Computer Code Abstract

GAUGE

1. Name of Program: GAUGE, A Two-Dimensional Few-Group Neutron Diffusion-Depletion Program for a Uniform Triangular Mesh.

2. Computer for Which Program is Designed: UNIVAC 1108, also operable with minor modification on UNIVAC 1107 and IBM 360/65.
Programming Language: FORTRAN IV.

3. Nature of Physical Problem Solved: The two-dimensional few-group neutron diffusion theory equations for a uniform triangular mesh are solved to obtain the multiplication factor and the spatial flux and power distribution of reactors with hexagonal core configuration. Complete reactor life histories with partial refueling at a number of reload time points can be calculated. At each discrete time point, a control rod search may be performed to maintain criticality at all times. The depletion scheme of all burnable nuclides is specified by the user at execution time. Three modes of operation are possible: 1) straight burnup calculation; 2) control rod criticality search, allowing the adjustment of a number of control rod banks according to a prescribed rod sequencing scheme; and 3) a series of static calculations with insertion of rods into fixed prescribed positions.

4. Method of Solution: A seven-point difference expression for a uniform 60° triangular mesh is used, assuming that the smallest homogeneous diffusion region has the form of a hex block which may represent an individual fuel element. The block inversion method[1] is applied to calculate the fine flux distribution for the basic cells of a coarse spatial mesh for given flux values at the boundaries of the cells. A coarse mesh rebalancing[2] for the same supermesh is done after each fission source iteration. In addition, an asymptotic fission source extrapolation[3] is used periodically to eliminate the next-to-lowest eigenfunction.

   A general and flexible burnup routine system was developed[3] which allows an optimal choice of either a difference approximation or an analytical solution of the depletion equations. The code decides internally, for each time step and every nuclide, which approximation is used. As the most general case, a full triangular depletion matrix is allowed.

5. Restrictions on the Complexity of the Problem: The code allows 1519 hexagonal fuel or reflector elements with 4405 mesh points, 4 energy groups with downscattering only into the next lower energy group, 280 burnup regions, 40 burnable nuclides, 80 microscopic cross-section blocks and 5 variable self-shielding factor tables. The flux is assumed to be zero at the outer reactor boundary.

6. Related and Auxiliary Programs: As a counterpart to GAUGE, a three-dimensional static diffusion theory program GATT[4] for a hexagonal z mesh was developed based on the same principles.

7. Typical Running Time:

   a) 4-group problem with 637 hexagonal elements, 1201 mesh points, 35 nuclides, 170 regions, no control search: 1 min per long time step.

   b) Same problem with criticality search: 2 min.

   c) Full-size problem: 4 min per long time step.

8. Status: The program has been in production use since July 1967, and may be obtained by domestic users from the Argonne Code Center.

9. Machine Requirements: 65k central memory size, one drum (or scratch tape) unit, input, output, and restart tape.

10. Operating System Under Which Program is Executed: EXEC-II.

11. Other Programming Information: Overlay loading is used. GAUGE contains a main overlay, 2 primary, and 3 secondary overlay sections. With the exception of the edit segment, the diffusion calculation is completely core-contained.

12. *References:*

[1]H. KRAETSCH and M. R. WAGNER, *Trans. Am. Nucl. Soc.*, **10**, 173 (1967).

[2]R. FROEHLICH, "A Theoretical Foundation for Coarse Mesh Variational Techniques," GA-7870, General Atomic Division, General Dynamics Corporation (1967).

[3]M. R. WAGNER, "GAUGE, A Two-Dimensional Few Group Neutron Diffusion-Depletion Program for a Uniform Triangular Mesh," GA-8307, Gulf General Atomic Inc. (1968).

[4]H. KRAETSCH and M. R. WAGNER, "GATT, A Three-Dimensional Few Group Neutron Diffusion Theory Program for a Hexagonal-z Mesh," GA-8547, Gulf General Atomic Inc. (1968).

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