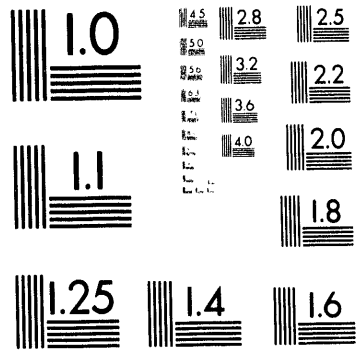
1.0
1.1
1.25
1.4
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2.0
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2.8
3.2
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4.0
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1 of 1

WSRC-TR-92-372

NRTSC
Technology
On Time
On Target

KEY WORDS: MCNP
VALIDATION
CERTIFICATION

RETENTION PERIOD: LIFETIME

MCNP CERTIFICATION PACKAGE (U)

By

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ISSUED: August 1992

SRL SAVANNAH RIVER LABORATORY, AIKEN, SC 29808
Westinghouse Savannah River Company
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TITLE: MCNP CERTIFICATION PACKAGE (U).

TASK: Calculational Methods for Analysis of NIM Placement (92-007-L-A-1).

APPROVALS

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DISCLAIMER

INTRODUCTION AND SUMMARY

In response to a Department of Energy (DOE) request, Westinghouse Savannah River Company committed to certify all computer codes used in critical calculations at the site. Since the Monte Carlo Neutron Photon Transport (MCNP) code (Ref. 1) will be used to perform critical analyses involving criticality and shielding, the code must be certified.

Certification as applied to existing computer codes includes the verification and validation process, placing the code in configuration control, and establishing user qualification standards and training requirements. All software intended for use in critical calculations must be certified. This report is intended to fulfill the requirements for the certification of the MCNP code, version 4.2, built June 11, 1992, by J.H. Hightower on the SRS CRAY.

This report does not release MCNP for use under production status for any application for which a MCNP validation document does not exist. These validation documents will describe the specific range of applicability, limitations on use, results and biases for a particular MCNP application.

This work was performed under NRTSC QA task #92-007-L-A-1, *Computational Methods for Analysis of NIM Placement*, and is documented in Ref. 2. The report follows the requirements of QAP IV-9 of the NRTSC QA Procedures.

DISCUSSION

Application

MCNP is a general-purpose Monte Carlo code that can be used for the solution of radiation transport problems involving neutrons, photons, or coupled neutron-photon systems, including the calculation of eigenvalues for critical systems. The code treats an arbitrary three-dimensional configuration of materials through a set of user defined

cells and surfaces. MCNP provides the choice of several nuclear data table formats, including continuous, thinned continuous, multigroup and discrete reaction cross sections. The code was developed by, and is maintained at, the Los Alamos National Laboratory (LANL).

MCNP has been used for a host of applications, including criticality safety, shielding design, design of nuclear instrumentation, calculation of material activations, radiological dose determination, spacecraft radiation modeling, and reactor design and analysis. Those applications for which MCNP will be certified at the Savannah River Site will be defined by those applications for which a validation report exists. These reports will be generated, as required, to expand the application base for MCNP on the Site.

Input

User data is provided to the code in a file which has data in a card image format. The user supplies data on the materials, cells and surfaces used in the problem, as well as describing the source, tallies and number of histories requested. A complete description of the input files and their generation is provided in Ref. 1 & 5.

There are plans to develop input generators prior to releasing the code for general production use, especially to ensure that validated cross-section sets and atom densities are correctly specified. However, the input files for these processors are beyond the scope of this report and will be covered in subsequent documents.

Output

The MCNP code produces an output file which contains an echo of the input file, code calculated values of tallies, information on histories, and balance tables for each cell. A complete description of the MCNP output file is contained in Ref. 1.

Solution Method

MCNP uses the Monte Carlo method to "track" individual particle histories through a medium with the particle's energy, direction, and event being determined by random numbers. A complete description of the traveled path allows for the determination of events (scatter, absorption, fission, leakage) based on probability theory. The overall results of tracking a number of particles along their paths in a particular medium provides an approximation to the behavior of the actual system the model represents. Details of the theory utilized in the MCNP code can be found in Ref. 1.

Accuracy and Limitations

MCNP is currently only being certified on the SRS CRAY, however, the code is capable on running on the IBM mainframe or on a workstation. The accuracy and limitations of the code (and its attendant cross sections) are determined by the application for which it is being used. The accuracy and limitations will be given in the validation document for the particular application.

A Software Test Report has been issued for the code (Ref. 3), showing that the code meets the accuracy requirements of the Software Requirements Specification (Ref. 4).

Code Source Listing Locations

The source code for MCNP is stored under the Scientific Code Management System, which protects it from unauthorized changes, and ensures strict quality assurance standards are adhered to. The source listing for CRAY and workstation versions of MCNP are located on the VAX cluster in the SCMS libraries. The nuclear data files are located in write protected datasets on the CRAY (/usr/local/src/prod/mcnpcc/mccclib) and in CFS (/mcnplib/data). The MCNP code uses the XSDIR file (/usr/local/src/prod/mcnpcc/xsdir1.n) to determine the location of the data libraries needed.

Program Execution

Instructions for running MCNP on the SRS CRAY are found in Ref. 5, MCNP Test Problems. The execution of these 25 Los Alamos generated test problems exercise various code options and data libraries and provide assurance that the code has been compiled, installed and executed correctly. Examples of input and output decks are included in Ref. 1 for several types of problems.

Access Control and Security

A list of users of the code is kept by the code proprietor. Only those users labeled as cognizant on the proprietors list may use the code for critical calculations. Changes to the MCNP coding can be performed only by the code proprietor, and are implemented by the SCMS custodian only after execution of the test problem set (Ref. 5).

Shell scripts and banners or page headings have been added to the MCNP code. The banners are printed every time a new module is entered, and identify the version of the code and the date of compilation. The shell scripts are maintained by the SCMS custodian in accordance with the requirements of Ref. 6.

Technically knowledgeable personnel have been assigned to serve as code proprietor and backup proprietor for the MCNP code. These proprietors are members of the user community who are experienced users of the code. The backup proprietor has been identified to ensure continuity of code expertise.

A proprietor's code notebook (Ref. 2) is being maintained in which an ongoing history of code development, alterations, validation, and error corrections are recorded. This notebook will be continuously maintained by the code proprietor.

User Qualifications

User qualification status is broken down into Apprentice Users and Cognizant Users as defined by Ref. 7 and 8. These Technical Procedures will be used by applicants, with the following exception, to qualify as either an Apprentice or a Cognizant User. Due to the variety of applications for which MCNP can be used, a test will not be required to become a Cognizant User. Instead, the user will be trained in either a SOLCET (or equivalent) class, or via the aid of a MCNP workbook. The Criticality Methods and Analysis Technical Activity Leader shall determine if a user has sufficient training on MCNP to be considered a Cognizant User for a particular application. A list of Apprentice and Cognizant Users will be kept by the code proprietor.

Manual and Other Documentation

A users manual has been written for MCNP which details code theory, input and output (Ref. 1).

A controlled tracking system is in place to inform all cognizant users of coding and system changes in the MCNP code, as well as the development of validation documents. All memoranda issued via this system are numbered and approved by management. The cognizant users list is maintained by the code proprietor.

A Software Baseline Status Listing is being maintained by the code proprietor in the task files. This document will be kept current as revisions and additions to the software documentation are made.

Technical Review

A technical review of this document has been performed in accordance with QAP II-14 of the NRTSC QA Manual. The review sheets will be maintained as part of the official task records.

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