Computer Code Abstract

FLASH6

1. Name of Program: FLASH6.
2. Computer and Language(s): CDC-6600 and CDC-7600, FORTRAN-IV.
3. Problem Solved: The FLASH6 computer program[1] has been developed to simulate a loss-of-coolant accident (LOCA) or other severe reactor-plant variable-pressure transients for light-water-moderated nuclear reactor plants. FLASH6 provides for modeling a reactor plant using a combination of control volumes (nodes), connecting flow paths, pumps, and steam generators. FLASH6 is an extension of the FLASH5 program,[2] and new or updated modeling features include water property routines, momentum equation model, main coolant pump, beyond critical heat flux (CHF) heat transfer options, fuel rod thermal model, gap conductance, clad expansion, and phase separation model. FLASH6 contains those models required by the U.S. Code of Federal Regulations, Title 10, Part 50 (*10-CFR-50*), Appendix K, which are relevant to the Light Water Breeder Reactor Development Program.
4. Method of Solution: An implicit numerical integration technique is used in FLASH6 to solve the conservation equations of mass and energy for the control volumes and conservation of momentum for the flow paths. Thermodynamic equilibrium is assumed. Pressure in the control volumes is obtained from the equation-of-state for water. In addition, heat may be added to control volumes by the reactor core, steam generator, and plant metal heat capacity models.
5. Limitation on Problem Complexity: A detailed representation of a reactor core region may be modeled by using up to 80 pressure-determining nodes within the core. The core nodes are connected in one-dimensional chains to represent core flow paths. Up to 20 core flow paths may be used. A one-dimensional heat conduction model with up to five radial nodes is used to represent the flow of heat from the fuel element to each core fluid node. The thermal resistance of the fuel-clad gap is continuously calculated as a time-varying function of gap dimension, gap temperature, and gap pressure. Thirty nodes and 60 flow paths are available to model the noncore regions of a plant.
6. Related and Auxiliary Programs: FLASH6 uses Bettis Atomic Power Laboratory programming environment routines[3] such as CARDS for input data, FMG for writing binary data files for problem restarts, and plotting routines for graphical output. The environmental routines are available with the FLASH6 program upon request. The routines and data for water and transport properties are included in the FLASH6 program and are described in Ref. 1.
7. Typical Running Time: Running time varies widely with problem complexity. The sample problem transmitted with FLASH6 to the Argonne Code Center contains 28 nodes and 28 flow paths. The problem also contains a single core channel with eight axial levels and two radial nodes to represent the fuel element. For this problem, FLASH6 will execute ~688 time steps for each CDC-7600 central processor unit (CPU) minute.
8. Unusual Features: The FLASH6 program requires 200000_8 locations of high-speed large core storage for storing and processing water property data.
9. Status: Production.
10. Machine Requirements: CDC-6600—144 K of central memory
    200 K of ECS
    CDC-7600—144 K of central memory
    200 K of LCM.
11. Operating System: CDC-6600—Scope 3.3
    CDC-7600—Scope 1.1.
12. Other Information: Reference 1 is a complete and self-contained document of the FLASH6 model, numerical methods, and user input guide.
13. Availability: Reference 1 is available from

    U.S. Department of Commerce
    National Technical Information Service
    5285 Port Royal Road
    Springfield, Virginia 22151.

    Copies of the computer program may be obtained by domestic users from

    Argonne Code Center
    Attention: Mrs. Margaret Butler
    Argonne National Laboratory
    9700 South Cass Avenue
    Argonne, Illinois 60440.

14. *References*:

[1]J. J. BEYER, W. D. PETERSON, D. A. PRELEWICZ, and G. W. SWARTELE, "FLASH6: A FORTRAN-IV Computer Program for Reactor Plant Loss-of-Coolant Accident Analysis," WAPD-TM-1249, Bettis Atomic Power Laboratory (1976).

[2]J. H. MURPHY, J. A. REDFIELD, and V. C. DAVIS, "FLASH-5: A FORTRAN-IV Program for Transient Simulation of a Reactor Plant with a Detailed Core," WAPD-TM-999, Bettis Atomic Power Laboratory (1973).

[3]W. R. CADWELL, Ed., "Reference Manual—Bettis Programming Environment," WAPD-TM-1181, Bettis Atomic Power Laboratory (1974).

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