NUCLEAR SCIENCE AND ENGINEERING: **34**, 88-89 (1968)

Computer Code Abstracts

M0648

1. Name or Designation of Program: M0648.
2. Computer for Which Program is Designed and Programming Language Used: Written for the CDC-6600 in FORTRAN IV.
3. Nature of Physical Problem Solved: M0648 solves the one-dimensional slab transport problem with slowing down for an arbitrary spatial external source and arbitrary scattering.
4. Method of Solution: The double Legendre polynomial expansion of the flux is utilized to obtain a system of linear differential equations which is solved with a round-off free analytic technique.[1] The energy-group concept is utilized and the solution is repeated for each energy group in connection with the slowing down matrix which must be provided as input.[2]
5. Restrictions on the Complexity of the Problem: The maximum number of energy groups is 17 and regions is 12. The maximum number of Legendre polynomial terms that can be retained is 8 (DP_7), the maximum number of equally spaced mesh points per region is 99, and the maximum total number of mesh points is 440. The maximum number of material compositions is 10, but no composition can consist of a multiplying medium or of a pure absorber. The boundary conditions can be arbitrary incident on either end or symmetry on one or both ends of the slab.
6. Typical Running Time: The running time is a function of many variables; for some, it cannot be estimated. For a typical problem of 7 energy groups, 350 mesh points, and 5 regions, the CP time for the CDC-6600 is about two minutes.
7. Unusual Features of the Program: This program is particularly suited for deep penetration problems and for problems where the angular distribution is required with good accuracy.
8. Status: In production.
9. Machine Requirements: M0648 requires 140K octal of machine memory and 3 tape units for scratch storage.
10. Operating System or Monitor Under Which Program is Operating: M0648 is designed to operate under the SCOPE 3.1 system. The software environment as well as the hardware usage, assumed by the program, is given by Pfeifer.[3]
11. Other Programming or Operating Information or Restrictions: None.
12. The code is available from the Argonne Code Center.
13. *References:*

[1]L. LOIS, "Numerical Solution of the One Velocity Boltzmann Neutron Transport Equation in Slab Geometry," Thesis, Columbia University (1966).

[2]L. LOIS, "A Solution of the Slab Transport Problem," WAPD-TM-661, Bettis Atomic Power Laboratory (1968).

[3]C. J. PFEIFER, "CDC-6600 FORTRAN Programming Bettis Environmental Report," WAPD-TM-668, Bettis Atomic Power Laboratory (1968).

Lambros Lois

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory
Post Office Box 79
West Mifflin, Pennsylvania 15122

Received May 10, 1968

LETO

1. Name or Designation of Program: LETO.
2. Computer for Which Program is Designed and Programming Language Used: Written for the CDC-6600 in FORTRAN IV.
3. Nature of Physical Problem Solved: This program will solve the gamma-ray transport and energy deposition problem in one-dimensional laminar slab geometry. The energy-group scheme employed to account for photon energy degradation.[1] An arbitrary external spatial isotropic source may be specified with an arbitrary energy spectrum. The boundary conditions may be (a) free boundaries with arbitrary incident, (b) symmetry on the left arbitrary incident on the right, and (c) symmetry on both ends.
4. Method of Solution: LETO utilizes a set of linear differential equations, obtained by an expansion of the flux in double-range Legendre polynomials, and a round-off free analytic solution is obtained, for the one-velocity one-region problem.[2] This is then extended to all regions and energy groups. The cross sections are obtained by a third-degree Lagrange interpolation at specified energy points from a 25-point table. The group cross sections and the slowing down matrix is then obtained from an infinite medium solution in each of the material regions. The energy source can be constructed from program library spectra and the spatial source can be computed from thermal-neutron flux input.
5. Restrictions on the Complexity of the Problem: The maximum number of: regions is 12; materials is 10;

groups is 13; mesh points per region is 151; total mesh points is 522; total energy mesh points is 171; terms in the double-range Legendre polynomial expansion of the flux is 6; and terms in the Legendre polynomial expansion of scattering is 6.

6. Related and Auxiliary Programs: The infinite medium solution is obtained with a modified version of the code SIMPS,[3] which is now an integral part of LETO. The spatial solution is obtained via the M0648 program.[1]

7. Typical Running Time: Although the running time cannot be precisely computed from the problem parameters, an estimate may be obtained from the formula

$$CP = 50 + \sum_{i=1}^{NMAT} 5 \cdot NOEL + 5 \cdot NGR^2 + 1.5 \cdot L^2 \quad ,$$

where

CP = Central Processor time in sec

NMAT = Number of material regions

NOEL = Number of elements/material region

NGR = Number of groups

L = Terms of the Legendre polynomial expansion.

8. Unusual Features of the Program: This program is suited for deep penetration problems. Usually it can cover an entire reactor and the shield in a single run. The energy absorbed by one isotope in any region can be computed.

9. Status: In production.

10. Machine Requirements: LETO requires 140K octal of machine memory and 3 tape units for scratch storage.

11. Operating System or Monitor Under Which Program is Operating: LETO is designed to operate under the SCOPE 3.1 system. The software environment, as well as the hardware usage assumed by the program, is given by Pfeifer.[4]

12. Other Programming or Operating Information or Restrictions: The term "overlay" is associated with the SCOPE 3.1 operating system. An overlay determines the amount of program text in central memory of any memory load. The LETO program contains a main overlay and 3 primary overlays. Overall program control is vested in the main overlay and the primary overlays are loaded and executed through the use of the OVERLAY routine.

13. The code is available from the Argonne Code Center.

14. *References:*

[1]L. LOIS, "A Solution of the Slab Transport Problem," WAPD-TM-661, Bettis Atomic Power Laboratory (1968).

[2]L. LOIS, "Numerical Solution of the One Velocity Neutron Transport Equation in Slab Geometry," Thesis, Columbia University (1966).

[3]T. E. DUDLEY and M. R. MENDELSON, "Group Constants for Gamma Ray Heating," KAPL-M-6497, Knolls Atomic Power Laboratory (1965).

[4]C. J. PFEIFER, "CDC-6600 FORTRAN Programming Bettis Environmental Report," WAPD-TM-668, Bettis Atomic Power Laboratory (1967).

Lambros Lois

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory
Post Office Box 79
West Mifflin, Pennsylvania 15122

Received May 10, 1968

Announcement

Alterations in programs of the U. S. Atomic Energy Commission are cause for the transfer of the work-a-day activities of the Editor and his close professional colleagues and the transfer of the office of Nuclear Science and Engineering from Oak Ridge National Laboratory to the Y-12 Plant of the Union Carbide Corporation, Nuclear Division.

The Society recognizes the association of the Journal with the Laboratory since 1959; it looks forward to an equally pleasant relationship with Y-12. There will be no change in the physical location of the office or in its address.