Computer Code Abstract

RETRAC: A Program for the Analysis of Materials Test Reactors

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1. Program Identification: REactor TRansient Analysis Code[1] (RETRAC) is a computer code specially developed for the analysis of materials test reactor (MTR) cores.

2. Description of Problem Solved: The RETRAC code uses a set of coupled neutron point-kinetics equations and thermal-hydraulic conservation laws to simulate nuclear reactor core behavior under transient or accident conditions. The reactor core is represented by a single equivalent unit cell composed of three regions: fuel, clad, and moderator (coolant).

3. Method of Solution: At each time step, core thermal power is calculated by solving a set of six delayed neutron group kinetics equations with adjusted reactivity feedbacks. The numerical resolution is performed by using the Range-Kutta-Gill method.[2] The externally inserted reactivity is specified in the input data file, whereas Doppler, fuel, clad, and water temperature reactivity feedbacks are calculated by the code itself. Core cooling is treated as a homogeneous one-dimensional fluid flow through a representative unit cell composed of three successive regions: fuel, clad, and coolant. Several flow regime models are considered for both single- and two-phase states of the coolant. The conservation laws are solved by the method of characteristics coupled with an implicit finite difference scheme to ensure stability and convergence of the numerical algorithm.[3]

   Validation tests of the RETRAC code were performed by using the International Atomic Energy Agency 10-MW benchmark cores, for protected transients.[4,5] Further assessment studies are in progress using experimental data.

4. Related Material: No additional programs are required.

5. Restrictions: The RETRAC code uses steady-state thermal-hydraulic correlations. Their use is not always justified, but this seems to be quite useful in quasi-steady-state cases such as loss-of-flow transients.

6. Special Features of the Program: The method of characteristics used to solve the set of thermal-hydraulic conservation equations is a very stable and highly converging numerical scheme, which has shown a net superiority over the one used by the PARET code,[6] particularly in steady-state calculations.

7. Computers: The code was developed on a VAX-4000 working station.

8. Running Time: The running time depends essentially on the time step selected and the accuracy desired by the code user.

9. Machine Requirements: Minimum space required: 650 kbytes.

10. Program Language: FORTRAN 77.

11. Operating System: Virtual memory system.

12. Additional Programming Information: The code requires at least two logical units for input and output files.

13. Material Available: A referenced report and a diskette containing the source file, two sample problems, and their related output files. The material is available from the authors.

14. References:

[1] B. BAGGOURA, T. HAMIDOUCHE, and A. BOUSBIA-SALAH, "RETRAC, A Program for the Analysis of M.T.R. Research Reactor Cores," Internal Technical Report, Centre de Radioprotection et de Sûreté.

[2] E. R. COHEN, "Some Topics in Reactor Kinetics," *Proc. 2nd Int. Conf. Peaceful Uses of Atomic Energy*, Geneva, Switzerland, September 1-13, 1958, Vol. 11, United Nations Publication.

[3] S. NAKAMURA, *Computational Methods in Engineering and Science*, Wiley-Interscience, New York (1977).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, *Safety and Licensing Guidebook of Research Reactor Core Conversion from the Use of High Enriched Uranium to the Use of Low Enriched Uranium*, Vol. 3, Appendixes G and H, International Atomic Energy Agency, Vienna (1990).

[5] "Research Reactor Core Conversion from the Use of High Enriched Uranium to the Use of Low Enriched Uranium Fuel Guidebook," IAEA-TECDOC-233, International Atomic Energy Agency (1980).

[6] W. L. WOODRUFF, "A Kinetics and Thermal-Hydraulics Capability for the Analysis of Research Reactors," *Nucl. Technol.*, **64**, 196 (1984).