Two cross section fitting procedures may be used. In one, fitted cross sections are provided for each isotope which are independent of position but may be changed at any time in life. Thermal self-shieding factors can be specified for each isotope taking on different values for various subregions. A correction is made to the epithermal absorption and removal cross sections to account for the U^{238} (Hf^{177}) resonances. A second procedure allows the fast cross sections of U^{235} and the isotopes in the U^{238} (Hf^{177}) chain to be fitted as the inverse of a bilinear function in the isotopic densities of U^{235} and U^{238} (Hf^{177}). Assuming that the "mixed number density" scheme is used in the thermal group, the cross sections of U^{238} (Hf^{177}), Xe^{135}, and Sm^{149} are fitted as linear functions of the density of U^{235}. In either of the schemes, explicit treatment of B^{10} plates is included by use of fictitious diffusion and absorption cross sections fitted as polynomials in the B^{10} density. Variable self-shielding factors are allowed for U^{235} and B^{10} fitted as the inverse of a linear function in the fraction of the isotope remaining at the various points in the mesh.

Maximum or maneuvering xenon calculations may be performed at various times in the calculation.

Provision is included for the study of fuel replacement. The *xy* version is also designed to provide the flux-weighted macroscopic data required to do the flux synthesis by the ZIP program.

6. Restrictions on the complexity of the problem: No more than 178 mesh subdivisions may be used along the horizontal axis or 201 mesh divisions along the vertical axis with a limit of 20,000 on the product of the two. A maximum of 150 material compositions or subregions of interest can be defined and 2, 3, or 4 lethargy groups can be used. Input is compatible with the other diffusion theory programs on the Philco-2000 computer such as WANDA-5, PDQ-4, CANDLE, etc. The program is intended to operate within the BKS System.
7. Typical running time: The typical running time for one time step is greater than that of the corresponding PDQ-4 problem by a factor of one-third.
8. Present status: In use
9. *References:* O. J. Marlowe, Nuclear reactor depletion programs for the Philco-2000 computer. WAPD-TM-221 (January 1961).
   R. B. Smith and C. H. Hunter, The BKS system for the Philco-2000 computer. WAPD-TM-233 (April 1961).
   W. R. Cadwell and H. P. Henderson, Input preparation for diffusion-depletion programs on the Philco-2000 computer. WAPD-TM-238 (January 1961).
   W. R. Cadwell, PDQ-4—A program for the solution of the neutron-diffusion equations in two dimensions on the Philco-2000. WAPD-TM-230 (June 1961).
   C. J. Pfeifer and F. R. Urbanus, ZIP-2—A one-dimensional few-group synthesis nuclear reactor depletion program for the Philco-2000 computer. WAPD-TM-228 (November 1961).
10. Material available from Philco:
    Binary program deck
    Symbolic program tape
    Referenced documents

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WANDA-5

1. Name of program: WANDA-5
2. Computer for which program is designed: Philco-2000
   Programming system: TAC
3. Nature of problem solved: Numerical solution of the one-dimensional few-group neutron diffusion equations. One to eight energy groups may be used and rectangular, cylindrical, or spherical geometry formulations are available. The flux or its derivative may be set to zero at the boundaries. The program will vary buckling or poison cross section in any subset of regions, or the position of one or more interfaces separating regions to find a specified critical eigenvalue. One iteration or fixed source problems may be calculated and adjoint solutions may be obtained. All one-group problems are treated as one iteration problems.
4. Method of solution: The diffusion equations are replaced by difference equations giving rise to a tridiagonal matrix inverted by Gauss elimination. Extrapolation procedures are incorporated in the source calculation to accelerate convergence.
5. Restrictions on the complexity of the problem: Limited to 500 points, 100 regions, eight groups, and 2000 group-points. This program is intended to operate within the BKS system.
6. Typical running time: 1 min
7. Present status: In use
8. *References:* O. J. Marlowe and M. C. Suggs, WANDA-5—A one-dimensional neutron diffusion equation program for the Philco-2000 computer. WAPD-TM-241 (November 1960).
   W. R. Cadwell and H. P. Henderson, Input preparation for diffusion-depletion programs on the Philco-2000 computer. WAPD-TM-238 (January 1961).
   R. B. Smith and C. H. Hunter, The BKS system for the Philco-2000 computer. WAPD-TM-233 (April 1961).
9. Material available from Philco:
   Binary program deck
   Symbolic program tape
   Referenced documents

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ZIP-2 and ZIP-3

1. Name of programs: ZIP-2, ZIP-3
2. Computer for which programs are designed: Philco-2000
   Programming system: TAC
3. Nature of problem solved: ZIP-2 and ZIP-3 are diffusion theory synthesis depletion programs for design calculations. The synthesis technique is a method of approximating a solution to the three-dimensional, few-group diffusion theory equations by "stacking" a

number of different solutions to the two-dimensional (x,y) solutions. The "stacking" is performed by deriving flux-weighted averaged quantities (diffusion constants, macroscopic cross sections and leakages) from the x,y solutions for input to the ZIP programs which solve the one-dimensional (z) equations.

4. Method of solution: The flux-weighted averaged constants are obtained either by evaluating polynomials as functions of fuel fraction (ZIP-2) or by using Lagrange interpolation and extrapolation in a table of of flux-weighted averaged constants which are functions of fuel fraction (ZIP-3). These constants are used in the WANDA spatial calculation to determine the eigenvalue and fluxes. A search through several rod configurations may be done to obtain a specified eigenvalue by varying either the position of interfaces separating various regions and/or by changing rod configurations.
5. Basic physics approximations used: Five time-dependent isotopes are allowed including I^{135}, Xe^{135}, Pm^{149}, Sm^{149}, and U^{235}. U^{235} is not used explicitly but rather the fraction of U^{235} remaining is used in the depletion calculations. Provisions are made to allow a time-dependent weighting of Xe^{135} and Sm^{149} absorptions to be added into the macroscopic absorption cross section obtained as a function of U^{235} fraction. Maximum xenon calculations may be performed at any time.
6. Restrictions on the complexity of the problems: Limited to 400 mesh intervals, 50 subregions, 50 compositions, and 50 rod configurations. The programs are intended to operate within the BKS system.
7. Typical running time: 4 min per time step
8. Present satus: In use
9. *References:* W. R. Cadwell and H. P. Henderson, Input preparation for diffusion-depletion programs on the Philco-2000 computer. WAPD-TM-238 (January 1961).
   R. B. Smith and C. H. Hunter, The BKS system for the Philco-2000 computer. WAPD-TM-233 (April 1961).
   O. J. Marlowe and M. C. Suggs, WANDA-5—A one-dimensional neutron diffusion equation program for the Philco-2000 computer. WAPD-TM-241 (November 1960).
   O. J. Marlowe, Nuclear reactor depletion programs for the Philco-2000 computer. WAPD-TM-221 (January 1961).
   C. J. Pfeifer and F. R. Urbanus, ZIP-2—A one-dimensional few-group synthesis nuclear reactor depletion program for the Philco-2000 computer. WAPD-TM-228 (November 1961).
10. Material available from Philco:
    ZIP-3 binary program deck
    ZIP-3 symbolic program tape
    Referenced documents

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CURF-1

1. Name of program: CURF-1
2. Computer for which program is designed: Philco-2000
   Programming system: TAC
3. Nature of problem solved: CURF-1 determines the real coefficients of a polynomial of the form

$$F(x) = A_0 + a_1x + a_2x^2 + \cdots + a_{n-1}x^{n-1} + a_nx^n \quad (n \leqq 9)$$

   It is used to process the output from the TURBO program to generate input for the ZIP program.
4. Method of solution: Using the method of least squares, the program selects the curve which minimizes the sum of the squares of the vertical deviations of the given points from the curve such that the standard deviation $\mu \leqq \epsilon$, where ϵ is specified by the user.
   If the minimizing coefficients have been determined then the standard deviation

$$\mu = \sqrt{\sum_{i=1}^{m} \frac{[y_i - F(x_i)]^2}{m}}$$

   will satisfy the given requirements, namely $\mu \leqq \epsilon$.
5. Restrictions on the complexity of the problem: CURF-1 accepts a maximum of 400 data points. The user may specify the exact degree of the polynomial to which the given data points are to be fitted. If the exact degree is not specified, CURF-1 will determine the polynomial of smallest degree ($\leqq 9$) which best fits the given data points under the restrictions imposed.
6. Typical running time: Running time, for a fourth degree polynomial fitting 37 data points, is 1.5 sec.
7. Present status: In use
8. *References:* A. V. Pace, CURF-1—A least squares polynomial fitting program for the Philco-2000. WAPD-TM-226 (January 1961).
   R. B. Smith and C. H. Hunter, The BKS system for the Philco-2000 computer. WAPD-TM-233 (April 1961).
9. Material available from Philco:
   Binary program deck
   Symbolic program tape
   Referenced documents

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BAFL-1

1. Name of program: BAFL-1
2. Computer for which program is designed: Philco-2000
   Programming system: TAC
3. Nature of problem solved: This program calculates by finite difference approximations small deflections of thin elastic rectangular plates under transverse loading.
4. Method of solution: The finite difference equations approximating the partial differential equations are solved by the two-line cyclic Chebyshev semi-iterative method.
5. Basic physics approximations in the problem formulation: The classical bending theory of thin plates.
6. Restrictions on the complexity of the problem: The program is limited to a uniform mesh of up to 1600 points. Boundary conditions allow each of the four sides to be either clamped (built-in), simply supported (hinged), symmetric (floating clamped), or free. The plate loading may be a combination of a uniform load and pointwise loads. This program is intended to operate within the BKS system.