Computer Code Abstract

CITATION

1. Name of Code: CITATION

2. Computer for Which Code is Designed: The code is designed to effectively use the computers in IBM-360 series and others which have 500 000 word, directly addressable storage. It could easily be made operational on any computer having at least 128 000 word storage, but considerable reprogramming would be required if extensive data handling were to be done efficiently on a smaller machine.

3. Problems Solved: This code is designed to attack the reactor core depletion and dynamics problems in a general sense. A variety of mathematical formulations is available to choose from—for example, the general neutron-flux-eigenvalue problem may be solved in one-, two- or three-dimensional geometry with arbitrary scattering in the discrete-energy, finite-difference diffusion-theory formulation. Certain other formulations are being added (since the development effort continues on this program) and still others will be incorporated.

   At the time this is written the program will solve eigenvalue problems within a finite-difference representation of the diffusion-theory approximation to neutron transport in multigroup form with arbitrary scattering. The eigenvalue problem may involve the determination of the effective multiplication factor, or be a direct criticality search on buckling, on $1/\nu$ absorber, or on the concentrations of specified nuclides which may include fuel. The adjoint problem may be solved and perturbation calculations performed. Up to three geometric dimensions may be considered including X-Y-Z, R-Θ-Z and Hexagonal-Z coordinate systems.

4. Method of Solution: Explicit, finite-difference approximations in space and time have been given preference although certain other techniques are being incorporated. The neutron-flux-eigenvalue problems are solved by direct iteration to determine the multiplication factor or the nuclide densities required for a critical system.

5. Restrictions on Complexity of the Problem: This code has been designed to attack problems which can be run in a reasonable amount of time; storage of data is allocated dynamically to give the user flexibility in dimensioning. Typically, a finite-difference diffusion problem could have 200 depleting zones, 10 000 nuclide densities and up to 30 000 space-energy point flux values with all equation constants for the iterative eigenvalue problem available in storage.

6. Typical Machine Time: The two-dimensional finite-difference diffusion-theory eigenvalue problems iterate at a rate of ~0.00010 sec/point/iteration with alternating-direction line relaxation (two sweeps per iteration) with 8-byte words on the IBM 360/91 (0.0005 on the 360/75). Since ~30 iterations are required for each eigenvalue problem, machine time for a depletion or dynamics problem is ~0.003 sec/point/time step; this time should be multiplied by the number of times each step is to be repeated (i.e., by the number of times eigenvalue problems are repeated).

7. Unusual Features of the Program: This code is considered unusual in that it should be relatively easy to modify the contents or to add routines.

   Effective techniques are incorporated to determine a critical system. More than one set of microscopic cross sections may be used in a system and nuclide behavior can be followed on a sub-zone scale within depletion regions. The data required for nuclide chain relationships, for delayed neutrons and for calculating the capture gamma source can be supplied on the microscopic cross-section tape allowing automation of many types of calculations. The user has flexible control over the route of a calculation as well as of the edit of results.

8. Related and Auxiliary Programs: The microscopic cross-section tape for this code may be generated by various codes, but XSDRN[2] is designed specifically for this purpose.

9. Status: This code is in production use at ORNL and additional development effort is being devoted to it to extend the treatment. Users load the code from a disk or tape with control cards and any routine may be replaced at execution time by either a Hex deck or a FORTRAN deck to be compiled.

10. Machine Requirements: IBM 360/91 or equivalent with at least 128 000 4-byte words directly addressable core storage, eight I/O devices, excluding input and output devices and system requirements.

11. Programming Language Used: Only IBM FORTRAN IV language is used, but tightened-up loops in machine language may also become available.

12. Operating System: IBM OS 360 with FORTRAN IV, H-level compiler.

13. Programming Information: At the present time this code contains ~13 000 source statements, and without overlay, storage for the code instructions would approach 90 000 4-byte words.

14. Users Information: The report containing instructions for use is loose-leaf to allow continuing modification.

We recommend that the latest FORTRAN tape of this code be obtained from the Argonne Code Center for use at any installation and that a direct channel of communication be opened up by a letter to us requesting that you be placed on the CITATION distribution list to obtain additions to the report.

15. *Acknowledgment:* This research was sponsored by the U.S. Atomic Energy Commission under contract with the Union Carbide Corporation.

16. *References*:

[1]N. M. GREENE and C. W. CRAVEN, JR., "XSDRN: A Discrete Ordinates Spectral Averaging Code," USAEC Report ORNL-TM-2500, Oak Ridge National Laboratory.

[2]N. M. GREENE et al., "XSDRN: A Discrete Ordinates Spectral Averaging Code," USAEC Report ORNL-TM-2500, Oak Ridge National Laboratory.

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