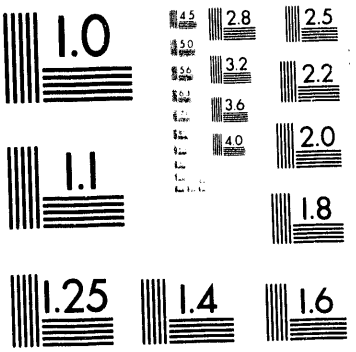
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6

1 of 1

SAFETY TECHNOLOGY DEPARTMENT

WSRC-TR-93-529

TORT Certification Package

Task Number: 93-044-1

ROBERT L. FROST

October 1993

C. E. Gipson Jr 10-20-93
Reviewing Official

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Authorized Derivative Classifier

WESTINGHOUSE SAVANNAH RIVER COMPANY
SAVANNAH RIVER TECHNOLOGY CENTER
AIKEN, SC 29808
PREPARED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT
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DISCLAIMER

STD
SAFETY TECHNOLOGY DEPARTMENT

WSRC-TR-93-529
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KEYWORDS:
TORT
Certification
Discrete Ordinates
Transport Theory
Shielding

Retention-Permanent

TORT Certification Package

By

ROBERT L. FROST

ISSUED: October 1993

SRTC SAVANNAH RIVER TECHNOLOGY CENTER, AIKEN, SC 29808
Westinghouse Savannah River Company
Prepared for the U. S. Department of Energy under Contract DE-AC09-89SR18035

Document: WSRC-TR-93-529

Title: TORT Certification Package

Task Number: 93-044-1

Task Title: Certification of TORT, DORT, and MORSE-CGA

APPROVALS

R L Webb

R.L. Webb, Technical Reviewer

Date: 10/13/93

C E Apperson

C. E. Apperson, Manager
Applied Physics Group

Date: 10-20-93

M. R. Buckner

M.R. Buckner, Manager
Applied Technology Section

Date: 10-27-93

ABSTRACT

The TORT code has been certified. TORT is a three-dimensional discrete ordinates transport theory code, that can solve neutron, photon, or coupled neutron/photon problems. The code will be used primarily for shielding and radiation field calculations at SRS. As defined in this work, certification does not imply validation. The code must be validated for a particular type of calculation before it can be used for critical applications.

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. The TORT code will be used to perform critical analyses of radiation transport, and therefore must be certified.

Certification as applied to existing computer codes includes the verification process, placing the code in configuration control, establishing user qualification standards and training requirements, *etc.* All software intended for use in critical calculations must be certified. This report is intended to fulfill the requirements for the certification of the TORT code, version 2.6.5 (released Jan. 5, 1993), built at SRS March 5, 1993, by H.L. Harris.

The reader should note that certification as defined here does not include the validation process. In the past, work performed by the Applied Physics Group was directly related to reactor safety or performance. This relatively narrow scope meant that defining validation requirements that would encompass all uses of the code was possible. (This is not to say that performing such analyses was easy, only that it was possible to define what was needed in advance.) In our new environment, APG performs criticality and shielding analyses. A large variety of combinations of geometry, materials, and types of systems involved, and types of analyses required are encountered. For this reason, task plan 93-044-1 specified that the TORT, DORT and MORSE-CGA codes would be certified without validation. Validation will subsequently be performed for specific tasks that the codes are to be used for, using certified software. Thus certified software will be validated for specific tasks.

Certification does imply that the code has been verified, placed in configuration management, and that all applicable documents as required in 1Q34 have been approved. Verification is accomplished by running the test problems included with the code, and comparing the results to those provided with the source code. Verification is documented in the test problem report.

This work was performed under STD QA task number 93-044-1, *Certification of TORT, DORT and MORSE-CGA*, and follows the requirements of QAP IV-9 of 1Q34.

DISCUSSION

Application

TORT is a three dimensional transport theory code that uses multigroup cross sections and employs discrete ordinates theory to solve for the neutron flux as a function of position, energy group, and direction. It can solve neutron, photon, or coupled neutron/photon problems. The code was written by W.A. Rhoades and R.L. Childs at Oak Ridge National Laboratory.

The TORT code was developed to solve shielding problems that require three dimensional geometry capabilities to accurately model. It is used routinely at Oak Ridge for that purpose. At SRS, it is anticipated that TORT will be used for analysis of evacuation zones in the vicinity of nuclear incident monitor alarms. Other applications will almost surely arise in the shielding arena in the future.

Input

Input data is contained in a single file in card image format. The TORT code uses the FIDO input processor, which eases the input description for large arrays of data. This input file supplies data on geometry, sources, and mesh spacing, as well as computational options, convergence criteria, and output edit instructions. A complete discussion of the input requirements is given in Ref. 1.

The code also requires a file containing all cross sections required for the problem. These cross sections must be in group organized format, as is produced by the GIP processing code. A third file containing boundary or distributed source information is optional. Typically, this file is produced as output from a previous TORT problem.

Output

The output from a TORT run depends to a large extent on the edit options requested in the input. An echo of the input selections is always printed as the first item. This is followed by a detailed edit of the space meshing, and a set of zone plan views. The latter lists the material number present at each k level, as a function of i and j. It is used to confirm the geometry input is as intended. If selected in the input, the next item to be printed is a multigroup cross section edit. The results of the calculation are printed next. Information on convergence and acceleration effectiveness as well as the current value of k-effective is printed for each source and flux iteration. The flux results can be printed after each iteration or only after the calculation has converged, depending on input selection. Flux edits can be requested for every mesh cell or only for selected "key" cells. In addition, a response function edit can be obtained, in which the fluxes have been multiplied by a function of energy, position, and direction, as specified in the input. If response functions are used, they can be printed with the same options as discussed above for fluxes. The last item to be printed is a summary of cpu time spent on the problem.

Solution Method

TORT solves the Boltzmann Transport Equation using discrete ordinates techniques. The flux sweep uses one of three optional methods: weighted difference, nodal, or characteristics. Details of the theory used can be found in Ref. 1.

Accuracy and Limitations

The accuracy of the TORT code in solving particular types of problems will be addressed in the validation studies performed for those cases. TORT is limited to xyz or rθz geometries; it is not possible to exactly represent cubical and cylindrical geometries together as can be done in most Monte Carlo codes. TORT employs a multigroup energy treatment. The accuracy of the results generated are directly related to the accuracy with which the multigroup cross section library is processed. Since discrete ordinates theory samples in only a finite number of directions, ray effects can create problems when transport occurs through regions that are less than a mean free path in length.

Code Source Listing Location

The source code for TORT 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 code for TORT is stored on the VAX in the following directory: disc$scms:[scms.source]TORT.dir.

Program Execution

Instructions for executing TORT can be found in Ref. 1. A set of test problems has been developed which tests all major functions of the TORT code. The input and output from these problems are detailed in Ref. 2. The test problem input can be found on the Cray in the directory /u3/b7001/torttest. The TORT executable modules are located in the directory /usr/local/scms/bin.

Access Control and Security

A list of users of the code is maintained by the proprietor. Only those users labeled as cognizant on the proprietor's list may use the code for critical calculations. Changes to the TORT coding are made only by the proprietor, and are implemented by the SCMS custodian after successful execution of the test problem set.

Shell scripts and banners or page headings have been added to the TORT code. The banners 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. 3.

Technically knowledgeable personnel have been assigned to serve as code proprietor and backup proprietor for the TORT 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. 4) is being maintained in which an ongoing history of code development, alterations, validation, and error corrections is recorded. This notebook will be continuously maintained by the code proprietor.

User Qualifications

User qualification status is divided into the two categories of Apprentice and Cognizant User, as defined in Refs. 5 and 6. Due to the variety of problems for which TORT may be used, a test will not be required to become a Cognizant User. Instead, the Apprentice will be trained by a Cognizant User. The code proprietor will determine when the Apprentice User has sufficient knowledge and understanding of the code to become a Cognizant User. Cognizant Users may be certified only for specific types of calculations or for all calculation types. A list of Apprentice and Cognizant Users will be maintained by the code proprietor.

Discrepancy Reporting

Cognizant user who find a discrepancy or apparent error in the TORT coding, or who wish to request an upgrade/enhancement of the code, shall file an SCDR with the technical proprietor. The proprietor will report any errors to the code developers at Oak Ridge via a numbered document mailed directly to the developers.*

Manual and Other Documentation

A user's manual for TORT is in place that details code theory, input and output (Ref. 1), and which also includes a programmer's manual.

A controlled tracking system is in place to inform all cognizant users of coding and system changes in the TORT code. All memoranda issued through this system are numbered and approved by management. The cognizant user list is maintained by the code proprietor.

A Software Requirements Specification and Software Test Plan were developed and approved by the appropriate personnel. A Software Baseline Status Listing is being maintained by the code proprietor. This document will be kept current as revisions and additions to the software documentation are made. All of these documents are maintained by the code proprietor in the task files, along with the task plan and the test problem report (Ref. 2).

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* The original developers of TORT are W.A. Rhoades and R.L. Childs, both from Oak Ridge National Laboratory, Oak Ridge, TN 37831. Dr. Rhoades is still active in the TORT project.

Technical Review

A technical review of this document has been performed in accordance with QAP II-14 of the 1Q34 Manual. The review sheets will be maintained as part of the official task records.

Approvals

The Certification Package Approval form has been signed by the required personnel and comprises the final page of this report.

REFERENCES

1. W.A. Rhoades and R.L. Childes, *The TORT Three-Dimensional Discrete Ordinates Neutron/Photon Transport Code*, ORNL-6268, Nov. 1987.

2. R.L. Frost, *TORT Test Problem Report (U)*, SRT-APG-930028, May 17, 1993.

3. J.C. Jensen, *SCMS Entry Procedure*, TP-90-019, Nov. 15, 1990.

4. R.L. Frost, *TORT Proprietors Notebook*, WSRC-NB-92-32.

5. J.C. Jensen, *SCMS Entry Procedure*, TP-90-019, November 15, 1990.

6. R.L. Frost, *GLASS Training Procedure*, TP-91-051, October 1991.

Software Certification Approval Form

Identification			
Software Title: TORT (Three dimensional Oak Ridge Transport code)			Software Version: 2.6.5
Task Title: Certification of TORT, DORT and MORSE-CGA			Task No.: 93-044-1
Software Certification			
Preparer (Task leader or designee)			
Print Name: Robert L. Frost	Signature: Robert L. Frost	Date: 10/15/93	Organization: SRTC
Approvals			
Task Leader (If different than preparer, concurrence with content of certification.)			
Print Name	Signature	Date	Organization
Technical Reviewer (All technical review comments have been resolved.)			
Print Name: R.L. Webb	Signature: Roger L. Webb	Date: 10/13/93	Organization: SRTC
Software Quality Coordinator (Package meets QAP IV-9 and task plan requirements.)			
Print Name: A. O. Smetana	Signature: Andrew Smetana	Date: 10/27/93	Organization: E&PD
Responsible Manager (Accepts software as being certified.)			
Print Name: C.E. Apperson	Signature: C.E. Apperson Jr	Date: 10-20-93	Organization: SRTC
Customer (Accepts the software as being certified and meeting deliverable requirements.)			
Print Name: C.E. Apperson	Signature: C.E. Apperson Jr	Date: 10-20-93	Organization: SRTC

Distribution (Controlled identification; all signers and technical proprietor)

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Continued on attachment? ☐ Yes ☐ No

Refer to NRTSC procedure QAP IV-9, "Software Certification," for additional information.

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