Computer Code Abstract

The DORT Two-Dimensional Discrete Ordinates Transport Code

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1. Problem Solved: DORT determines the flux or fluence of particles throughout one- or two-dimensional geometric systems due to sources generated as a result of particle interaction with the medium or incident on the system from extraneous sources. The principal application is to the deep-penetration transport of neutrons and photons. Criticality (k-type and search) problems can also be solved. Numerous printed edits of the results are available, and results can be transferred to output files for subsequent analysis.

2. Method of Solution: The Boltzmann transport equation is solved using either the method of discrete ordinates or diffusion theory. In the discrete ordinates method, the primary mode of operation, initial scattering, and source guesses are established based on user-supplied information. Then, starting with user-supplied boundary conditions, the flow of particles moving in a set of discrete directions in each cell of a space mesh and in each group of a multigroup energy structure is related to preceding values by explicit recursion relationships. Several types of recursion are available, to be chosen by the user for a particular application. Iterations are performed on the source until convergence is reached. Several method are available to accelerate the convergence process.

   The code can produce output data files to be used in providing an accurate restart of a previous problem or in delivering information to other codes. Anisotropic cross sections can be expressed in a Legendre expansion of arbitrary order, and techniques are available to remove negative scattering sources resulting from truncation of the cross-section expansion. The space mesh can be specified such that the number of first-dimensional (i) intervals varies with the second dimension (j). The number of discrete directions can vary in space mesh and energy. Direction sets can be biased, with directions concentrated such as to give fine detail to streaming phenomena.

3. Related Material

   Data files
   Cross-section input file
   Independent source file (optional)
   Flux guess input file (optional)
   Flux result output files (optional)
   Total source output file (optional)

   Related programs
   DOT: predecessor to DORT (Ref. 1)
   DOS DRIVER: coordinates execution of problems using several code modules (IBM or Cray)[2]
   GIP: prepares cross-section input files[2]
   RTFLUM: edits flux files and converts between various flux file formats[2]
   BNDRYS: selects boundary fluxes for subsequent use as internal boundary sources[2]
   GRTUNCL: prepares first-collision source due to a point source in R-Z geometry (on or off axis)
   VISTA: selects and prepares two-dimensional boundary flux data from DORT for use with DOTTOR and MASH (Ref. 3)
   DOTTOR: prepares a three-dimensional boundary source for TORT based on VISTA results[4]
   TORT: three-dimensional code similar to DORT[5]
   MASH: system of codes for scoring adjoint Monte Carlo calculations against VISTA boundary flux data[3]
   DOGS: system of codes for graphic display of DORT results[6]
   DGRAD/VIP/TPERT: system of codes for perturbation calculations based on DORT results.[7]

4. Restrictions: External force fields or nonlinear effects cannot be treated. Flexible dimensioning is used throughout, so that no restrictions are imposed on individual problem parameters. Certain options, especially diffusion theory, are not compatible with problems using variable mesh and quadrature features.

5. Computers: DORT is designed to be applicable to most full-scale computers that support direct (random) access disk storage or the equivalent. Machine-dependent features such as calls to system-dependent subroutines are restricted to interchangeable interface packages. The code originators maintain configurations for IBM and Cray computers, and adaptation to VAX, CDC, and other types has been reported by others.

6. Running Time: CPU time used in the flux calculation can be estimated by (number of space mesh cells) × (number of

directions) × (number of energy groups) × (number of iterations per group) × (flux calculation time).

The flux calculation time for the theta-weighted difference routine with P_3 scattering on a Cray X-MP is ~2.6 μs. Thus, a large problem with 50 000 mesh cells, 30 directions, 69 energy groups, and 8 iterations per group would require ~0.6 h of CPU time in the flux routine. The zero-weighted routine is somewhat faster. The time added by the acceleration routines is highly variable, often falling in the 10 to 40% range. If the default procedure for negative source removal is replaced with another option, the cost may increase by 20 to 100%, depending on the frequency of negative occurrence. The flux calculation takes 16 times as long on the IBM 370/3033, while the acceleration takes ~4 times as long. Some systems assess charges for memory rental and input/output activity, but those are so variable from system to system that no general characterization would be helpful.

7. Programming Languages: The programming standards described in American Nuclear Society STD.3-1971 are used. The program can be operated with 100% FORTRAN language on Cray computers. Although the code is written predominantly to FORTRAN 66 standards, it is fully compatible with Cray compilers through version 1.14 and with IBM VS compilers using the LANGUAGELEVEL=66 option. A non-FORTRAN subroutine library is available for use on IBM computers. On both Cray and IBM systems, optional non-FORTRAN routines can be used to enhance execution speed.

8. Operating System: No special requirements are made on the operating system except that the system must support direct (random) access data files. Configurations for use with Cray-CTSS, Cray-COS, and IBM OS/MVS are available.

9. Machine Requirements: The code and associated system space require ~85 000 words on a Cray and 115 000 words on an IBM. Problem data may require from 4000 words for a small test problem to 700 000 words for a 50 000 mesh-cell problem. External data storage must be provided for nine scratch files, of which five must be direct (random) access. User-supplied input and output data files must be supplied on sequential-access devices, i.e., tapes or the equivalent.

10. Material Available: user's manual, source file in update form, including comment files and documentation updates, job control language for unloading source and installing code, and sample problem solutions and tutorial description.

11. Authors: The originators of DORT are W. A. Rhoades and R. L. Childs. Since DORT is directly based on the earlier DOT codes, major contributors to that work should also be recognized: W. W. Engle, Jr., M. L. Gritzner, F. R. Mynatt, R. J. Rodgers, D. B. Simpson, and E. T. Tomlinson. Questions concerning this code should be referred to the Radiation Shielding Information Center (RSIC), Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37831.

12. References:

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