Computer Code Abstracts

PIGG

1. Name of Code: PIGG.
2. Computer for Which Code is Designed: CD 3600.
3. Nature of Physical Problems Solved: PIGG solves the P_1 equations in a Greuling-Goertzel approximation for the spatially dependent multigroup neutron flux in both slab and cylindrical geometry. The resonance absorption and fission are calculated using single-pin resonance and fission integrals, Dancoff factors, and resonance-distribution functions. The thermal region can be treated either as one group or as few groups to which diffusion equations are applied. Logarithmic boundary conditions are applied at the external boundaries. The output is very extensive and includes the criticality factor, point-wise group spectra and macrogroup constants, region-averaged macrogroup constants, and epithermal reaction rates for selected isotopes in different mesh points and macrogroups. Interesting applications include calculation of space-dependent epithermal spectra in BWR-fuel elements, spectrum transients near core-reflector interfaces, and effective macrogroup boundary conditions on control absorbers.
4. Method of Solution: Three point difference equations for the group flux are obtained using box integration. The equations are solved using power iteration accelerated by Chebyshev extrapolation of the normalized source. Matrix factorization technique is used for solving the inhomogeneous equations.
5. Restrictions on the Complexity of the Problem: 39 epithermal and 6 thermal groups. 100 mesh points in 20 regions, and 10 homogeneous compositions. 28 different materials may be used for calculation of macroscopic cross sections in 6 macrogroups. For special calculations of reaction rates, 10 selected nuclides in 6 selected mesh points may be used.
6. Typical Running Time: 3 min.
7. Unusual Features of the Program: Options for full or part output on line printer, magnetic tape, and card punch.
8. Related and Auxiliary Programs: Library tape containing macrogroup lethargy structure and Watt's normalized fission spectrum, resonance integral distribution functions and cross sections for 28 materials; program to update the library tape.
9. Status: In production.
10. Machine Requirements: 32K CD 3600, 4 scratch units on drums and up to 3 units on magnetic tapes.
11. Programming Language Used: 3600 FORTRAN, an extended FORTRAN 63.
12. Operating System or Monitor under which Program is Executed: DRUM SCOPE V2.0.
13. Material Available through ENEA Computer Program Library, Ispra, Italy:
    a. FORTRAN source deck and sample problem
    b. Library tape
    c. Program to update library tape
    d. Reference document.
14. *Reference:*

J. O. BERG, G. E. FLADMARK, T. KULIKOWSKA, and O. P. TVERBAKK, "PIGG, a Multigroup One-Dimensional P-1 Code," Kjeller Report KR-129, Institutt for Atomenergi, Kjeller, Norway (May 1968).

T. Kulikowska

Institute of Nuclear Research
Swierk, Poland

J. O. Berg
G. E. Fladmark
O. P. Tverbakk

Institutt for Atomenergi
Kjeller, Norway

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ETOX

A Code to Calculate Group Constants for Nuclear Reactor Calculations

1. Name of Code: ETOX[1]
2. Computer for Which Code is Designed: UNIVAC 1108. Programming Language: "Standard" FORTRAN-IV.
3. Nature of Code: ETOX (ENDF/B[2] TO 1DX[3]) calculates multigroup constants for nuclear reactor calculations using data from the Evaluated Nuclear Data File (ENDF/B[2]). The code is designed to compute and punch:

    a. Infinite dilute cross sections

    b. Temperature dependent self-shielding factors for arbitrary values of σ_0 (total cross section per atom) in the "Russian" (Bondarenko[4]) format

    c. Inelastic scattering probability matrices.
4. Method of Solution: Microscopic cross section values are constructed as specified by the ENDF/B.[2] Group constants are obtained by integrating the microscopic data over group intervals using the flux weighting scheme $\phi(u) \propto 1/\Sigma_t(u)$, $\Sigma_t(u) = N_j\sigma_{tj} + N_j\sigma_0$. Integration methods used include Romberg,[5] Guassian Quadrature,[6] N-point,[7] Simpson[6] and Trapazoidal.[6] The code allows

as input, arbitrary sets of values of group energies, temperatures, and σ_0's.

5. Restriction on Complexity: ETOX uses random access drum storage to make maximum use of core.
6. Running Time: Twenty-six group data for a representative set of 14 isotopes requires ~28 min on the UNIVAC 1108.
7. Related and Auxiliary Programs: The format of the input data is compatible with the ENDF/B data tape. The format of the output is compatible for input to the computer codes 1DX[3] and FCC-IV[8], which are multipurpose diffusion codes for generating cross sections to be used in fast-reactor analysis.
8. Status: In use at Battelle Northwest.
9. Machine Requirements: A 65K memory, 3 tape units, and random access drum storage.
10. Material Available: A source deck, sample problem, and operation instructions are available from the authors.
11. Acknowledgment: This paper is based on work performed under United States Atomic Energy Commission Contract AT(45-1)-1830.
12. *References:*

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[2]H. C. HONECK, "ENDF/B, Specification for an Evaluated Nuclear Data File for Reactor Applications," BNL-50066 (T-46) Brookhaven National Laboratory.

[3]R. W. HARDIE and W. W. LITTLE, Jr., "1DX, A One-Dimensional Diffusion Code for Generating Effective Nuclear Cross Sections," Submitted to *Nucl. Sci. Eng.* (1969).

[4]*Group Constants for Nuclear Reactor Calculations*, I. I. BONDARENKO, Ed., Consultants Bureau, New York (1964).

[5]W. ROMBERG, "Vereinfachte Numerische Integration," *Det. Kong. Norske Videnskaber Selskab Forhandlinger, Band 28, Nr. 7* (1955).

[6]*Handbook of Mathematical Functions*, M. ALBRAMOWITZ and I. A. STEGUN, Eds., p. 916 Dover Publications, Inc. (1965).

[7]D. M. O'SHEA, B. J. TOPPEL, and A. L. RAGO, "MC^2-A Code to Calculate Multigroup Cross Sections," ANL-7318 Argonne National Laboratory (1967).

[8]W. W. LITTLE, Jr., and R. W. HARDIE, "A Revised Version of the FCC Fundamental Mode Fast Reactor Code," FCC-IV, BNWL-450 Battelle Northwest Laboratory (1967).

R. E. Schenter
J. L. Baker

Physics & Engineering Division

and

R. B. Kidman

FFTF Reactor Physics and Operations
Battelle Memorial Institute
Pacific Northwest Laboratory
Richland, Washington

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1DX

A One-Dimensional Cross Section Generating Code

1. Name of Code: 1DX.[1]
2. Computer for Which Code is Designed: UNIVAC 1108. Programming Language: FORTRAN-IV.
3. Nature of Code: 1DX is a multipurpose, one-dimensional diffusion code for generating cross sections to be used in fast-reactor analyses. The code is designed to:
   a. compute and punch resonance shielded cross sections using data in the "Russian"[2] format
   b. compute and punch group-collapsed microscopic and/or macroscopic cross sections averaged over the spectrum in any specified zone
   c. compute k_{eff} and perform criticality searches on time absorption, material concentrations, zone dimensions, and buckling using either a flux or an adjoint model.
4. Method of Solution: Resonance shielded cross sections are calculated using data (infinite dilution cross sections and resonance shielding factors) in the Russian format. Interpolation schemes are used to compute shielding factors applicable to specific compositions. A flux iteration option for computing the elastic-removal cross section is also included. Group-collapsed cross sections by reactor zone are calculated using flux weighting.

   The eigenvalue and spatial flux profiles are computed using standard source-iteration techniques. Convergence is accelerated using fission source over-relaxation. 1DX will also accept input cross sections in the "DTF" format (i.e., resonance-shielded cross sections).
5. Restrictions on Complexity: 1DX uses variable dimensioning to make maximum use of existing core storage. All subscripted variables are stored in one array dimensioned to 25 000.
6. Running Time: A representative 26-group problem with 30 spatial intervals using data in the Russian format requires ~40 sec on a UNIVAC 1108. If the cross-section data is in the "DTF" format, the same problem would require ~5 sec.
7. Related and Auxiliary Programs: The format of the input data (e.g., flux dumps, geometry, and composition specifications, etc.) is compatible with Los Alamos one- and two-dimensional transport codes DTF-IV[3] and 2DF[4], the BNW two-dimensional burnup code 2DB[5], and the BNW perturbation code PERT-V.[6] The computer code ETOX[7] will prepare cross-section data in the Russian format from the ENDF/B data tape.
8. Status: In use.
9. Machine Requirements: A 65 K memory and seven peripheral storage devices.
10. Material Available: A source deck, sample problem, and operation instructions are available from the authors.