NUCLEAR SCIENCE AND ENGINEERING: **22**, 496-498 (1965)

Computer Code Abstracts

CCA—108

1. Name of Code: AIROS
2. Computer for Which Code is Designed and Others Upon Which It is Operable: IBM-7094
3. Nature of Physical Problem Solved: AIROS solves the space-independent reactor-kinetics equations and provides for the determination of reactivity by solving in addition the discretized equations that represent the spatial heat and mass transfer model for several fuel channels. In addition, variation of the film coefficient with flow is accounted for along with the provision for flow decay and afterglow heating. Scrams can be initiated by delayed signals from instruments that sense any quantity calculated, e.g., power, inverse period or temperature. Generalized feedback equations are used to provide flexibility in the models that represent multichannel heat transfer including conduction and convection, energy, pressure and other phenomenon. The reactivity equation is also generalized. The reactivity feedback coefficients can be constand or vary as the square root or reciprocal of temperature. Furthermore any feedback variable can be used to initiate a reactivity scram, each with a unique delay time.
4. Method of Solution: The numerical technique used to integrate the neutron and feedback differential equations is that developed by E. R. Cohen as previously used in the AIREK codes. An improved interval-switching technique allows rapid calculations with predetermined accuracy.
5. Restrictions on the Complexity of the Problem: 15 delayed-neutron-precursor groups; 100 feedback variables with any variable "connected to" no more than 8 others. Printout of no more than 39 feedback variables.
6. Typical Running Time: One to two minutes for a problem with six delayed-neutron-precursor groups and fifty feedback variables (including CRT).
7. Unusual Features of the Code:

   a) Special provision is made for reactor startup problems resulting in large reduction in running time.

   b) Much of the required input data is preset but can be changed if desired.

   c) Addressable input data is used so that on multiple cases, only changes need be specified.

   d) A restart feature is provided wherein re-restart cards are punched upon abnormal problem termination and/or on an input option.

   e) Extensive printed and graphical displays are provided as follows: power, inverse period, reactivity and any 39 feedback variables. Printing and display of feedback variables is under the user's control, and the latter can be grouped on CRT frames as desired.

8. Related and Auxiliary Programs: None.
9. Status: In production.
10. *References:*

[1]R. A. Blaine and R. F. Berland, "AIROS—A Digital Simulator for Power Reactor Dynamics," NNA-SR-9943 (August, 1964).

[2]R. A. Blaine, "Modifications to AIROS," Atomics International Internal Letter, dated October 1, 1964.

[3]M. Hoffman and W. A. Rhoades, "AICRT 3, A General Code for Display of Digital Data," NAA-SR-MEMO-9069 (10/63).

11. Machine Requirements: 32 K; IBM 7094; SC-4200 graphical display device.
12. Programing Languages Used: FORTRAN IV (95%); MAP (5%).
13. Operating System or Monitor Under Which Program is Executed: IBSYS
14. Any Other Programing or Operating Information or Restrictions: If an SC-4020 graphical display device is not available, the AICRT-3 display routine can be rewritten; otherwise link 2 can be deleted and AIROS can be run as a non-overlay job without CRT.

    The NAA SC-4020 (IBSYS) subroutine package is available through:

    UAIDE Librarian
    c/o Stromberg-Carlson
    P. O. Box 2449
    San Diego, California
15. Material Available:
    a) AIROS source deck (2000 cards);
    b) sample data decks;
    c) reference documents;
    d) abstract.

R. A. Blaine

Supervisor, Nuclear Codes Unit
Mathematics and Computer
Applications Group
Atomics International
P. O. Box 309
Canoga Park, California

Received February 8, 1965

CCA—109

1. Name of Code: GRAVE
2. Computer for Which Code is Designed and Others Upon Which It is Operable: IBM 7094
3. Nature of Physical Problem Solved: GRAVE is the program to form group-averaged cross sections using the neutron cross-section master tape developed under the Atomics International automated cross-section program. Nineteen group-averaged parameters are obtainable as follows: σ_T, σ_{EL}, $\sigma_{N,\gamma}$, σ_F, $\bar{\nu}$, $\bar{\mu}$, $\bar{\xi}$, σ_{IN}, $\sigma_{N,\alpha}$

$\sigma_{N,P}$, $\sigma_{N,2N}$, σ_A, σ_{TR}, $\sigma_{NON\text{-}EL}$, $\bar{\alpha}$, $\xi\sigma_{EL}$, $\nu\sigma_F$, $\bar{\mu}\sigma_{EL}$, and σ_R. The spectrum is constructed from a combination of fission, E^{-n}, power series, Maxwellian or input spectra.

4. Method of Solution: Group-averaged cross sections are obtained by flux weighting in nonresonance groups and by the use of ARES II for resonance groups.
5. Restrictions on the Complexity of the Problem: The following limits may not be exceeded: 300 groups, 21 elements and 5 flux regions.
6. Typical Running Time: Twenty-one elements with all 19 parameters can be processed in 6 min using 18 to 54 groups.
7. Unusual Features of the Code: GRAVE requires the neutron cross-section master tape prepared by the MOMUS program. Punched output is available on option.
8. Related and Auxiliary Programs:
   a) MOMUS - prepares and updates neutron cross-section master tape.
   b) PRISM - produces elastic, inelastic and total transfer matrices.
9. Status: In production.
10. *References:*

[1]R. A. Blaine and J. S. Temple, "GRAVE, A Group Cross Section Averaging Program," NAA-SR-MEMO-9276 (December, 1963).

[2]R. A. Blaine, "Modificatiosn of the GRAVE Program," Atomics International Internal Letter, dated January, 1965.

[3]F. L. Fillmore and B. D. O'Reilly, "ARES-II, A Resonance Integral Code," NAA-SR-MEMO-8889 (August, 1963).

[4]R. A. Blaine, "MOMUS, A Program to Construct, Up-Date and Modify the Neutron Microscopic Cross Section Master Tape," NAA-SR-MEMO-8823 (August, 1963).

11. Machine Requirements: 32 K, IBM 7094.
12. Programing Languages Used: FORTRAN (95%) and FAP (5%)
13. Operating System or Monitor Under Which Program is Executed: Standard IBM FORTRAN monitor.
14. Any Other Programing or Operating Information or Restrictions: None.
15. Material Available:
    a) GRAVE source deck (including ARES II)—3500 cards;
    b) ARES Library—500 cards;
    c) Sample data;
    d) References 1, 2, and 3, as listed above.
    (MOMUS must be requested separately.)

R. A. Blaine

Supervisor, Nuclear Codes Unit
Mathematics and Computer
Applications Group
Atomics International
P. O. Box 309
Canoga Park, California

Received February 8, 1965

CCA—110

1. Name of Code: I.N.S. 10-1
2. Computer for Which Code Designed: IBM 1620 with a 40K core
   Programing System: FORTRAN II
3. Nature of Problem Solved: I.N.S. 10-1 is used to obtain starting points for least-squares analysis of elastic alpha-particle-scattering data. It was written specifically for oxygen-16 but is suitable for other zero-spin nuclei. The program compares an experimental angular distribution with the angular distribution calculated from a set of phase shifts. A mesh of phase shifts is studied and from the χ^2 calculated for each mesh point, minima in χ^2 are selected where χ^2 is the sum of the squares of the deviations between the experimental and calculated cross sections.
4. Method of Solution: Computation of the scattering cross section is by use of the formula given by Blatt and Biedenharn[1] and the program is divided into two main parts:

   a) Initializing

   b) χ^2 calculation.

   a) All data are read and stored, and computations and subroutines which would otherwise become repetitive, if included in the main calculation, are evaluated. This cycle is performed once only.

   b) Values of χ^2 are obtained for each set of phase shifts, and the phase shifts are incremented so as to cover a complete mesh. Repetitive calculations are kept to a minimum in this section in view of the large number of mesh points to be examined.

5. Restrictions on Complexity of Problem: As written the program will accept up to 15 values of Θ (scattering angle) and up to 10 phase shifts (δ_l). These limits could be extended provided storage was available. The main restriction for the 1620 is in time. If a large number of mesh points are to be studied, it is recommended that a faster computer be used. For example an IBM-7090 would reduce computing time by a factor $\approx 10^3$.
6. Typical Running Time: On the 1620 with 15 values of Θ and four of δ_l the program takes about 50 sec to initialize and 65 sec per mesh point thereafter.
7. Status: Program is in use and details are available from I.N.S.
8. *References:*

[1]Blatt and Biedenharn, *Rev. Mod. Phys.* **24,** 258 (1952).

[2]G. Pallo, "A Computer Program for Analysis of Data on the Elastic Scattering of Alpha Particles by Oxygen," Institute of Nuclear Sciences Report—INS-R-19. (This report gives full details of the program.)

G. Pallo

Institute of Nuclear Sciences
D.S.I.R.
Private Bag
Lower Hutt, New Zealand

Received February 23, 1965

CCA - 111

1. Program Names: PDQ-5 and PDQ-6
2. Computer for Which Programs are Designed: Philco-212 Programing System: The programs are written in FORTRAN II language. They operate on the Philco-212 computer under control of the BKS monitor system and also make use of the Bettis FORTRAN subroutine package. Conversion to another computer would require translation of the subroutine package and, for efficient operation, a rather extensive modification of the programs.