Computer Code Abstract

REBUS-3

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1. Program Identification: REBUS-3.

2. Function: REBUS-3 is a system of codes designed for the analysis of fast reactor fuel cycles. Two basic types of analysis problems are solved: (a) the infinite-time or equilibrium conditions of a reactor operating under a fixed fuel management scheme, or, (b) the explicit cycle-by-cycle or nonequilibrium operation of a reactor under a specified periodic or nonperiodic fuel management program. For the equilibrium-type problems, the code uses specified external fuel supplies to load the reactor. Optionally, reprocessing may be included in the specification of the external fuel cycle, and discharged fuel may be recycled back into the reactor. For nonequilibrium cases, the initial composition of the reactor core may be explicitly specified, or the core may be loaded from external feeds as in equilibrium problems.

   Four types of search procedures may be carried out in order to satisfy user-supplied constraints: (a) adjustment of the reactor burn cycle time to achieve a specified discharge burnup, (b) adjustment of the fresh fuel enrichment to achieve a specified multiplication constant at a specified point during the burn cycle, (c) adjustment of the control poison density to maintain a specified value of the multiplication constant throughout the reactor burn cycle, and (d) adjustment of the reactor burn cycle time to achieve a specified value of the multiplication constant at the end of the burn step.

3. Method of Solution: The total reactor burn cycle time is divided into one or more subintervals, the number of which is specified by the user. An explicit burnup is performed in each region of the reactor over each of these subintervals using the average reaction rates over the subinterval. These average reaction rates are based on fluxes obtained from an explicit one-, two-, or three-dimensional diffusion theory neutronics solution computed at both the beginning and end of the subinterval. The transmutation equations are solved by the matrix-exponential technique. The isotopes to be considered in the burnup equations, as well as their transmutation reactions, are specified by the user.

4. Related or Auxiliary Programs: This is a stand-alone version of the modular REBUS-3 code system described in Ref. 1. REBUS-3 is fully compatible with the CCCC (Ref. 2) coding standards and interface data sets. It utilizes the DIF3D (Ref. 3), SYN3D (Ref. 4), and nodal option of DIF3D (Ref. 5) codes to obtain the neutronics solution. DIF3D (with finite difference and hexagonal nodal option) and SYN3D are included in the code package.

5. Unusual Features: Will handle both equilibrium and nonequilibrium problems using a number of different core geometries, including triangular and hexagonal mesh. The neutronics solution can be obtained using finite difference, spatial flux synthesis, or nodal diffusion-theory methods. Fully automatic restart capability. No restrictions on number of neutron energy groups. General external cycle with no restrictions on number of external feeds, reprocessing plants, etc. Fuel management is completely general for nonequilibrium problems.

6. Restrictions: The recycle of discharged fuel is not permitted in nonequilibrium-type problems.

7. Computer: IBM 370 series machines.

8. Running Time: 3 to 30 min on IBM 370/195 machine depending on size and complexity of problem.

9. Status: The modular version of the code is in production use at Argonne National Laboratory.

10. Programming Languages: Fortran (99.9%), assembly language (0.1%).

11. Operating System: OS/MVT or MVS with Fortran library.

12. Machine Requirements: IBM OS/370 machine with at least 500 K core storage. Supplied sample problems require ~1080 K-bytes for execution.

13. Other Programming or Operating Information: Creation of load module requires a total of 11.7 million bytes of direct access (disk) storage. Several subroutines require enlarging the dimensions of the address constant table and the table used during generation of optimized code in the IBM compiler IFEAAB.

14. Material Available: Restricted Distribution

    Magnetic Tape Transmittal

    1. User's Manual

    2. Implementation Instructions

3. Magnetic Tape Containing:
   a. source code
   b. JCL procedure for execution
   c. linkage editor control cards
   d. two sample data decks
   e. output listings for both sample problems.

15. Category: D

Keywords: Breeding
Criticality
Depletion
Fuel cycle
Numerical calculations

16. Sponsor: Division of Reactor Research and Technology, U.S. Department of Energy.

17. References:

[1]B. J. TOPPEL, "The Fuel Cycle Analysis Capability, REBUS-3," ANL-83-2, Argonne National Laboratory (1983).

[2]R. DOUGLAS O'DELL, "Standard Interface Files and Procedures for Reactor Physics Codes, Version IV," LA-6941-MS, Los Alamos National Laboratory (1977).

[3]K. L. DERSTINE, "DIF3D: A Code to Solve One-, Two-, and Three-Dimensional Finite-Difference Diffusion Theory Problems," ANL-82-64, Argonne National Laboratory (1983).

[4]C. H. ADAMS, "SYN3D: A Single Channel Spatial Flux Synthesis Code for Diffusion Theory Calculations," ANL-76-21, Argonne National Laboratory (1976).

[5]R. D. LAWRENCE, "The DIF3D Nodal Neutronics Option for Two- and Three-Dimensional Diffusion Theory Calculations in Hexagonal Geometry," ANL-83-1, Argonne National Laboratory (1983).