Computer Code Abstracts

KARE

1. Name of program: KARE
2. Computer for which the program is designed: 32K Philco-2000 with 14 tape units. Programming system: TAC.
3. Nature of the problem solved: One- and two-dimensional diffusion equations in up to five energy groups in r–z, x–y with diagonal line, or uniform triangular mesh geometry. The basic KARE System (*1–3*) calculates material and energy dependent group constants under various reactor operating conditions at any time during the life of a reactor, the spatial distribution of fission sources and energy dependent neutron fluxes based upon these group constants, and fuel and poison depletion as a result of sustained operation with constant (i.e., steady state) xenon poisoning. Included are reactivity calculations and criticality searches; problems may be sequenced to form a complete life study.
4. Method of solution: Group constants may be supplied as input, calculated according to the three-group Deutsch prescriptions (*4*), or calculated according to a two, three, or four group FICS scheme.
   In FICS, fast group constants are produced through curve fitted formulas based on MUFT5 results (*5*), and thermal group constants are calculated by the variational techniques of Ombrellaro *et al.* (*6*).
   Spatial calculations consist of an inner (or flux) iteration procedure and an outer (or source) iteration procedure. The inner iterations use either the Peaceman-Rachford alternating direction implicit method, or line relaxation, depending upon geometry and mesh size. The outer iterations are accelerated in accordance with the Chebychev error reduction technique.
   The fuel depletion in each material region is assumed proportional to the power in the region. Poison depletion is related directly to fuel depletion.
5. Restrictions on the complexity of problems solved:
   a. Number of groups ≤ 5
   b. Number of mesh points $\leq 20{,}000$
   c. Number of material regions ≤ 511
6. Typical running time: Without a good source guess, typical running times for each time step of a two-dimensional KARE life study are:

$$T = \frac{PG}{500} \text{ for } r - z \text{ problems}$$

$$T = \frac{PG}{250} \text{ for } x - y \text{ or FLEER problems}$$

$$T = \frac{PG}{200} \text{ for } 90° \text{ periodic } x - y \text{ problems}$$

where

T = machine time in minutes,
P = number of flux points,
G = number of energy groups.

These times are usually 25 to 50% less when a good source guess from a similar problem is available.

7. Unusual features:
   a. Allowed boundary conditions are flux zero, current zero, current-to-flux ratio given, 90° periodicity applied to the top and right of a square, and 120° periodicity applied to the left and bottom of a rhombus.
   b. Each problem done as part of a life study is automatically supplied with a source and flux guess from an earlier problem.
   c. Reactivity coefficients may be calculated with the PSP perturbation program which is an integral part of the KARE System. Detailed characteristics of PSP will be described in a future abstract.
   d. KLAG, a multichannel flux synthesis routine for use with KARE, will be described in a future abstract.
8. Present status: In production at KAPL. For further information, contact P. V. Oby. Copies of the program may be obtained from the Transac User Groups Executive Secretary, Mr. John C. W. Cadoo, Jr., Philco Corporation, 3900 Welsh Road, Willow Grove, Pennsylvania.
9. *References*

1. J. A. Archibald, Jr., KARE, a system of diffusion theory programs for the Philco-2000: Volume I, General description and input preparation. KAPL-2165-1. (To be published. At least nine other volumes describing the various parts of the KARE System will be published in succeeding months.)

2. Reactor technology report No. 15—Physics. KAPL-2000-12, pp. VI.5–VI.16 (December, 1960).

3. J. A. Archibald, Jr., The KARE system for computing life studies automatically. *Trans. Am. Nuclear Soc.* **3,** 64 (1960).

4. R. W. Deutsch, Computing three-group constants for neutron diffusion. *Nucleonics* **15,** 47 (1957).

5. MUFT5, A fast neutron spectrum program for the Philco-2000. WAPD-TM-218 (February, 1961).

6. G. P. Calame, F. D. Federighi, and P. A. Ombrellaro, A two-mode variational procedure for calculating thermal diffusion theory parameters. *Nuclear Sci. and Eng.* **10,** 31 (1961).

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