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Computer Code Abstracts

EXTERMINATOR

1. Name of Code: EXTERMINATOR[1]
2. Computer for Which Code is Designed: IBM-7090 with at least 12 tape units.
   Programming System: FORTRAN, FAP.
3. Nature of Problem Solved: The multigroup, two-dimensional neutron diffusion equations are solved in XY, RZ, or Rθ geometry using the EQUIPOISE method[2].
4. Restrictions on the Complexity of the Problem:
   Let IMAX = maximum number of rows
   JMAX = maximum number of columns
   KMAX = maximum number of groups
   MMAX = maximum number of different compositions
   NMAX = maximum number of nuclides
   Then
   $3 \leq IMAX \leq 250$
   $3 \leq JMAX \leq 250$
   $1 \leq KMAX \leq 50$
   $1 \leq MMAX \leq 500$
   $9 \leq IMAX * JMAX \leq 20000$
   $3 \leq IMAX * KMAX \leq 2000$
   $18 \leq JMAX * (5 + KMAX) \leq 2000$
   $0 \leq MMAX * NMAX \leq 6300$
   $1 \leq KMAX * MMAX \leq 1000$
   $1 \leq KMAX ** 2 * MMAX \leq 10000$
5. Typical Running Time: The calculation rate varies from 0.0018 to 0.0035 sec/point/iteration/group. The running times of some typical problems were:

Points	Groups	No. Iter.	Time(Min)	Rate
2500	2	100	15	0.0018
2254	4	85	37	0.0029
2500	6	100	50	0.0020
1681	16	106	162	0.0034

6. Unusual Features of the Code:
   A. Three outer-boundary conditions may be imposed; zero flux, zero normal derivative, or periodic, in which case the fluxes along the top and bottom rows of the reactor are identical. The internal logarithmic derivative boundary condition may also be specified.
   B. Eigenvalue problems, constant source problems, or poison search problems may be solved.
   C. Input cross sections may be macroscopic, microscopic, or both. Microscopic cross sections may be used from a previously made tape, from cards, or both.
   D. The code takes into account scattering from any group to any other group.
   E. Either point relaxation or single line relaxation may be used in the solution of a problem. Convergence is accelerated by means of the extrapolated Liebmann process in which the extrapolated Liebmann coefficient is made to vary as necessary during the course of a calculation to obtain reasonable convergence rates. When the convergence rate drops below a certain level, the fluxes are extrapolated by means of the Aitken-δ^2 process. In cell problems and in problems in which the groups are not well coupled, a group rebalancing procedure is used to accelerate convergence[3].
   F. The level of convergence of a problem is indicated by pointwise flux convergence, eigenvalue convergence, a pointwise flux convergence criterion modified by the estimated rate of convergence, and neutron balances for each group.
   G. Although EXTERMINATOR is programmed mostly in FORTRAN, FAP coded subroutines are used to permit buffered tape operations. To gain efficient use of tape operation and to be able to recover from tape errors, the tapes containing group constants are duplicated. During the iterative part of the calculation, two tapes (one from each of two channels) are reading into core buffer regions and two tapes are rewinding while the program is calculating new fluxes with previously read data. Since the 'compute time' is approximately equal to the 'tape time,' EXTERMINATOR runs at computer speed.
7. Present Status: In Use.
8. *References:*
   1. Tom B. Fowler, Melvin Tobias and David R. Vondy, EXTERMINATOR – A Multigroup Code for Solving Neutron Diffusion Equa-

tions in One and Two-Dimensions, ORNL-TM-842, To be issued.
2. M. L. Tobias and T. B. Fowler, The EQUIPOISE Method—A Simple Procedure for Group-Diffusion Calculations in Two- and Three-Dimensions, *Nucl. Sci. Eng.*, 12(4): 513-518 (1962).
3. M. L. Tobias, D. R. Vondy, and T. B. Fowler, A Note on a Simple Method for Acceleration of Finite-Difference Group-Diffusion Calculations, *Nucl. Sci. Eng.*, 15(1): 98-99 (1963).

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WIGLE

1. Name of Program - WIGLE
2. Computer for Which Program is Designed — Philco-2000
   Programming System: FORTRAN
   WIGLE has been compiled only on the Philco-2000 computer and runs on this computer under control of the BKSB monitor system[2]. Input is read and processed by calls on the INPF subroutine package[3], and the program can be run on another computer only if INPF is available on that computer or if the input section of the program is rewritten.
3. Nature of Problem Solved: WIGLE is a one-dimensional, two-group, diffusion theory program which computes the space-time behavior of a reactor during a transient associated with a time-dependent change of reactor parameters. Either zero, one, or six delayed neutron groups may be treated. The solution is obtained in slab geometry with a zero flux or zero gradient condition applied at each boundary. All macroscopic parameters are assumed to vary linearly with time; the initial and final values are provided by region in the input. Under option, these parameters may be held fixed beyond a specified time step. The source is provided pointwise in the input and may be altered twice during the course of a problem.
4. Method of Solution: The time part of the WIGLE equations is solved by the central difference method, the time steps being arbitrary numbers supplied as input. On option, the time derivatives of either or both group fluxes may be suppressed. At each time step the spatial equations are solved by a simultaneous inversion of the two-group operator; thus no spatial iteration is required.
5. Restrictions: The limitations on mesh points, regions and time steps are 200, 10 and 500.
6. Typical Running Time: A nine-point problem with 150 time steps runs in about five seconds.
7. Present Status: In use.
8. *References:*

[1]W. R. Cadwell, A. F. Henry and A. J. Vigilotti, "WIGLE - A Program for the Solution of the Two-Group Space-Time Diffusion Equations in Slab Geometry," WAPD-TM-416, (January 1964).

[2]R. B. Smith and O. F. Swift, "BKSB - A Revision of the BKS System for the Philco-2000 Computer," WAPD-TM-379, (August 1963).

[3]O. J. Marlowe, "Bettis FORTRAN Programming: Auxiliary Subroutines," WAPD-TM-365, (February 1963).

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