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Computer Code Abstract

EQUIPOISE BURNOUT

1. Name of code: EQUIPOSE BURNOUT
2. Computer for which code is designed: IBM 7090 with at least 13 tape units.
   Programming system: FORTRAN
3. Nature of problem solved: The steady-state, two-group, two-dimensional, multiregion neutron diffusion equations are solved as a function of nuclide concentrations to establish neutron flux levels at a given time. Nuclide concentrations are calculated on the basis of a constant flux level following a given time step. These calculations are repeated for a number of time steps. The EQUIPOISE method is used for the solution of the group-diffusion equations in two dimensions permitting a direct search on fuel or poison concentrations to maintain criticality. Coolant density distribution can be taken into consideration and fuel cycle costs calculated.
4. Restrictions on the complexity of the problem—Maximum of:
   - 1600 space mesh points
   - 100 space mesh points in one direction
   - 69 regions
   - 99 nuclides
   - 10 nuclide chain routes in any region
   - 10 nuclides in any chain route
   - 6 nuclides in 10 regions which may be varied in concentration during a criticality search
   - 10 different P_3 cell calculations, each of which may apply to a maximum of 29 regions
   - 30 regions comprising a maximum of 6 flow routes which may contain circulating nuclides or for which coolant density may be determined
   - 50 regions and 50 different nuclides for which the spectral hardening calculation may be made—results of which may apply to all regions and nuclides
   - 90 time steps if the economics calculation is to be made
5. Typical running time: The running time required to satisfy reasonable convergence criteria may be approximated from the relation

$$T(\text{min}) = 5.0 + 0.0025\, N_p \sum_{i=1}^{n} N_{si} N_{ci}\,,$$

where

N_p is the number of mesh points,
n is the number of time steps,
N_{si} is 1 for nonsearch calculations, 1.5 for usual search problem, or 3.0 for complex rod movement,
N_{ci} is 1 if coolant density is not determined, or 2.5 if there is a coolant density calculation.

6. Unusual features of the code:
   A. Criticality may be maintained by fuel, poison, or control rod position search (the rod bank may be removed or inserted as required); the variable in the criticality search is treated as the eigenvalue of the problem and a direct search made in little more time than that required by the usual eigenvalue calculation of the multiplication constant.
   B. A generalized explicit solution of the coupled nuclide chain equation is used which accounts for contributions along more than one chain route. Nuclide chains for each region are specified as input.
   C. Coolant density distribution, as for a boiling water reactor, may be established at any time step by iteration between the eigenvalue (or search) calculation and the coolant density calculation.
   D. Correlations may be made from initial P_3 calculations to account for the effect of exposure on thermal flux depression.
   E. Thermal spectrum hardening effects may be accounted for by the Wilkins "heavy gas" model using Westcott parameters for energy dependence of cross sections.
   F. Region compositions may be rearranged, added, or removed in any way whenever specified.
   G. Account may be taken of fuel and/or fertile material circulating through regions which may contain fixed fuel and/or fertile material.
   H. Associated fuel cycle costs may be calculated using standard economics factors.
   I. Periods of shutdown may be considered at any time; the results may be included in subsequent depletion time steps.
   J. At the expense of more complex input requirements, this code contains many optional features permitting broad applications. The program was developed as a general reactor code (within the limits of the model chosen) which may be used for calculations ranging from simple time-independent eigenvalue problems to complicated time-dependent search problems. A complete history of operation may be determined, in theory, including conditions at the time control rods are completely removed (or k_{eff} reaches a predetermined value for nonsearch problems), in a single machine calculation.
7. Present status: In use, available pending publication of report.
8. *References:* D. R. Vondy and T. B. Fowler, EQUIPOISE BURNOUT: A reactor depletion code. ORNL Report to be issued.

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