cross section versus temperature table. A highly simplified fuel temperature model is included.

4. Method of Solution: The improved quasi-static method as described in Ref. 1 is used to solve the time-dependent problem. The method consists of factoring the total flux into the product of a space-energy-time-dependent shape function and a purely time-dependent amplitude function, normalized so that the most rapidly varying part of the total flux is included in the amplitude function. The coupled set of equations which results is solved iteratively. The factorization method was developed specifically for fast reactor safety analysis. The advantages of factorization are greatest for such systems, though the code has been shown to perform adequately on thermal reactor problems.

5. Restrictions on the Complexity of the Problem: 30 energy groups, 15 downscatter groups, 6 delayed neutron families, 20 spatial regions, 16 material mixtures per region, 150 mesh points.

6. Typical Running Time: A 29-group, 15 downscatter, 51 mesh point rod-drop problem run to 30 reactor sec executed in 29 min on the CDC 3600 and 10 min on the IBM 360/75. A 10-group, 6 downscatter, 53 point pulsed-reactor problem run to 1-msec reactor time executed in 10 min on the IBM 360/75.

7. Unusual Features of the Program: The running time can be reduced greatly for problems requiring relatively low accuracy, but the code has been shown to reproduce the results of direct finite-difference codes when convergence is tightened. An automatic time-step selector provides the capability of using small time steps in those portions of the transient where necessary to maintain accuracy, and larger time steps where possible to reduce running time. A true point kinetics problem can be run using only the initial shape function. A compact problem edit is given in terms of the familiar integral quantities of reactivity, effective delayed-neutron fraction, generation time, etc. Very general problem driving functions and time step controls may be used. A group-collapsing system is built into the problem preparation module of the code.

8. Status: Extensive testing and comparison with other kinetics codes has been completed. The code is in use at Argonne National Laboratory.

9. Machine Requirements: The CDC-3600 version requires a 64K memory and a maximum of eight tapes plus input, output, and punch tapes. The IBM-360 version requires 140K short words of memory, a maximum of eight disk datasets plus input, output, and punch datasets.

10. Programming Language Used: FORTRAN IV. Each version is independent of the peculiarities of local language to the maximum extent possible. Variances are documented on comment cards within the code. The CDC-3600 version has been adapted to the CDC-6000 series language through interaction with work carried out on a CDC-6500 machine.

11. Operating System: CDC-3600—SCOPE 6.2. IBM 360/75—OS/360 (Release 17).

12. Material Available: The source deck, cross-section library, sample problems, and the reference document[2] which describes the code are available from the Argonne Code Center. The requestor should specify either the CDC-3600 version or the IBM-360 version as required. The CDC-3600 version is recommended for adaptation to a CDC-6000 series machine.

13. *Acknowledgment*: This work was performed under the auspices of the U. S. Atomic Energy Commission.

14. *References*:

[1]K. O. OTT and D. A. MENELEY, *Nucl. Sci. Eng.*, **36**, 402 (1969).

[2]D. A. MENELEY, K. O. OTT, and E. S. WIENER, "Fast Reactor Kinetics—The QX1 Code," ANL-7769, Argonne National Laboratory (March 1971).

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SN35

1. Name of Code: SN35.

2. Computer for Which Program is Designed: ICL-1905.

3. Nature of Physical Problem Solved: SN35 solves the time-independent neutron transport approximation for specially dependent neutron flux distribution in spherical geometry. The code provides the pay-off matrices of a two-person nonzero sum game for given strategies and given quantities of fertile material in a fast critical system.

4. Method of Solution: It is a new approach to solve the neutron transport equation. The parameter which is modified at the end of each outer iteration is not critical radius but ratio of critical quantity of fissile material and given quantity of fertile material.

5. Restrictions on the Complexity of the Problem: 41 spatial points, 16 energy groups, 5 angular directions, 5 nuclides, 3 zones of heterogeneity.

6. Typical Running Time: 60 min.

7. Unusual Features of the Program: Number of spatial points used in every zone is proportional to its thickness which is variable with outer iteration.

8. Related and Auxiliary Programs: The problem solved is a nonlinear one; therefore, the algorithm is analogous but not identical with standard SN.

9. Status: In use.

10. Machine Requirements: 28K words core; no peripheral storage devices are required.

11. Programming Language Used: FORTRAN-1900.

12. Operating System on Monitor Under Which Program is Executed: Supervisor and, in particular, George.

13. Other Programming and Operating Information or Restrictions: The program is compiled by XFAM 4E and listed by editor XMUM MARK 3A.

14. Material Available: A source deck, sample problem, and operating instructions are available from the authors.

15. *Acknowledgment*: This paper is based on work performed under State Committee for Nuclear Energy Contract 134/7 (1970).

16. *References*:

M. PAVELESCU, V. ANTON, I. PURICA, "Numerical Method for Solving Transport Equation in the Case of Multizone Nuclear Reactors," Preprint IFA FR-85-1971, Institutt for Atomeneigi, Kjeller, Norway.

I. PURICA, "Optimization of the Initial Breeding Ratio of a Nuclear Reactor Considered as a Game Theory Problem," *Proc. U. N. Intern. Conf. Peaceful Uses At. Energy, 3rd*, Geneva, P/674 (1964).

"Reactor Physics Constants," ANL-5800, 2nd ed., Argonne National Laboratory (1963).

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APEL

1. Name of Code: APEL.

2. Computer for Which Program is Designed: ICL-1905.

3. Nature of Physical Problem Solved: APEL solves the time-independent neutron transport approximation for spatially dependent neutron flux distribution in a spherical geometry. The code provides critical parameters (flux distribution, critical mass, reaction rates, initial breeding ratio) for given volume fractions of the fast system.

4. Method of Solution: SNG.

5. Restrictions on the Complexity of the Problem: 50 spatial points, 16 energy groups, 5 angular directions, 5 nuclides, 3 zones of heterogeneity.

6. Typical Running Time: 30 min.

7. Unusual Features of the Program: Number of spatial points used in a zone is proportional to its thickness.

8. Related and Auxiliary Programs: The macroscopic multigroup cross sections are computed in the code itself; therefore, no relation with auxiliary program is required.

9. Status: In Use.

10. Machine Requirements: 28K words core and no peripheral storage device are required.

11. Programming Language Used: FORTRAN-1900.

12. Operating System or Monitor Under Which Program is Executed: Supervisor and, in particular, George 2.

13. Other Programming and Operating Information or Restrictions: The program is compiled by XFAM 4E and listed by editor XMUM MARK 3A.

14. Material Available: A source deck, sample problem, and operating instructions are available from the authors.

15. *Acknowledgment*: This paper is based on work performed under State Committee for Nuclear Energy Contract 134/7 (1970).

16. *References*:

M. PAVELESCU, V. ANTON, and I. PURICA, "Numerical Method SNG," Preprint IFA, FR-81-1971, Institutt for Atomenergi, Kjeller.

"Reactor Physics Constants," ANL-5800, 2nd ed., Argonne National Laboratory (1963).

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