4A files contained in the \mcnp4a directory on the GATEWAY2000 P5-90 PC is provided below. Only the files required to execute MCNP4A are listed. The listing includes the file size, date and time for each file created. Upon approval of this SQR, a copy of these files along with the source code will be made available to the SCCB Secretary for locking up in the SCM controlled safe. All the files not required for executing the code will be removed from the \mcnp4a directory.

531DOS2	305,152	04-15-96	10.07A
532DOS2	874,496	04-15-96	10:07A
BMCCS2	3,500,032	04-15-96	10.07A
D92	2,514,944	04-15-96	10:06A
DRES2	2,705,408	08-12-92	07:13P
DRMCCS2	5,117,952	08-12-92	09.27P
EL2	770,048	04-15-96	10:03A
ENDF5P2	5,947,392	08-12-92	04:49P
ENDF5T2	3,665,420	08-12-92	07:32P
ENDF5U2	5,937,152	08-12-92	06:01P
ENDL852	5,859,328	04-15-96	10:05A
EPRIXS2	2,320,384	08-12-92	05:33P
LLLDOS2	1,687,552	04-15-96	10:08A
MAKXSF.EXE	326,054	04-15-96	08:38A
MCNP.EXE	1,582,026	04-15-96	08:44A
MCPLIB2	440,320	04-15-96	10:03A
MGXSNP2	1,628,160	08-12-92	04:09P
NEWXS2	1,812,480	08-12-92	04:01P
NEWXSD2	716,800	08-12-92	03:45P
PRPR.EXE	286,306	04-15-96	08:37A
RMCCS2	8,265,728	08-12-92	05:15P
RMCCSA2	3,532,800	08-13-92	07:49P
RUN386.EXE	189,412	04-02-93	04:29P
THERXS2	90,112	04-15-96	10:05A
TMCCS2	2,416,640	04-15-95	10:04A
W184XS	1,385,864	08-27-92	11:41A
XSDIR	141,508	04-03-96	08.28A
XSLIST	108,511	01-05-94	11:46A

Attachment IV: MCNP4A New Appendix G For Manual

Los Alamos
NATIONAL LABORATORY

Applied Theoretical & Computational Physics Division
Transport Methods, XTM
Mail Stop B225
Los Alamos, New Mexico 87545
(505) 667-4189, FAX (505) 665-5538

Date: April 5, 1996
Symbol: XTM:96-145 (U)

Jennie Manneschmidt
RSIC, MS 6362
ORNL, P.O. Box 2008
Oak Ridge, TN 37831-6362

Dear Jennie,

After more closely reviewing the evaluations upon which the ENDF60 neutron data library (DLC-181:MCNPDAT6) is based, we have concluded that two nuclides need to be removed from distribution: ^{242}Am (ground state) 95242.60c and ^{238}NP 93238.60c. These files appear in the ENDF60 library as am92242 and np93238. The corresponding lines in the XSDIR file for these nuclides should also be removed. For these two nuclides, the data files represent the evaluations, but the evaluations do not include any reaction data above an incident neutron energy of 11keV. We feel that these evaluations are too incomplete to be used effectively in transport calculations.

I have also included an updated errata sheet for the report LA-12891, "ENDF/B-VI Data for MCNP", and the most recent Table 1 for the Appendix G information which includes the ENDF60 data library. These two items should be included in the distribution with the other documentation. I do not believe that it is necessary to include the new Table 1 information with the MCNP4A manual, but you may choose to do so if you wish. Thanks for your help in this matter. Please don't hesitate to contact me if you have any questions.

Sincerely,

Stephanie Frankle
(505)665-6461
frankles@lanl.gov

ERRATA

LA--12887: MCNP™ ENDF/B-VI Validation
Infinite Media Comparisons of ENDF/B-VI and ENDF/B-V

and

LA--12891: ENDF/B-VI Data for MCNP

{ CORRECTIONS ARE INDICATED BY A *}

Table 1. The MCNP ENDF60 Library

Material	ZAID	Filename	Evaluation	Release	Type	Photon
^{1}H	1001.60c	h1001	LANL	6.1[a]	New[b]	Yes[c]
^{2}H	1002.60c	d1002	LANL, AWRE	-	New	-
^{3}H	1003.60c	t1003	LANL	-	-	No
^{3}He	2003:60c	he2003	LANL	6.1	New	No
^{4}He	2004.60c	he2004	LANL	-	-	No
^{6}Li	3006.60c	li3006	LANL	6.1	New	-
^{7}Li	3007.60c	li3007	LANL	-	New	-
^{9}Be	4009.60c	be4009	LLNL	-	New	-
^{10}B	5010.60c	b5010	LANL	6.1	New	-
^{11}B	5011.60c	b5011	LANL	-	New	-
C	6000.60c	c6000	ORNL	6.1	New	-
^{14}N	7014.60c	n7014	LANL	LANL	New	-
^{15}N	7015.60c	n7015	LANL	-	New	-
^{16}O	8016.60c	o8016	LANL	-	New	-
^{17}O	8017.60c	o8017	BNL	-	-	No
^{19}F	9019.60c	f9019	ORNL	-	New	-
^{23}Na	11023.60c	na11023	ORNL	6.1	-	-
Mg	12000.60c	mg12000	ORNL	-	-	-
^{27}Al	13027.60c	al13027	LANL	-	-	-
Si	14000.60c	si14000	ORNL	-	-	-
^{31}P	15031.60c	p15031	LLNL	-	-	-
S	16000.60c	s16000	BNL	-	-	-
^{32}S	16032.60c	s16032	LLNL	-	-	-
Cl	17000.60c	cl17000	GGA	-	-	-
K	19000.60c	k19000	GGA	-	-	-
Ca	20000.60c	ca20000	ORNL	-	New*	-
^{45}Sc	21045.60c	sc21045	BNL	6.2	New*	-
Ti	22000.60c	ti22000	BRC, ANL	-	-	-
V	23000.60c	v23000	ANL, LLNL, +	-	New	-
^{53}Cr	24050.60c	cr24050	ORNL	6.1	New	-

[a] All releases are release 6.0 of ENDF/B-VI unless otherwise noted. LANL indicates modifications were performed.
[b] All types are translations from ENDF/B-V Release 0, unless otherwise noted.
[c] All nuclides have photon production, unless otherwise noted.

Table 1 (cont.) The MCNP ENDF60 Library

Material	ZAID	Filename	Evaluation	Release	Type	Photon
^{52}Cr	24052.60c	cr24052	ORNL	6.1	New	-
^{53}Cr	24053.60c	cr24053	ORNL	6.1	New	-
^{54}Cr	24054.60c	cr24054	ORNL	6.1	New	-
^{55}Mn	25055.60c	mn25055	ORNL	-	New	-
^{54}Fe	26054.60c	fe26054	ORNL	6.1	New	-
^{56}Fe	26056.60c	fe26056	ORNL	6.1	New	-
^{57}Fe	26057.60c	fe26057	ORNL	6.1	New	-
^{58}Fe	26058.60c	fe26058	ORNL	6.1	New	-
^{59}Co	27059.60c	co27059	ANL	6.2	New	-
^{58}Ni	28058.60c	ni28058	ORNL	6.1	New	-
^{60}Ni	28060.60c	ni28060	ORNL	6.1	New	-
^{61}Ni	28061.60c	ni28061	ORNL	6.1	New	-
^{62}Ni	28062.60c	ni28062	ORNL	6.1	New	-
^{64}Ni	28064.60c	ni28062	ORNL	6.1	New	-
^{63}Cu	29063.60c	cu29063	ORNL	6.2	New	-
^{65}Cu	29065.60c	cu29065	ORNL	6.2	New	-
Ga	31000.60c	ga31000	LLNL, LANL	-	-	-
^{89}Y	39089.60c	y39089	ANL, LLNL	-	New*	-
Zr	40000.60c	zr40000	SAI, BNL	6.1	-	No
^{93}Nb	41093.60c	nb41093	ANL, LLNL	6.1	New	-
Mo	42000.60c	mo42000	LLNL, HEDL	-	-	-
^{99}Tc	43099.60c	tc43099	HEDL, BAW	-	-	No
^{107}Ag	47107.60c	ag47107	BNL, HEDL	-	New*	No
^{109}Ag	47109.60c	ag47109	BNL, HEDL	-	New*	No
In	49000.60c	in49000	ANL	-	New	-
^{127}I	53127.60c	i53127	HEDL, RCN	LANL	New*	-
^{129}I	53129.60c	i53129	HEDL, RCN	-	-	No
^{133}Cs	55133.60c	cs55133	HEDL, BNL, +	-	-	No
^{134}Cs	55134.60c	cs55134	ORNL, HEDL	-	New	No
^{135}Cs	55135.60c	cs55135	HEDL	-	-	No
^{136}Cs	55136.60c	cs55136	HEDL	-	-	No
^{137}Cs	55137.60c	cs55137	HEDL	-	-	No

a All releases are release 6.0 of ENDF/B-VI unless otherwise noted. LANL indicates modifications were performed.
b All types are translations from ENDF/B-V Release 0, unless otherwise noted.
c All nuclides have photon production, unless otherwise noted.

Table 1 (cont.) The MCNP ENDF60 Library

Material	ZAID	Filename	Evaluation	Release	Type	Photon
^{138}Ba	56138.60c	ba56138	ORNL, HEDL	-	-	-
^{151}Eu	63151.60c	eu63151	LANL	-	New	-
^{153}Eu	63153.60c	eu63153	LANL	-	New	-
^{152}Gd	64152.60c	gd64152	BNL	-	-	No
^{154}Gd	64154.60c	gd64154	BNL	-	-	No
^{155}Gd	64155.60c	gd64155	BNL	-	-	No
^{156}Gd	64156.60c	gd64156	BNL	-	-	No
^{157}Gd	64157.60c	gd64157	BNL	-	-	No
^{158}Gd	64158.60c	gd64158	BNL	-	-	No
^{160}Gd	64160.60c	gd64160	BNL	-	-	No
^{165}Ho	67165.60c	ho67165	LANL	-	New	-
Hf	72000.60c	hf72000	SAI	-	-	No
^{181}Ta	73181.60c	ta73181	LLNL	-	-	-
^{182}Ta	73182.60c	ta73182	AI	-	-	No
^{182}W	74182.60c	w74182	LANL, ANL, +	-	New*	-
^{183}W	74183.60c	w74183	LANL, ANL, +	-	New*	-
^{184}W	74184.60c	w74184	LANL, ANL, +	-	New*	-
^{186}W	74186.60c	w74186	LANL, ANL, +	-	New*	-
^{185}Re	75185.60c	re75185	ORNL, LANL	-	New	No
^{187}Re	75187.60c	re75187	ORNL, LANL	-	New	No
^{197}Au	79197.60c	au79197	LANL	6.1	New	-
^{206}Pb	82206.60c	pb82206	ORNL	-	New	-
^{207}Pb	82207.60c	pb82207	ORNL	6.1	New	-
^{208}Pb	82208.60c	pb82208	ORNL	-	New	-
^{209}Bi	83209.60c	bi83209	ANL	-	New	-
^{230}Th	90230.60c	th90230	HEDL	-	-	No
^{232}Th	90232.60c	th90232	BNL, ANL, +	-	-	-
^{231}Pa	91231.60c	pa91231	HEDL	-	-	No
^{232}U	92232.60c	u92232	HEDL	-	-	No
^{233}U	92233.60c	u92233	LANL, ORNL	-	-	-
^{234}U	92234.60c	u92234	BNL, GGA	-	-	No

- a All releases are release 6.0 of ENDF/B-VI unless otherwise noted. LANL indicates modifications were performed.
- b All types are translations from ENDF/B-V Release 0, unless otherwise noted.
- c All nuclides have photon production, unless otherwise noted.

Table 1 (cont.) The MCNP ENDF60 Library

Material	ZAID	Filename	Evaluation	Release	Type	Photon
^{235}U	92235.60c	u92235	ORNL, LANL	6.2*	New	-
^{236}U	92236.60c	u92236	HEDL	-	New	No
^{238}U	92238.60c	u92238	ORNL, LANL, ÷	6.2	New	-
^{237}Np	93237.60c	np93237	LANL	6.1	New	-
$^{238}Np^{d}$	93238.60c	np93238	SRL	6.2*	New	No
^{239}Np	93239.60c	np93239	ORNL	-	New	No
^{236}Pu	94236.60c	pu94236	HEDL, SRL	-	-*	No
^{237}Pu	94237.60c	pu94237	HEDL	-	-*	No
^{238}Pu	94238.60c	pu94238	HEDL, AI, ÷	-	-	No
^{239}Pu	94239.60c	pu94239	LANL	6.2	New	-
^{240}Pu	94240.60c	pu94240	ORNL	6.2*	New	-
^{241}Pu	94241.60c	pu94241	ORNL	6.1	New	-
^{242}Pu	94242.60c	pu94242	HEDL, SRL, ÷	-	-	-
^{243}Pu	94243.60c	pu94243	BNL, SRL, ÷	6.2*	-	-
^{244}Pu	94244.60c	pu94244	HEDL, SRL	-	-	No
^{241}Am	95241.60c	am95241	CNDC	LANL	New	-
$^{242}Am^{d}$	95242.60c	am95242	SRL	6.1	-	No
^{243}Am	95243.60c	am95243	ORNL, HEDL, ÷	-	New	-
^{241}Cm	96241.60c	cm96241	HEDL	-	-	No
^{242}Cm	96242.60c	cm96242	HEDL, SRL, –	-	-	-
^{243}Cm	96243.60c	cm96243	HEDL, SRL, –	-	-	-
^{244}Cm	96244.60c	cm96244	HEDL, SRL, ÷	-	-	-
^{245}Cm	96245.60c	cm96245	SRL, LLNL	6.2	-	-
^{246}Cm	96246.60c	cm96246	BNL, SRL, ÷	6.2	-	-
^{247}Cm	96247.60c	cm96247	BNL, SRL, –	6.2	-	-
^{248}Cm	96248.60c	cm96248	HEDL, SRL, ÷	-	-	-
^{249}Bk	97249.60c	bk97249	CNDC	-	New	No
^{249}Cf	98249.60c	cf98249	CNDC	LANL	New	No
^{250}Cf	98250.60c	cf98250	BNL, SRL, –	6.2	-	-
^{251}Cf	98251.60c	cf98251	BNL, SRL, ÷	6.2	-	-
^{252}Cf	98252.60c	cf98252	BNL, SRL, ÷	6.2*	-	-

* All releases are release 6.0 of ENDF/B-VI unless otherwise noted. LANL indicates modifications were performed.

† All types are translations from ENDF/B-V Release 0, unless otherwise noted.

‡ All nuclides have photon production, unless otherwise noted.

d These data files are not recommended for use due to the evaluations being incomplete, and are currently being removed from distribution. Additionally, 95242.60c represents the ground state of ^{242}Am, not the metastable state.

Table 1
Continuous-Energy and Discrete Neutron Data Libraries maintained by XTM

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 1 ************ Hydrogen**										
** H-1 **										
1001.35c	0.9992	endl85	LLNL	pre-1985	0	3,506	330	20	yes	no
1001.42c	0.9992	endl92	LLNL	pre-1992	300	1,968	121	30	yes	no
1001.50c	0.9992	rmccs	ENDF/B-V.0	1977	294	2,766	244	20	yes	no
1001.50d	0.9992	drmccs	ENDF/B-V.0	1977	294	3,175	263	20	yes	no
1001.53c	0.9992	eprixs	ENDF/B-V.0	1977	587	4,001	394	20	yes	no
1001.60c	0.9992	endl60	ENDF/B-VI.1	1989	294	3,484	357	100	yes	no
** H-2 **										
1002.35c	1.9968	endl85	LLNL	pre-1985	0	2,507	135	20	yes	no
1002.50c	1.9968	endl5p	ENDF/B-V.0	1967	294	3,987	214	20	yes	no
1002.50d	1.9968	dre5	ENDF/B-V.0	1967	294	4,686	263	20	yes	no
1002.55c	1.9968	rmccs	LANL/T-2	1982	294	5,981	285	20	yes	no
1002.55d	1.9968	drmccs	LANL/T-2	1982	294	5,343	263	20	yes	no
1002.60c	1.9968	endl60	ENDF/B-VI.0	1967 [1]	294	2,704	178	20	yes	no
** H-3 **										
1003.35c	2.9901	endl85	LLNL	pre-1985	0	1,269	76	20	no	no
1003.42c	2.9901	endl92	LLNL	pre-1992	300	2,308	52	30	no	no
1003.50c	2.9901	rmccs	ENDF/B-V.0	1965	294	2,428	184	20	no	no
1003.50d	2.9901	drmccs	ENDF/B-V.0	1965	294	2,807	263	20	no	no
1003.60c	2.9901	endl60	ENDF/B-VI.0	1965	294	3,338	180	20	no	no
Z = 2 ************ Helium**										
** He-3 **										
2003.35c	2.9901	endl85	LLNL	pre-1985	0	2,481	182	20	yes	no
2003.42c	2.9901	endl92	LLNL	pre-1992	300	1,477	151	30	yes	no
2003.50c	2.9901	rmccs	ENDF/B-V.0	1971	294	2,320	229	20	no	no
2003.50d	2.9901	drmccs	ENDF/B-V.0	1971	294	2,612	263	20	no	no
2003.60c	2.9890	endl60	ENDF/B-VI.1	1990	294	2,834	342	20	no	no
** He-4 **										
2004.35c	3.9682	endl85	LLNL	pre-1985	0	1,442	78	20	no	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
2004.42c	3.9682	endl92	LLNL	pre-1992	300	1,332	49	30	no	no
2004.50c	4.0015	rmccs	ENDF/B-V.0	1973	294	3,061	345	20	no	no
2004.50d	4.0015	drmccs	ENDF/B-V.0	1973	294	2,651	263	20	no	no
2004.60c	4.0015	endf60	ENDF/B-VI.0	1973	294	2,971	327	20	no	no
Z = 3 ************ Lithium **										
** Li-6 **										
3006.42c	5.9635	endl92	LLNL	pre-1992	300	7,805	294	30	yes	no
3006.50c	5.9634	rmccs	ENDF/B-V.0	1977	294	9,932	373	20	yes	no
3006.50d	5.9634	drmccs	ENDF/B-V.0	1977	294	8,716	263	20	yes	no
3006.60c	5.9634	endf60	ENDF/B-VI.1	1989	294	12,385	498	20	yes	no
** Li-7 **										
3007.42c	6.9557	endl92	LLNL	pre-1992	300	5,834	141	30	yes	no
3007.50c	6.9557	endf5p	ENDF/B-V.0	1972	294	4,864	343	20	yes	no
3007.50d	6.9557	dre5	ENDF/B-V.0	1972	294	4,935	263	20	yes	no
3007.55c	6.9557	rmccs	ENDF/B-V.2	1979	294	13,171	328	20	yes	no
3007.55d	6.9557	drmccs	ENDF/B-V.2	1979	294	12,647	263	20	yes	no
3007.60c	6.9557	endf60	ENDF/B-VI.0	1988	294	14,567	387	20	yes	no
Z = 4 ************ Beryllium **										
** Be-7 **										
4007.35c	6.9567	endl85	LLNL	pre-1985	0	1,834	180	20	no	no
4007.42c	6.9567	endl92	LLNL	pre-1992	300	1,544	127	30	yes	no
** Be-9 **										
4009.21c	8.9348	100xs	LANL/T-2:XTM	1989	300	28,964	316	100	yes	no
4009.50c	8.9348	rmccs	ENDF/B-V.0	1976	294	8,886	329	20	yes	no
4009.50d	8.9348	drmccs	ENDF/B-V.0	1976	294	8,756	263	20	yes	no
4009.60c	8.9348	endf60	ENDF/B-VI.0	1986	294	64,410	276	20	yes	no
Z = 5 ************ Boron **										
** B-10 **										
5010.42c	9.9269	endl92	LLNL	pre-1992	300	4,733	175	30	yes	no
5010.50c	9.9269	rmccs	ENDF/B-V.0	1977	294	20,200	514	20	yes	no
5010.50d	9.9269	drmccs	ENDF/B-V.0	1977	294	12,322	263	20	yes	no
5010.53c	9.9269	eprixs	ENDF/B-V.0	1977	587	23,676	700	20	yes	no
5010.60c	9.9269	endf60	ENDF/B-VI.1	1989	294	27,957	673	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** B-11 **										
5011.35c	10.9147	endl85	LLNL	pre-1985	0	4,289	247	20	yes	no
5011.42c	10.9147	endl92	LLNL	pre-1992	300	4,285	244	30	yes	no
5011.50c	10.9150	endf5p	ENDF/B-V.0	1974	294	4,344	487	20	no	no
5011.50d	10.9150	dre5	ENDF/B-V.0	1974	294	2,812	263	20	no	no
5011.55c	10.9150	rmccsa	ENDF/B-V.0:T-2	1971 [2]	294	12,254	860	20	yes	no
5011.55d	10.9150	drmccs	ENDF/B-V.0:T-2	1971 [2]	294	7,106	263	20	yes	no
5011.56c	10.9147	newxs	LANL/T-2	1986	294	56,929	1,762	20	yes	no
5011.56d	10.9147	newxsd	LANL/T-2	1986	294	17,348	263	20	yes	no
5011.60c	10.9147	endf60	ENDF/B-VI.0	1989	294	108,351	2,969	20	yes	no

Z = 6 ************** Carbon **

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** C-nat **										
6000.50c	11.8969	rmccs	ENDF/B-V.0	1977	294	23,326	875	20	yes	no
6000.50d	11.8969	drmccs	ENDF/B-V.0	1977	294	16,844	263	20	yes	no
6000.60c	11.8980	endf60	ENDF/B-VI.1	1989	294	22,422	978	32	yes	no
** C-12 **										
6012.21c	11.8969	100xs	LANL/T-2:XTM	1989	300	28,809	919	100	yes	no
6012.35c	11.8969	endl85	LLNL	pre-1985	0	5,154	225	20	yes	no
6012.42c	11.8969	endl92	LLNL	pre-1992	300	6,229	191	30	yes	no
6012.50c	11.8969	rmccs [3]	ENDF/B-V.0	1977	294	23,326	875	20	yes	no
6012.50d	11.8969	drmccs [3]	ENDF/B-V.0	1977	294	16,844	263	20	yes	no
** C-13 **										
6013.35c	12.8916	endl85	LLNL	pre-1985	0	4,886	395	20	yes	no
6013.42c	12.8916	endl92	LLNL	pre-1992	300	5,993	429	30	yes	no

Z = 7 ************** Nitrogen **

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** N-14 **										
7014.42c	13.8828	endl92	LLNL	pre-1992	300	20,528	770	30	yes	no
7014.50c	13.8830	rmccs	ENDF/B-V.0	1973	294	45,457	1,196	20	yes	no
7014.50d	13.8830	drmccs	ENDF/B-V.0	1973	294	26,793	263	20	yes	no
7014.60c	13.8828	endf60	LANL/T-2	1992	294	60,397	1,379	20	yes	no
** N-15 **										
7015.42c	14.8713	endl92	LLNL	pre-1992	300	22,590	352	30	yes	no
7015.55c	14.8710	rmccsa	LANL/T-2	1983	294	20,920	744	20	yes	no
7015.55d	14.8710	drmccs	LANL/T-2	1983	294	15,273	263	20	yes	no
7015.60c	14.8710	endf60	ENDF/B-VI.0	1993	294	24,410	653	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date OF Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 8 ************ Oxygen**										
** O-16 **										
8016.21c	15.8575	100xs	LANL/T-2:XTM	1989	300	45,016	1,427	100	yes	no
8016.35c	15.8575	endl85	LLNL	pre-1985	0	10,357	465	20	yes	no
8016.42c	15.8575	endl92	LLNL	pre-1992	300	9,551	337	30	yes	no
8016.50c	15.8580	rmccs	ENDF/B-V.0	1972	294	37,942	1,391	20	yes	no
8016.50d	15.8580	drmccs	ENDF/B-V.0	1972	294	20,455	263	20	yes	no
8016.53c	15.8580	eprixs	ENDF/B-V.0	1972	587	37,989	1,398	20	yes	no
8016.54c	15.8580	eprixs	ENDF/B-V.0	1972	881	38,017	1,402	20	yes	no
8016.60c	15.8532	endf60	ENDF/B-VI.0	1990	294	58,253	1,609	20	yes	no
** O-17 **										
8017.60c	16.8531	endf60	ENDF/B-VI.0	1978	294	4,200	335	20	no	no
Z = 9 ************ Fluorine**										
** F-19 **										
9019.35c	18.8352	endl85	LLNL	pre-1985	0	31,547	1,452	20	yes	no
9019.42c	18.8352	endl92	LLNL	pre-1992	300	37,814	1,118	30	yes	no
9019.50c	18.8350	endf5p	ENDF/B-V.0	1976	294	44,130	1,569	20	yes	no
9019.50d	18.8350	dre5	ENDF/B-V.0	1976	294	23,156	263	20	yes	no
9019.51c	18.8350	rmccs	ENDF/B-V.0	1976	294	41,442	1,541	20	yes	no
9019.51d	18.8350	drmccs	ENDF/B-V.0	1976	294	23,156	263	20	yes	no
9019.60c	18.8350	endf60	ENDF/B-VI.0	1990	300	93,826	1,433	20	yes	no
Z = 10 ************ Neon**										
** Ne-20 **										
10020.42c	19.8207	endl92	LLNL	pre-1992	300	14,286	1,011	30	yes	no
Z = 11 ************ Sodium**										
** Na-23 **										
11023.35c	22.7923	endl85	LLNL	pre-1985	0	22,777	1,559	20	yes	no
11023.42c	22.7923	endl92	LLNL	pre-1992	300	19,309	1,163	30	yes	no
11023.50c	22.7920	endf5p	ENDF/B-V.0	1977	294	52,252	2,703	20	yes	no
11023.50d	22.7920	dre5	ENDF/B-V.0	1977	294	41,665	263	20	yes	no
11023.51c	22.7920	rmccs	ENDF/B-V.0	1977	294	48,863	2,228	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
11023.51d	22.7920	drmccs	ENDF/B-V.0	1977	294	41,665	263	20	yes	no
11023.60c	22.7920	endl60	ENDF/B-VI.1	1977	294	50,294	2,543	20	yes	no
Z = 12 ************ Magnesium **************************************										
** Mg-nat **										
12000.35c	24.0962	endl85	LLNL	pre-1985	0	9,686	675	20	yes	no
12000.42c	24.0962	endl92	LLNL	pre-1992	300	9,288	468	30	yes	no
12000.50c	24.0963	endf5u	ENDF/B-V.0	1978	294	56,334	2,430	20	yes	no
12000.50d	24.0963	dre5	ENDF/B-V.0	1978	294	14,070	263	20	yes	no
12000.51c	24.0963	rmccs	ENDF/B-V.0	1978	294	48,917	1,928	20	yes	no
12000.51d	24.0963	drmccs	ENDF/B-V.0	1978	294	14,070	263	20	yes	no
12000.60c	24.0963	endl60	ENDF/B-VI.0	1978	294	55,776	2,525	20	yes	no
Z = 13 ************ Aluminum **************************************										
** Al-27 **										
13027.21c	26.7498	100xs	LANL/T-2:XTM	1989	300	35,072	1,473	100	yes	no
13027.35c	26.7498	endl85	LLNL	pre-1985	0	36,895	2,038	20	yes	no
13027.42c	26.7498	endl92	LLNL	pre-1992	300	32,388	1,645	30	yes	no
13027.50c	26.7500	rmccs	ENDF/B-V.0	1973	294	54,162	2,028	20	yes	no
13027.50d	26.7500	drmccs	ENDF/B-V.0	1973	294	41,947	263	20	yes	no
13027.60c	26.7500	endl60	ENDF/B-VI.0	1973	294	55,427	2,241	20	yes	no
Z = 14 ************ Silicon **************************************										
** Si-nat **										
14000.21c	27.8440	100xs	LANL/T-2:XTM	1989	300	76,399	2,883	100	yes	no
14000.35c	27.8442	endl85	LLNL	pre-1985	0	19,016	1,012	20	yes	no
14000.42c	27.8442	endl92	LLNL	pre-1992	300	16,696	855	30	yes	no
14000.50c	27.8440	endl5p	ENDF/B-V.0	1976	294	98,609	2,440	20	yes	no
14000.50d	27.8440	dre5	ENDF/B-V.0	1976	294	69,498	263	20	yes	no
14000.51c	27.8440	rmccs	ENDF/B-V.0	1976	294	88,129	1,887	20	yes	no
14000.51d	27.8440	drmccs	ENDF/B-V.0	1976	294	69,498	263	20	yes	no
14000.60c	27.8440	endl60	ENDF/B-VI.0	1976	294	104,198	2,824	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 15 ************ Phosphorus**										
** P-31 **										
15031.35c	30.7077	endl85	LLNL	pre-1985	0	5,875	303	20	yes	no
15031.42c	30.7077	endl92	LLNL	pre-1992	300	6,805	224	30	yes	no
15031.50c	30.7080	endf5u	ENDF/B-V.0	1977	294	5,733	326	20	yes	no
15031.50d	30.7080	dre5	ENDF/B-V.0	1977	294	5,761	263	20	yes	no
15031.51c	30.7080	rmccs	ENDF/B-V.0	1977	294	5,732	326	20	yes	no
15031.51d	30.7080	drmccs	ENDF/B-V.0	1977	294	5,761	263	20	yes	no
15031.60c	30.7080	endf60	ENDF/B-VI.0	1977	294	6,715	297	20	yes	no
Z = 16 ************ Sulfur**										
** S-nat **										
16000.60c	31.7882	endf60	ENDF/B-VI.0	1979	294	108,683	8,382	20	yes	no
** S-32 **										
16032.35c	31.6974	endl85	LLNL	pre-1985	0	7,054	357	20	yes	no
16032.42c	31.6974	endl92	LLNL	pre-1992	300	6,623	307	30	yes	no
16032.50c	31.6970	endf5u	ENDF/B-V.0	1977	294	6,789	363	20	yes	no
16032.50d	31.6970	dre5	ENDF/B-V.0	1977	294	6,302	263	20	yes	no
16032.51c	31.6970	rmccs	ENDF/B-V.0	1977	294	6,780	362	20	yes	no
16032.51d	31.6970	drmccs	ENDF/B-V.0	1977	294	6,302	263	20	yes	no
16032.60c	31.6970	endf60	ENDF/B-VI.0	1977	294	7,025	377	20	yes	no
Z = 17 ************ Chlorine**										
** Cl-nat **										
17000.35c	35.1484	endl85	LLNL	pre-1985	0	12,903	1,014	20	yes	no
17000.42c	35.1484	endl92	LLNL	pre-1992	300	12,012	807	30	yes	no
17000.50c	35.1480	endf5p	ENDF/B-V.0	1967	294	23,313	1,499	20	yes	no
17000.50d	35.1480	dre5	ENDF/B-V.0	1967	294	18,209	263	20	yes	no
17000.51c	35.1480	rmccs	ENDF/B-V.0	1967	294	21,084	1,375	20	yes	no
17000.51d	35.1480	drmccs	ENDF/B-V.0	1967	294	18,209	263	20	yes	no
17000.60c	35.1480	endf60	ENDF/B-VI.0	1967	294	24,090	1,816	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 18 ************** Argon										
** Ar-nat **										
18000.35c	39.6048	rmccsa	LLNL	pre-1985	0	5,585	259	20	yes	no
18000.35d	39.6048	drmccs	LLNL	pre-1985	0	14,703	263	20	yes	no
18000.42c	39.6048	endl92	LLNL	pre-1992	300	5,580	152	30	yes	no
18000.59c	39.6048	arkrc [4]	LANL/T-2	1982	294	3,473	252	20	yes	no
Z = 19 ************** Potassium										
** K-nat **										
19000.35c	38.7624	endl85	LLNL	pre-1985	0	11,130	714	20	yes	no
19000.42c	38.7624	endl92	LLNL	pre-1992	300	11,060	544	30	yes	no
19000.50c	38.7660	endf5u	ENDF/B-V.0	1974	294	22,051	1,243	20	yes	no
19000.50d	38.7660	dre5	ENDF/B-V.0	1974	294	23,137	263	20	yes	no
19000.51c	38.7660	rmccs	ENDF/B-V.0	1974	294	18,798	1,046	20	yes	no
19000.51d	38.7660	drmccs	ENDF/B-V.0	1974	294	23,137	263	20	yes	no
19000.60c	38.7660	endf60	ENDF/B-VI.0	1974	294	24,482	1,767	20	yes	no
Z = 20 ************** Calcium										
** Ca-nat **										
20000.35c	39.7357	endl85	LLNL	pre-1985	0	12,933	974	20	yes	no
20000.42c	39.7357	endl92	LLNL	pre-1992	300	13,946	1,002	30	yes	no
20000.50c	39.7360	endf5u	ENDF/B-V.0	1976	294	62,624	2,394	20	yes	no
20000.50d	39.7360	dre5	ENDF/B-V.0	1976	294	29,033	263	20	yes	no
20000.51c	39.7360	rmccs	ENDF/B-V.0	1976	294	53,372	1,796	20	yes	no
20000.51d	39.7360	drmccs	ENDF/B-V.0	1976	294	29,033	263	20	yes	no
20000.60c	39.7360	endf60	ENDF/B-VI.0	1980	294	76,468	2,704	20	yes	no
** Ca-40 **										
20040.21c	39.6193	100xs	LANL/T-2:XTM	1989	300	53,013	2,718	100	yes	no
Z = 21 ************** Scandium										
** Sc-45 **										
21045.60c	44.5679	endf60	ENDF/B-VI.2	1992	294	105,627	10,639	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 22 ************** Titanium										
** Ti-nat **										
22000.35c	47.4885	endl85	LLNL	pre-1985	0	13,421	1,337	20	yes	no
22000.42c	47.4885	endl92	LLNL	pre-1992	300	8,979	608	30	yes	no
22000.50c	47.4676	endf5u	ENDF/B-V.0	1977	294	54,801	4,434	20	yes	no
22000.50d	47.4676	dre5	ENDF/B-V.0	1977	294	10,453	263	20	yes	no
22000.51c	47.4676	rmccs	ENDF/B-V.0	1977	294	31,832	1,934	20	yes	no
22000.51d	47.4676	drmccs	ENDF/B-V.0	1977	294	10,453	263	20	yes	no
22000.60c	47.4676	endf60	ENDF/B-VI.0	1977	294	76,454	7,761	20	yes	no
Z = 23 ************** Vanadium										
** V-nat **										
23000.50c	50.5040	endf5u	ENDF/B-V.0	1977	294	38,312	2,265	20	yes	no
23000.50d	50.5040	dre5	ENDF/B-V.0	1977	294	8,868	263	20	yes	no
23000.51c	50.5040	rmccs	ENDF/B-V.0	1977	294	34,110	1,899	20	yes	no
23000.51d	50.5040	drmccs	ENDF/B-V.0	1977	294	8,868	263	20	yes	no
23000.60c	50.5040	endf60	ENDF/B-VI.0	1988	294	167,334	8,957	20	yes	no
** V-51 **										
23051.42c	50.5063	endl92	LLNL	pre-1992	300	94,082	5,988	30	yes	no
Z = 24 ************** Chromium										
** Cr-nat **										
24000.35c	51.5493	endl85	LLNL	pre-1985	0	9,218	358	20	yes	no
24000.42c	51.5493	endl92	LLNL	pre-1992	300	12,573	377	30	yes	no
24000.50c	51.5490	rmccs	ENDF/B-V.0	1977	294	134,454	11,050	20	yes	no
24000.50d	51.5490	drmccs	ENDF/B-V.0	1977	294	30,714	263	20	yes	no
** Cr-50 **										
24050.60c	49.5170	endf60	ENDF/B-VI.1	1989	294	119,178	11,918	20	yes	no
** Cr-52 **										
24052.60c	51.4940	endf60	ENDF/B-VI.1	1989	294	117,680	10,679	20	yes	no
** Cr-53 **										
24053.60c	52.4860	endf60	ENDF/B-VI.1	1989	294	114,982	10,073	20	yes	no
** Cr-54 **										
24054.60c	53.4760	endf60	ENDF/B-VI.1	1989	294	98,510	9,699	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 25 ************* Manganese										
** Mn-55 **										
25055.35c	54.4661	endl85	LLNL	pre-1985	0	7,493	446	20	yes	no
25055.42c	54.4661	endl92	LLNL	pre-1992	300	10,262	460	30	yes	no
25055.50c	54.4661	endf5u	ENDF/B-V.0	1977	294	105,093	12,525	20	yes	no
25055.50d	54.4661	dre5	ENDF/B-V.0	1977	294	9,681	263	20	yes	no
25055.51c	54.4661	rmccs	ENDF/B-V.0	1977	294	25,727	1,578	20	yes	no
25055.51d	54.4661	drmccs	ENDF/B-V.0	1977	294	9,681	263	20	yes	no
25055.60c	54.4661	endf60	ENDF/B-VI.0	1988	294	184,269	8,207	20	yes	no
Z = 26 ************* Iron										
** Fe-nat **										
26000.21c	55.3650	100xs	LANL/T-2.XTM	1989	300	149,855	15,598	100	yes	no
26000.35c	55.3672	endl85	LLNL	pre-1985	0	30,983	2,772	20	yes	no
26000.42c	55.3672	endl92	LLNL	pre-1992	300	38,653	3,385	30	yes	no
26000.50c	55.3650	endf5p	ENDF/B-V.0	1978	294	115,447	10,957	20	yes	no
26000.50d	55.3650	dre5	ENDF/B-V.0	1978	294	33,896	263	20	yes	no
26000.55c	55.3650	rmccs	LANL/T-2	1986	294	178,392	6,899	20	yes	no
26000.55d	55.3650	drmccs	LANL/T-2	1986	294	72,632	263	20	yes	no
** Fe-54 **										
26054.60c	53.4760	endf60	ENDF/B-VI.1	1989	294	121,631	10,701	20	yes	no
** Fe-56 **										
26056.60c	55.4540	endf60	ENDF/B-VI.1	1989	294	174,517	11,618	20	yes	no
** Fe-57 **										
26057.60c	56.4460	endf60	ENDF/B-VI.1	1989	294	133,995	7,606	20	yes	no
** Fe-58 **										
26058.60c	57.4360	endf60	ENDF/B-VI.1	1989	294	93,450	6,788	20	yes	no
Z = 27 ************* Cobalt										
** Co-59 **										
27059.35c	58.4269	endl85	LLNL	pre-1985	0	38,958	4,177	20	yes	no
27059.42c	58.4269	endl92	LLNL	pre-1992	300	119,231	13,098	30	yes	no
27059.50c	58.4269	endf5u	ENDF/B-V.0	1977	294	117,075	14,502	20	yes	no
27059.50d	58.4269	dre5	ENDF/B-V.0	1977	294	11,769	263	20	yes	no
27059.51c	58.4269	rmccs	ENDF/B-V.0	1977	294	28,355	1,928	20	yes	no
27059.51d	58.4269	drmccs	ENDF/B-V.0	1977	294	11,769	263	20	yes	no
27059.60c	58.4269	endf60	ENDF/B-VI.2	1992	294	186,618	11,838	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 28 ************* Nickel **										
** Ni-nat **										
28000.42c	58.1957	endl92	LLNL	pre-1992	300	44,833	3,116	30	yes	no
28000.50c	58.1826	rmccs	ENDF/B-V.0	1977	294	139,913	8,927	20	yes	no
28000.50d	58.1826	drmccs	ENDF/B-V.0	1977	294	21,998	263	20	yes	no
28058.35c	57.4376	endl85	LLNL	pre-1985	0	42,744	4,806	20	yes	no
** Ni-58 **										
28058.42c	57.4376	endl92	LLNL	pre-1992	300	38,930	4,914	30	yes	no
28058.60c	57.4380	endf60	ENDF/B-VI.1	1989	294	172,069	16,445	20	yes	no
** Ni-60 **										
28060.60c	59.4160	endf60	ENDF/B-VI.1	1991	294	110,885	10,055	20	yes	no
** Ni-61 **										
28061.60c	60.4080	endf60	ENDF/B-VI.1	1989	294	93,801	5,882	20	yes	no
** Ni-62 **										
28062.60c	61.3960	endf60	ENDF/B-VI.1	1989	294	82,085	7,230	20	yes	no
** Ni-64 **										
28064.60c	63.3790	endf60	ENDF/B-VI.1	1989	294	66,656	6,144	20	yes	no
Z = 29 ************* Copper **										
** Cu-nat **										
29000.35c	63.0001	endl85	LLNL	pre-1985	0	7,039	293	20	yes	no
29000.50c	63.5460	rmccs	ENDF/B-V.0	1978	294	51,850	3,435	20	yes	no
29000.50d	63.5460	drmccs	ENDF/B-V.0	1978	294	12,777	263	20	yes	no
** Cu-63 **										
29063.60c	62.3890	endf60	ENDF/B-VI.2	1989	294	119,097	11,309	20	yes	no
** Cu-65 **										
29065.60c	64.3700	endf60	ENDF/B-VI.2	1989	294	118,385	11,801	20	yes	no
Z = 30 ************* Zinc **										
** Zn-nat **										
30000.40c	64.8183	endl92	LLNL	pre-1992	300	271,897	33,027	30	yes	no
30000.42c	64.8183	endl92	LLNL:XTM	pre-1992	300	271,897	33,027	30	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 31 Gallium										
** Ga-nat **										
31000.35c	69.1211	endl85	LLNL	pre-1985	0	7,509	469	20	yes	no
31000.42c	69.1211	endl92	LLNL	pre-1992	300	6,311	219	30	yes	no
31000.50c	69.1211	rmccs	ENDF/B-V.0	1980	294	7,928	511	20	yes	no
31000.50d	69.1211	drmccs	ENDF/B-V.0	1980	294	6,211	263	20	yes	no
31000.60c	69.1211	endf60	ENDF/B-VI.0	1980	294	9,228	566	20	yes	no
Z = 33 Arsenic										
** As-74 **										
33074.35c	73.2889	endl85	LLNL	pre-1985	0	50,881	6,424	20	yes	no
33074.42c	73.2889	endl92	LLNL	pre-1992	300	55,752	6,851	30	yes	no
** As-75 **										
33075.35c	74.2780	rmccsa	ENDF/B-V.0	1974	0	50,931	6,421	20	yes	no
33075.35d	74.2780	drmccs	ENDF/B-V.0	1974	0	8,480	263	20	yes	no
33075.42c	74.2780	endl92	LLNL	pre-1992	300	56,915	6,840	30	yes	no
Z = 35 Bromine										
** Br-79 **										
35079.55c	78.2404	t2ddc [5]	LANL/T-2	1982	294	10,431	1,589	20	no	no
** Br-81 **										
35081.55c	80.2212	t2ddc [5]	LANL/T-2	1982	294	5,342	831	20	no	no
Z = 36 Krypton										
** Kr-78 **										
36078.50c	77.2510	rmccsa	ENDF/B-V.0	1978	294	9,057	939	20	no	no
36078.50d	77.2510	drmccs	ENDF/B-V.0	1978	294	4,358	263	20	no	no
** Kr-80 **										
36080.50c	79.2298	rmccsa	ENDF/B-V.0	1978	294	10,165	1,108	20	no	no
36080.50d	79.2298	drmccs	ENDF/B-V.0	1978	294	4,276	263	20	no	no
** Kr-82 **										
36082.50c	81.2098	rmccsa	ENDF/B-V.0	1978	294	7,220	586	20	no	no
36082.50d	81.2098	drmccs	ENDF/B-V.0	1978	294	4,266	263	20	no	no
36082.59c	81.2098	misc5xs [4]	LANL/T-2	1982	294	7,010	499	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** Kr-83 **										
36083.50c	82.2018	rmccsa	ENDF/B-V.0	1978	294	8,078	811	20	no	no
36083.50d	82.2018	drmccs	ENDF/B-V.0	1978	294	4,359	263	20	no	no
36083.59c	82.2018	arkrc [4]	LANL/T-2	1982	294	8,069	704	20	yes	no
** Kr-84 **										
36084.50c	83.1906	rmccsa	ENDF/B-V.0	1978	294	9,364	944	20	no	no
36084.50d	83.1906	drmccs	ENDF/B-V.0	1978	294	4,463	263	20	no	no
36084.59c	83.1906	arkrc [4]	LANL/T-2	1982	294	10,370	954	20	yes	no
** Kr-86 **										
36086.50c	85.1726	rmccsa	ENDF/B-V.0	1975	294	10,416	741	20	no	no
36086.50d	85.1726	drmccs	ENDF/B-V.0	1975	294	4,301	263	20	no	no
36086.59c	85.1726	arkrc [4]	LANL/T-2	1982	294	8,740	551	20	yes	no
Z = 37 ************** Rubidium **************										
** Rb-85 **										
37085.55c	84.1824	t2ddc [5]	LANL/T-2	1982	294	27,304	4,507	20	no	no
** Rb-87 **										
37087.55c	86.1626	t2ddc [5]	LANL/T-2	1982	294	8,409	1,373	20	no	no
Z = 39 ************** Yttrium **************										
** Y-88 **										
39088.35c	87.1543	endl85	LLNL	pre-1985	0	11,299	272	20	yes	no
39088.42c	87.1543	endl92	LLNL	pre-1992	300	11,682	181	30	yes	no
** Y-89 **										
39089.35c	88.1421	miscxs	LLNL		0	49,885	6,154	20	yes	no
39089.42c	88.1421	endl92	LLNL	pre-1992	300	69,315	8,771	30	yes	no
39089.50c	88.1421	endf5u	ENDF/B-V.0 [6]	1985	294	18,631	3,029	20	no	no
39089.50d	88.1421	dre5	ENDF/B-V.0 [6]	1985	294	2,311	263	20	no	no
39089.60c	88.1420	endf60	ENDF/B-VI.0	1986	294	86,556	9,567	20	yes	no
Z = 40 ************** Zirconium **************										
** Zr-nat **										
40000.35c	90.4364	endl85	LLNL	pre-1985	0	14,738	1,292	20	yes	no
40000.42c	90.4364	endl92	LLNL	pre-1992	300	131,855	17,909	30	yes	no
40000.56c	90.4360	zr [7]	ENDF/B-V:XTM	1976	300	52,064	7944	20	no	no
40000.56d	90.4360	zr [7]	ENDF/B-V:XTM	1976	300	5,400	263	20	no	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
40000.57c	90.4360	zr [7]	ENDF/B-V:XTM	1976	300	16,816	2,116	20	no	no
40000.57d	90.4360	zr [7]	ENDF/B-V:XTM	1976	300	5,400	263	20	no	no
40000.58c	90.4360	zr [7]	ENDF/B-V:XTM	1976	587	57,528	8,777	20	no	no
40000.60c	90.4360	endl60	ENDF/B-VI.1	1976 [7]	294	66,035	10,298	20	no	no
** Zr-93 **										
40093.50c	92.1083	kidman	ENDF/B-V.0	1974	294	2,579	236	20	no	no

Z = 41 ************* Niobium **

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** Nb-93 **										
41093.35c	92.1083	endl85	LLNL	pre-1985	0	50,441	6,095	20	yes	no
41093.42c	92.1083	endl92	LLNL	pre-1992	300	73,324	9,277	30	yes	no
41093.50c	92.1051	endl5p	ENDF/B-V.0	1974	294	128,960	17,279	20	yes	no
41093.50d	92.1051	drc5	ENDF/B-V.0	1974	294	10,332	263	20	yes	no
41093.51c	92.1051	rmccs	ENDF/B-V.0	1974	294	14,675	963	20	yes	no
41093.51d	92.1051	drmccs	ENDF/B-V.0	1974	294	10,332	263	20	yes	no
41093.60c	92.1051	endl60	ENDF/B-VI.1	1990	294	110,269	10,678	20	yes	no

Z = 42 ************* Molybdenum **

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** Mo-nat **										
42000.35c	95.1158	endl85	LLNL	pre-1985	0	8,628	573	20	yes	no
42000.42c	95.1158	endl92	LLNL	pre-1992	300	9,293	442	30	yes	no
42000.50c	95.1160	endl5u	ENDF/B-V.0	1979	294	35,634	4,260	20	yes	no
42000.50d	95.1160	dre5	ENDF/B-V.0	1979	294	7,754	263	20	yes	no
42000.51c	95.1160	rmccs	ENDF/B-V.0	1979	294	10,139	618	20	yes	no
42000.51d	95.1160	drmccs	ENDF/B-V.0	1979	294	7,754	263	20	yes	no
42000.60c	95.1160	endl60	ENDF/B-VI.0	1979	294	45,573	5,466	20	yes	no
** Mo-95 **										
42095.50c	94.0906	kidman	ENDF/B-V.0	1980	294	15,411	2,256	20	no	no

Z = 43 ************* Technetium **

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
** Tc-99 **										
43099.50c	98.1500	kidman	ENDF/B-V.0	1978	294	12,152	1,640	20	no	no
43099.60c	98.1500	endl60	ENDF/B-VI.0	1978	294	54,262	8,565	20	no	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 44 ************** Ruthenium **										
** Ru-101 **										
44101.50c	100.0390	kidman	ENDF/B-V.0	1980	294	5,299	543	20	no	no
** Ru-103 **										
44103.50c	102.0220	kidman	ENDF/B-V.0	1974	294	3,052	235	20	no	no
Z = 45 ************** Rhodium **										
** Rh-103 **										
45103.50c	102.0210	mccsa	ENDF/B-V.0	1978	294	18,870	2,608	20	no	no
** Rh-105 **										
45103.50d	102.0210	drmccs	ENDF/B-V.0	1974	294	4,663	263	20	no	no
45105.50c	104.0050	kidman	ENDF/B-V.0	1974	294	1,591	213	20	no	no
Z = 45 ********* Average fission product from Uranium-235 *******************										
** U-235 fp **										
45117.90c	115.5446	rmccs	LANL/T-2	1982	294	10,314	399	20	yes	no
45117.90d	115.5446	drmccs	LANL/T-2	1982	294	9,507	263	20	yes	no
Z = 46 ************** Palladium ***										
** Pd-105 **										
46105.50c	104.0040	kidman	ENDF/B-V.0	1980	294	4,647	505	20	no	no
** Pd-108 **										
46108.50c	106.9770	kidman	ENDF/B-V.0	1980	294	4,549	555	20	no	no
Z = 46 ********* Average fission product from Plutonium-239 ******************										
** Pu-239 fp **										
46119.90c	117.5255	rmccs	LANL/T-2	1982	294	10,444	407	20	yes	no
46119.90d	117.5255	drmccs	LANL/T-2	1982	294	9,542	263	20	yes	no

ZAID	Atomic Wt. Ratio	Library Name	Source	Date of Eval.	Temp. (°K)	Length (words)	Num. of Energies	Emax (MeV)	GPD	Nubar
Z = 47 ************* Silver										
** Ag-nat **										
47000.55c	106.9420	mccsa	LANL/T-2	1984	294	29,092	2,350	20	yes	no
47000.55d	106.9420	dmccs	LANL/T-2	1984	294	12,409	263	20	yes	no
** Ag-107 **										
47107.35c	105.9867	endl85	LLNL	pre-1985	0	13,134	994	20	yes	no
47107.42c	105.9867	endl92	LLNL	pre-1992	300	27,108	2,885	30	yes	no
47107.50c	105.9870	mccsa	ENDF/B-V.0	1978	294	12,111	1,669	20	no	no
47107.50d	105.9870	dmccs	ENDF/B-V.0	1978	294	4,083	263	20	no	no
47107.60c	105.9870	endf60	ENDF/B-VI.0	1983	294	64,008	10,101	20	no	no
** Ag-109 **										
47109.35c	107.9692	endl85	LLNL	pre-1985	0	13,452	1,094	20	yes	no
47109.42c	107.9692	endl92	LLNL	pre-1992	300	33,603	3,796	30	yes	no
47109.50c	107.9690	mccsa	ENDF/B-V.0	1978	294	14,585	2,120	20	no	no
47109.50d	107.9690	dmccs	ENDF/B-V.0	1978	294	3,823	263	20	no	no
47109.60c	107.9690	endf60	ENDF/B-VI.0	1983	294	76,181	11,903	20	no	no
Z = 48 ************* Cadmium										
** Cd-nat **										
48000.35c	111.4443	endl85	LLNL	pre-1985	0	12,283	1,115	20	yes	no
48000.42c	111.4443	endl92	LLNL	pre-1992	300	211,537	29,369	30	yes	no
48000.50c	111.4600	endf5u	ENDF/B-V.0	1974	294	19,714	2,981	20	no	no
48000.50d	111.4600	drc5	ENDF/B-V.0	1974	294	3,026	263	20	no	no
48000.51c	111.4600	mccs	ENDF/B-V.0	1974	294	6,734	818	20	no	no
48000.51d	111.4600	dmccs	ENDF/B-V.0	1974	294	3,026	263	20	no	no
Z = 49 ************* Indium										
** In-nat **										
49000.42c	113.8336	endl92	LLNL	pre-1992	300	65,498	7,870	30	yes	no
49000.60c	113.8340	endf60	ENDF/B-VI.0	1990	294	93,662	10,116	20	yes	no
Z = 49-50 ********* Fission products										
** Ave fp **										
49120.42c	116.4906	endl92 [8]	LLNL	pre-1992	300	12,755	164	30	yes	no
49125.42c	116.4906	endl92 [8]	LLNL	pre-1992	300	9,142	119	30	yes	no