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Computer Code Abstracts

FIGRO

1. Name or Designation of Program: FIGRO, Analysis of Fuel Swelling and Calculation of Temperature in Bulk-Oxide Cylindrical Fuel Elements.[1,2]

2. Computer for Which Program is Designed and Programming Languages Used: CDC-6600, FORTRAN IV, and ASCENT. The program is in FORTRAN IV; however, some ASCENT subroutines have been used that are part of the Bettis computing environment.[3]

3. The temperature distribution and fractional change in volume of a bulk-oxide fuel rod due to formation of fission products are calculated at a single point in time for a given fuel depletion and heat generation rate. The analysis is performed on a steady-state basis using the Greenwood-Speight swelling model for the van der Waals equation of state.

   The fuel thermal conductivity is a function of temperature, depletion, and porosity. Fuel swelling depends on temperature, depletion, internal hydrostatic pressure, and fissioning rate. The clad-fuel interface heat transfer is based on the Ross-Stoute model with temperature-dependent gas mixture thermal conductivities.

4. Method of Solution: The fuel rod is divided radially into concentric annular rings and then steady-state difference equations are written to describe the heat conduction in the radial direction. These equations are solved for the temperature of each ring which is then used along with a user-specified depletion and hydrostatic pressure to compute the swelling of the ring. The total fuel rod swelling is computed as the sum of the individual swellings.

5. Restrictions on Complexity of the Problem: Up to 100 radial sections may be user specified. The fuel can be a solid pellet, a cored pellet, or a two-zone solid pellet. Each zone is assumed to be a region of constant depletion.

6. Related and Auxiliary Programs: None.

7. Typical Running Time: Two seconds per case.

8. Unusual Features of the Program: FIGRO solves the one-dimensional heat-conduction equation with thermally varying properties for a cylinder which has a volume growth induced by temperature and irradiation effects.

9. Status: In production and obtainable by domestic users from the Argonne Code Center.

10. Machine Requirements: 32 000 central memory locations.

11. Operating System or Monitor Under Which Program is Executed: FIGRO currently operates under the SCOPE 2.0 system. The FCHIP, CARDS, and INP routines[3] are called by the program.

12. Other Programming or Operating Information or Restrictions: Conversion to another computer necessitates the use of the Bettis software environment.

13. *References:*

[1]I. GOLDBERG, L. L. LYNN, and C. D. SPHAR, "FIGRO—FORTRAN IV Digital Computer Program for the Analysis of Fuel Swelling and Calculation of Temperature in Bulk-Oxide Cylindrical Fuel Elements, "WAPD-TM-618, Westinghouse Electric Corp. (December 1966).

[2]L. A. WALDMAN, L. L. LYNN, and I. GOLDBERG, "FIGRO (Addendum)," WAPD-TM-618, Westinghouse Electric Corp. (December 1967).

[3]C. J. PFEIFER, "CDC-6600 Fortran Programming—Bettis Environmental Report," WAPD-TM-668, Westinghouse Electric Corp. (January 1967).

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2DB

A Two-Dimensional Fast-Reactor Burnup Code

1. Name of Code: 2DB.[1]

2. Computer for Which Code is Designed: UNIVAC 1108. Programming Language: "Standard" FORTRAN-IV.

3. Nature of Code: 2DB is a flexible, two-dimensional (X-Y, R-Z, R-θ geometry) diffusion code for use in fast-reactor analyses. The code can be used to:

   a) compute fuel burnup

   b) perform criticality search on time absorption (α), material concentrations, and region dimensions using a regular or adjoint model. Criticality searches can be performed during burnup to compensate for fuel depletion.

4. Method of Solution: Standard source-iteration techniques; group rebalancing and successive over-relaxation with line inversion (SLOR) are used to accelerate convergence.