Computer Code Abstracts

MIST

1. Name of Code: MIST.
2. Computer for which Code is designed: IBM 7090.
   Programming System: FORTRAN II.
3. Nature of Problem Solved:

   Obtains the solution to the one-dimensional Boltzmann equation in slab geometry. The numerical approximation used is a linear one which can be described as an extension and generalization of the S_n approximation. The equations are formulated in terms of a "double S_n" approximation and the solution is obtained by a *direct method* (one requiring no inner iterations).

   The boundary conditions for each group may be independently specified and permit very general specifications with respect to:

   (a) Perfect mirror reflection or symmetry (by input of mirror albedos).

   (b) Anisotropic diffuse sources (by input of Legendre polynomial coefficients (up to $l = 9$) or a short table describing a known angular distribution of the flux).

   (c) Isotropic (Lambert surface) reflection.

   Isotropic volume sources in each group may also be independently specified. The scattering from one group to another is assumed to be isotropic but the scattering function within each group can be a second order Legendre polynomial series.
4. Restriction on the complexity of the problem:

   In order to maintain the maximum flexibility, the MIST program is divided into four separate codes. The limit on the number of spatial and angular mesh points for each code is as follows:

Code	Maximum number	
	Angular intervals	Space points
MIST 4	4	250
MIST 6	6	150
MIST 8	8	100
MIST 10	10	70

Maximum number of energy groups	6
Maximum number of regions	40
Maximum number of materials	40
Maximum number of downscatter groups	5

   Machine Requirements: 32K memory, 5 tape units
5. Typical running times: 2 group, 69 point problem requiring six outer iterations to pointwise convergence of 0.001:

Angular intervals	Time (min)
2	0.58
4	1.03
6	1.68
8	2.52
10	3.56

   Problems which require no outer iterations will take a maximum of $\sim$ one minute.
6. Availability: Production; available upon receipt of magnetic tape. Contact D. M. Shapiro.
7. *Reference:* D. M. Shapiro *et al.* "MIST" (Multigroup Internuclear Slab Transport), INTERNUC 67, August 18. 1961. Work performed for Phillips Petroleum Company Atomic Energy Division under Contract AT(10-1) 205, subcontract C-222.

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GREEN

1. Name of code: GREEN.
2. Computer for which code was designed: IBM 704; programing system: FORTRAN II.
3. Nature of problem solved: Calculation of the spatially dependent coefficients of the spherical harmonic expansion of the scalar one speed neutron flux around a point source of arbitrary anisotropy in an infinite homogeneous scattering and absorbing medium. The code will also calculate the first order correction to the coefficients caused by nonisotropic scatter.
4. Restrictions on the complexity of the problem: In its present version it calculates the coefficients for distances from the source of from 0 to 10 cm in steps of $\frac{1}{6}$ cm. Coefficients for spherical harmonics from zeroth to fifth order may be calculated. Machine requirements: 8K memory.
5. Typical running time: 2 min per space point per value of the spherical harmonic index.
6. Unusual features of the code: The program provides an automatic method of calculation of the Green's function coefficients for the thermal neutron flux depression problem discussed in the next abstract.
7. Present status: In use on Oak Ridge Gaseous Diffusion Plant Central Data Processing's IBM 7090. Available in standard FORTRAN II language.
8. *References:* G. R. Dalton, Some Aspects of Thermal Neutron Detectors, Thesis, University of

Michigan, 1960, available from University Microfilm, Inc., Ann Arbor, Michigan.

G. R. Dalton and R. K. Osborn, Flux perturbations by thermal neutron detectors, *Nuclear Sci. and Eng.* **9**, 2 (1961).

G. R. Dalton, "A Complete Description of the Computer Codes Green and Detector," Engineering and Industrial Experiment Station Publication, College of Engineering, University of Florida, Gainesville, Florida, 1961.

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DETECTOR

1. Name of code: DETECTOR.
2. Computer for which code was designed: IBM 704; programing system: FORTRAN II.
3. Nature of problem solved: The one speed thermal neutron transport equation is solved in and around a right circular cylindrical neutron detector for either the wire or the coin case. The initial undisturbed flux is assumed to be isotropic and the detector is assumed to be located far from any other disturbing factors such as other detectors or boundaries.
4. Restrictions on the complexity of the problem: The calculation cannot be applied to extremely long wires nor to large radii coins, i.e., maximum dimension larger than about 5 cm. Furthermore it will break down if applied to extremely black absorbers such as control rods, i.e., minimum dimension times detector absorption cross section must be less than about 0.5.
5. Typical running time: 10 min per detector (IBM 704).
6. Unusual features of the code: The program solves the transport equation for the disturbed scalar flux at a series of up to 6620 points within the detector. By use of axial and midplane symmetry this is reduced to a series of 11 radial and 10 axial grid surfaces. The code also calculates the scalar flux component of the solution of the transport equation at a series of radial and axial points outside the detector. Finally, the ratio of the average scalar flux in the detector relative to the undisturbed flux is calculated.
7. Present status: In use on Oak Ridge National Laboratory Central Data Processing's IBM 7090. Available in standard FORTRAN II language.
8. *References:* G. R. Dalton, Some Aspects of Thermal Neutron Detectors, Thesis, University of Michigan, 1960, available from University Microfilm, Inc., Ann Arbor, Michigan.

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G. R. Dalton, "A Complete Discription of the Computer Codes Green and Dectectors," Engineering and Industrial Experiment Station Publication. College of Engineering, University of Florida, Gainesville, Florida, 1961.

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TRAC-1

1. Name of code: TRAC-1.
2. Computer for which code is designed: Philco-2000; programming system: TAC (for use with BKS sequencing system).
3. Nature of problem solved: Monte Carlo estimation of a regionwise distribution of neutron absorption probabilities in a two-dimensional quarter-cell rectangular region with symmetry boundary conditions, either in a one-energy mode or with a slowing-down mode ahead of the one-energy mode.
4. Restrictions on the complexity of the problem: Maximum number of subregions of the quarter-cell—75; maximum number of groups of subregions for the edit—99; epithermal absorption is required to be of the form "c/v"; heavy element scattering is assumed to be isotropic in the laboratory system; hydrogen scattering is assumed to be isotropic in the center of mass system at epithermal energies and linear in the cosine of the scattering angle in the one-group mode. Machine requirements: 32K core storage with seven tape units.
5. Typical running time: Variable, depending on the statistical accuracy required and the average number of collisions made to absorption. "Average" problems may be solved in from 5 to 20 min.
6. Unusual features of the code: TRAC-1 estimates absorption probabilities in arbitrary groupings of subregions of the quarter-cell by combining an estimate based on the average distance traveled by the neutrons in each region with an estimate based on the final distribution of absorptions. This technique is like that introduced in the KAPL code TRAM. Making use of a technique due to C. W. Maynard based on the reciprocity theorem, the variance in estimating the absorption probability in a single region or group of regions may be significantly reduced. The same technique may be used to estimate the scalar flux at a single point of the quarter-cell by starting all of the neutron histories at this point.
7. Present status: In production use at BAPL. Copies of the program may be obtained from Mr. Robert A. Cohen, Manager, Customer Services, Philco Corp., Government and Industrial Group, Computer Division, 3900 Welsh Road, Willow Grove, Pennsylvania.
8. *References:* H. J. Berwind and J. Spanier, TRAC-1, A Monte Carlo Philco-2000 program for the calculation of neutron capture probabilities, WAPD-TM-229 (March, 1961).

R. B. Smith and C. H. Hunter, The BKS system for the Philco-2000 computer, WAPD-TM-233 (April, 1961).