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AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

Program ODD - A One-Dimensional Multigroup Code for The IBM-7090 (ANP Program No. 657)

P. G. Fischer
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GENERAL ELECTRIC

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ABSTRACT

This report discusses the physical and mathematical reactor models which are used in Program ODD. In addition, the report contains the FORTRAN II source program listings, decimal data input sheets and input and output for a sample case.

Program ODD was designed to make use of the Revised Nuclear Data System at ANPD which consists of twenty-five energy group cross-section data including high energy inelastic scattering matrices, resonance parameters for the resolved resonances and thermalization scattering matrices for the near thermal energy region.

The most unique aspect of the program is the mathematical technique employed for eliminating inner iterations and slow convergence rates occasioned by the"up-scattering" in the thermalization region of the energy lattice. Direct inversion of the energy matrix coupling the thermal and last four epithermal groups provides simultaneous consistent solutions for these groups within each power iteration.

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1.0 INTRODUCTION

Program ODD is a one-dimensional multigroup code using the diffusion approximation to the Boltzman equation to determine neutron fluxes and criticality in a reactor core. In these aspects it is very similar to many existing codes written at ANPD and at many other installations, and it is perhaps in order at this point to justify, or attempt to justify, the existence of still another such code. Actually, a special-purpose code, since it makes most efficient use of machine time, rapidly pays for itself in repetitive production use and this is generally justification enough. In addition, existing multigroup codes are either designed for a particular nuclear data system or, more usually, require extensive decimal input with associated high error probability in production use. With this background then, Program ODD can be justified as the basis production diffusion code corresponding to the ANPD Revised Nuclear Data System* although both are really justified together. Thus the Nuclear Data System was designed to contain the maximum energy detail which could be used on multigroup codes, both diffusion and transport, completely contained within a 32,000 word memory for problems of typical ANP complexity. Such a goal is realizable only with a specially designed nuclear data system and specially designed calculational codes.

The basic calculational blocks of Program ODD consist of: (a) composition data preparation; (b) regional data preparation; (c) one-dimensional diffusion calculations.

The composition data preparation portion, other than the use of a 25-group data tape, performs almost identically to the precalculational portions of Program C_5** after which it was modeled. This section of the program processes of up to 100 compositions consisting of up to 30

* "IBM-7090 Programs to Compile and Modify a Nuclear Data Tape", F. D. Wenstrup, etc., APEX 708

** Program C_5, Direct and Adjoint Bare Reactor Program ..., XDC 59-6-220 materials each. In addition to the usual homogenization procedures involving material self-shielding factors, Behrens corrections for enhanced diffusion on the presence of lumped voids, etc., the program provides for adjustment of resonance-region absorption and fission cross sections on the basis of computed or input specified self-shielding factors. The processed composition data are stored on an auxiliary tape which may be used directly in future calculations or to which additional data may be added in future runs.

The second logical program block selects, on the basis of input data, a maximum of 20 of the previously processed compositions for use in a single one-dimensional calculation. A given region of the reactor core may be specified then by a single composition or any mixture of these 20 compositions. This latter provision is useful for multiregion reactor cores which differ only in moderator-to-fuel ratio or void fraction, for example.

The one-dimensional multigroup calculation uses the basic Gauss-Seidel iteration scheme to converge on the fundamental space mode of the neutron flux. The only really unique feature is the simultaneous inversion of the last five groups, which avoids the necessity of inner iterations and poor convergence which generally occur in the presence of "up-scattering". The space detail is limited to 150 lattice points in up to 100 regions (utilizing only 20 compositions or mixtures thereof). The present version contains no convergence acceleration procedures since the typical ANP reactor has a dominance ratio between the fundamental and first harmonic modes of about 5 and this produces satisfactory convergence in 8-10 power iterations.

After the convergence of the flux solution, various regional averages are computed and flux gradients are calculated if requested. The program provides automatic calculation of both adjoint and direct flux solutions if desired, and any number of individual reactor analyses, making use of the same composition tape, may be run sequentially. If only the regional data, e.g., region boundaries or external boundary conditions, are changed, the composition tape is not reread.

Each of these logical program blocks is discussed separately in Sections 2.0, 3.0, and 4.0, respectively. Section 5.0 contains the program input sheets; Section 6.0 discusses the operating instructions and machine set-up and gives the input and output for the sample case; and Section 7.0 gives the unassembled program listings.

2.0 COMPOSITION DATA PREPARATION

2.1 General Discussion

As the name implies, this portion of the program processes and combines the material cross sections read from the Reactor Nuclear Data Tape (RNDT)* into the format required for the multigroup diffusion calculation,

$$-D(N)\nabla^2\varphi(N) + \Sigma_r(N)\varphi(N) = \frac{1}{\lambda} S(N) \sum_{N'} \nu\Sigma_f(N')\varphi(N') + \sum_{N'\neq N} \Sigma_s(N'/N)\varphi(N') \ . \qquad (2.1)$$

Thus, a homogeneous reactor region** is characterized by the following parameters:

$D_r(N), D_z(N)$ - group N diffusion coefficients for the radial and axial directions (cm). (The possible anisotropy arises from homogenization of coolant passages);

$\Sigma_r(N)$ - macroscopic group removal cross section (cm^{-1});

$S(N)$ - fraction of fission neutrons emitted into group N;

$\nu\Sigma_f(N)$ - macroscopic group fission production cross section (cm^{-1});

---

* The program does provide for decimal input of cross-sections, but, this was anticipated as a supplement to rather than a replacement for the RNDT.

** The present version of the program assumes a cylindrical reactor consisting of stacked concentric annular regions. This restriction could be quite easily removed, however.

$\Sigma_s(N'/N)$ - macroscopic cross section for scatter transfer from group N' to group N.

The detailed program logic within this section is intelligible only with reference to the actual format of the data tape itself which is described elsewhere*, but it is perhaps in order to summarize the required information. Thus, the data tape contains basically: (a) 25 group cross sections σ_s, $\xi\sigma_s$, σ_{tr}, σ_a, $\nu\sigma_f$, and $\xi_1\sigma_{s_1}$; (b) high-energy scatter-transfer matrices $\sigma_s(N'/N)$; (c) resonance parameters for resolved resonances; (d) near-thermal scatter-transfer matrices $\sigma_s(N'/N)$; (e) gamma ray energy production cross sections $\sigma(N_n/M_\gamma)$. Before homogenizing or mixing the individual material cross sections, the following operations are then performed: (a) on the basis of the specified material temperature, the corresponding thermal transfer matrix is selected and used also to adjust σ_s and σ_{tr} in the near-thermal region; (b) the resonance region σ_a and σ_{tr} are adjusted for self-shielding; (c) the scatter-transfer matrix is completed as required, since the data tape contains only a compressed matrix. The macroscopic cross sections are then computed as

$$\Sigma_x(N) = \sum_i N^i g^i(N)\sigma_x^i(N) \qquad (2.2)$$

where N^i is input specified atomic density in atoms/barn-cm and the $g^i(N)$ are spatial self-shielding factors, specified as input data if not unity.

In the following sections, the calculations outlined above are discussed in more detail.

2.2 Scatter Transfer Matrix

The RNDT contains scatter-transfer matrices coupling the last (lowest energy) five groups for ten discrete temperatures between 68°F. and 4500°F.

* APEX 708 - "IBM-7090 Programs to Compile and Modify a Nuclear Data Tape", F. D. Wenstrup, et. al.

Rather than attempt an involved interpolation procedure to insure consistency, the nearest "standard" temperature is assigned if the input specified material temperature is non-standard. The near-thermal scattering cross sections are then adjusted as

$$\sigma_s'(N) = \sum_{N'} \sigma_s(N'/N) \quad , \qquad 21 \leq N \leq 25 \tag{2.3}$$

$$\sigma_{tr}'(N) = \frac{\sigma_{tr}(N)}{\sigma_s(N)} \sigma_s'(N) \quad , \tag{2.4}$$

where the unprimed symbols refer to the quantities as read directly from the tape.

The high-energy scatter-transfer matrix appearing on the tape covers, for all practical purposes, only the region of inelastic scattering, since except for the very light elements, elastic scattering produces transfers only to the next (lower in energy) group. For this region of simply elastic scattering*, the transfer cross sections are computed from

$$\sigma_s(N/N+1) = \frac{\xi \sigma_s(N)}{\Delta u(N)} \quad , \tag{2.5}$$

$$\sigma_s(N/N) = \sigma_s(N) - \sigma_s(N/N+1) \quad , \tag{2.6}$$

where $\Delta u(N)$ is the lethargy width of group N. Equation (2.5) is derived assuming a flat-in-lethargy flux over group N, and initial correlation results seem to indicate that this is too gross an assumption. The same assumption has been used in processing the inelastic scattering matrix, for example, but a better physical representation could be quite easily incorporated, based on the ratio of scattering to losses within each group.

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* For the purposes of this section the elements hydrogen, helium, and lithium may be assumed to scatter inelastically throughout the entire energy range.

The various parts of the scatter-transfer matrix are then assembled as a 25-by-25 matrix.

2.3 Resonance Region Cross Sections

The 25-group cross sections on the RNDT represent, in the region from 1 ev to 1 Kev, averages over many isolated resonances for the heavier elements. Since these average cross sections are computed with a 1/E flux weighting, they are appropriate only in the case of infinitely dilute quantities of the resonance absorbers; for finite dilution and especially in heterogeneous dispersion of resonance materials, the neutron flux-in-lethargy is characterized by minima corresponding to the cross section maxima, and this produces average cross sections lower than the infinite-dilution values. To attempt to account for this effect, Program ODD makes use of the resonance data also present on the RNDT to adjust the normal group cross sections. Thus, either homogeneous or heterogeneous (slab geometry) self-shielding factors can be calculated or the desired self-shielding factors may be supplied as decimal input. Effective resonance integrals are then computed for each group and used to reduce the basic 25-group absorption and fission production cross sections. The homogeneous effective integral calculation employs the so-called narrow resonance approximation*. The heterogeneous slab geometry self-shielding calculation assumes no scattering within the absorber region, and a uniform incident flux from an adjacent moderator region**.

2.3.1 Homogeneous Resonance Integral

In the narrow resonance approximation, the effective integral over an isolated resonance may be written,

$$I_{eff} \approx \frac{I_0}{1 + \frac{N_i \sigma_0}{\Sigma_s}} \qquad (2.7)$$

* See, for example, "Resonance Absorption in Nuclear Reactors", L. Dressner, Pergamon Press, New York (1960), Ch. 2

** The physical formulation and numerical procedure used in Program ODD are discussed in detail in XDC 61-4-17 where I_0 is the infinite-dilution integral, σ_0 is the peak cross section in the resonance, N_i is the absorber atomic density, and Σ_s is the background (constant) scattering cross section (macroscopic).

The effect of finite material temperature, Doppler broadening, may be approximately accounted for by adjusting the peak cross section in equation (2.7). Thus,

$$I_{eff}(T^{o}K) \approx \frac{I_0}{1 + \frac{N_i \sigma_0}{\Sigma_s} \psi(\theta,0)} \tag{2.8}$$

where

$$\psi(\theta,x) = \frac{1}{\sqrt{4\pi\theta}} \int_{-\infty}^{\infty} \frac{\exp\left[-\frac{(x-y)^2}{4\theta}\right]}{1 + y^2} dy \tag{2.9}$$

is the Doppler-broadened isolated Breit-Wigner expression, and where $\theta = R \cdot T$. Equation (2.8) represents an additional approximation over (2.7) since it assumes that the broadened resonance retains a simple Breit-Wigner shape with only the peak cross section reduced.

The actual absorption and fission cross section adjustments are performed as

$$\Sigma_a'(N) = \Sigma_a(N) - \sum_{i,j} \frac{N_i I_{0_i}^j}{\Delta u(N)} \left[1 + \frac{\Sigma_s(N)}{N_i \sigma_{0_i}^j \psi(\theta_i^j,0)}\right]^{-1} , \tag{2.10}$$

$$\nu\Sigma_f'(N) = \nu\Sigma_f(N) - \sum_{i,j} \frac{N_i I_{0_i}^j \eta_i^j}{\Delta u(N)} \left[1 + \frac{\Sigma_s(N)}{N_i \sigma_{0_i}^j \psi(\theta_i^j,0)}\right]^{-1} , \tag{2.11}$$

where the summation is over all materials, i, and all resonances, j, whose energies $E_{0_i}^j$ full within group N, of lethargy width $\Delta u(N)$. The quantities E_0, I_0, σ_0, η, R used in these equations are available on the RNDT while N_i and T_i are decimal input.

2.3.2 Heterogeneous Resonance Integral

For the case of heterogeneous dispersal of absorber material, the adjusted resonance-region cross sections are computed as

$$\Sigma_a'(N) = \Sigma_a(N) - \frac{1}{\Delta u(N)} \sum_{i,j} N_i I_{0_i}^j L_i^j \qquad (2.12)$$

$$\nu\Sigma_f'(N) = \nu\Sigma_f(N) - \frac{1}{\Delta u(N)} \sum_{i,j} N_i I_{0_i}^j \eta_i^j L_i^j \quad . \qquad (2.13)$$

The self-shielding factors can be computed, under the assumption of a purely absorbing slab and a uniform incident flux as*

$$L = \frac{1}{\pi\tau} \int_{\infty}^{-\infty} \left[\frac{1}{2} - E_3(\psi\tau)\right] dx \qquad (2.14)$$

where τ is the absorber-slab thickness, and E_3 is the exponential integral of order three. The quantity $\psi(\theta,x)$ is given by equation (2.9).

If the self-shielding factors are supplied as input data, equations (2.12) and (2.13) are used directly.

2.4 Diffusion Coefficient Calculations

The basic diffusion coefficient calculation in use at ANPD involves the calculation of a "size" correction based on the ratio of system total buckling to the total cross section**. Thus

$$D(N) = \frac{1}{3[\Sigma_{tr}(N) + \Sigma_a(N) + \gamma(N)\Sigma_t(N)]} \quad , \qquad (2.15)$$

* KAPL-1241 - "The Absorption of Neutrons in Doppler Broadened Resonances" (1954) - G. M. Roe

** APEX 121 - "Critical Mass Calculation for Bare Hydrogen Moderated Reactors by Means of Transport Theory" - D. S. Selengut where

$$\Sigma_t(N) = \Sigma_s(N) + \Sigma_a(N) \quad . \tag{2.16}$$

The parameter $\gamma(N)$ is calculated from

$$\gamma(N) = .26001\ \alpha(N)^2 + .043502\ \alpha(N)^4 + .0048942\ \alpha(N)^6 \tag{2.17}$$

where

$$\alpha(N)^2 = K^2(N)/\Sigma_t(N) \quad , \tag{2.18}$$

with the total buckling calculated from input dimensions and an energy-dependent extrapolation distance. Equation (2.17) is used as an approximation to

$$\gamma(N) = 1 - \frac{\alpha(N)\tan^{-1}\alpha(N)}{3[\alpha(N) - \tan^{-1}\alpha(N)]} \quad .$$

The diffusion parameters $D_r(N)$, $D_z(N)$ are calculated as

$$D_r(N) = [1 + \epsilon_r(N)]D(N) \tag{2.19}$$

$$D_z(N) = [1 + \epsilon_z(N)]D(N) \tag{2.20}$$

with the Behrens* factors are given by

$$\epsilon_r(N) = V_F^2 \left[\frac{Y(N)}{e^{Y(N)} - 1} + Q_r Y(N) - 1 \right] e^{-X(N)} \tag{2.21}$$

*See D. J. Behrens, "The Migration Length of Neutrons in a Reactor" AERE T/R877, 1956; the attenuation factor $e^{-X(N)}$ is added to account for absorption (fuel) in the void region.

and a similar expression for $\epsilon_z(N)$ involving Q_z. In equation (2.21), V_F is the volume fraction of the void (fuel) region which is calculated from input data, X(N) is the optical thickness of the fuel region, Y(N) is the optical thickness of the moderator (scattering) region. The quantity Q is dependent on void geometry and may be different for the radial and axial directions. If the "Behrens" calculation is not requested,

$$\epsilon_r = \epsilon_z = 0 \quad .$$

2.5 Miscellaneous Calculations

2.5.1 Group Removal Cross Sections

Equation (2.1) does not contain either the group absorption cross section or the "scatter-in" cross section for the group itself. Instead, these are combined as

$$\Sigma_r(N) = \Sigma_a(N) + \Sigma_s(N) - \Sigma_s(N/N) \qquad (2.22)$$

and then

$$\Sigma_s'(N/N) = 0 \quad . \qquad (2.23)$$

2.5.2 Transmission Coefficients

For anticipated future needs, the present composition data preparation program includes calculation of transmission coefficients for a rod, annulus, or plate-type geometrical arrangement.

For a solid cylindrical rod of diameter D_0, in a channel of diameter D_{CH}, the energy dependent transmission fraction is

$$t(N) = 1 - \frac{D_0}{D_{CH}} \left[\frac{(1 - \alpha_n)g_n}{1 - \alpha_n(1 - g_n/2\sigma_n)} \right] \qquad (2.24)$$

with

$$\alpha_n = \frac{\Sigma_s(N)}{\Sigma_s(N) + \Sigma_a(N)} , \tag{2.25}$$

$$\sigma_n = \frac{D_O}{2} [\Sigma_s(N) + \Sigma_a(N)] , \tag{2.26}$$

$$g_n = \frac{4}{3} \sigma_n^2 \Bigg[I_0(\sigma_n)K_1(\sigma_n) - I_1(\sigma_n)K_0(\sigma_n)$$

$$+ \frac{I_1(\sigma_n)K_1(\sigma_n)}{\sigma_n} + 2\sigma_n \Big(I_0(\sigma_n)K_0(\sigma_n) + I_1(\sigma_n)K_1(\sigma_n) \Big) - 2 \Bigg] , \tag{2.27}$$

where I and K are the familiar Bessel functions.

For an annulus of thickness ϵ, outer diameter D_O, and channel diameter D_{CH},

$$t(N) = 1 - \frac{D_O}{D_{CH}} \left[\frac{(1 - \alpha_n)\sigma_n k_n}{1 - \sigma_n f_n} \right] , \tag{2.28}$$

with α_n defined by (2.25) and,

$$\sigma_n = \epsilon[\Sigma_s(N) + \Sigma_a(N)] \tag{2.29}$$

$$k_n = \frac{1}{\sigma_n} [1 - 2E_3(2\sigma_n)] \tag{2.30}$$

$$f_n = \frac{1}{2\sigma_n} \left[E_3(2\sigma_n) - 2E_3(\sigma_n) + \frac{1}{2} \right] \tag{2.31}$$

where E_3 is the exponential integral of order three.

For a plate of thickness ϵ,

$$t(N) = 1 - \frac{2\alpha_n \sigma_n \left[\frac{1}{2} - E_3(\sigma_n) \right]}{\alpha_n \sigma_n + \left[\frac{1}{2} - E_3(\sigma_n) \right]} \tag{2.32}$$

with

$$\alpha_n = \frac{\Sigma_a(N)}{\Sigma_s(N)} \qquad (2.33)$$

$$\sigma_n = \epsilon[\Sigma_s(N) + \Sigma_a(N)] \quad . \qquad (2.34)$$

2.5.3 Gamma Energy Source Matrix

Although the present version of Program ODD does not provide a calculation of the space dependent gamma ray source due to fission, capture, and inelastic scattering, provision has been included for the necessary cross section calculations.

Gamma ray energy production cross sections (Mev barns) can be read from the RNDT for each element and combined to produce the composition source matrix,

$$\Sigma_\gamma(N/M) = \sum_i N^i g^i(N) \; \sigma_\gamma(N/M) \quad , \qquad (2.35)$$

where N is the twenty-five-neutron-group index and M is an arbitrary gamma ray group index. The arbitrary character of the gamma-group index may be used to introduce any particular reaction cross section, e.g. (n,α), by designating the alpha particle as an additional gamma ray group.

2.6 Composition Data Tape Format

After each composition composed of up to 30 materials is processed, the five parameters D_r, D_z, Σ_r, $\nu\Sigma_f$, S for each of the twenty-five groups followed by the 25 x 25 matrix $\Sigma_s(N/N')$ are written on tape as a single record. If the gamma ray production matrix has been calculated, it is written as a second record, otherwise a single word record is written to simulate it.

Each composition so processed is identified by two words of binary coded decimal information provided as input and a program calculated logical record number corresponding to the first of the two records described above. After all desired compositions have been processed, this index information is written as the final tape record, followed by an end-of-file.

A restart case in which additional information is added to the composition tape, begins by reading in the existing index information and positioning the tape to the end of the previously written composition data. A total of 100 compositions may be written on a single tape.

A restart case in which no additional composition data is needed merely bypasses this portion of the program.

3.0 REGIONAL DATA PREPARATION

3.1 General

The primary purpose of this portion of the program is to select up to twenty of the previously processed compositions from the Composition Data Tape, storing them in proper memory locations in a compressed format. This program block also checks the regional input data for consistency wherever possible to avoid later program malfunction.

3.2 Composition Data Storage

The composition data, as written on tape by the preceding program block consists of 5 x 25 + 25 x 25 = 750 words for each composition. Actually, the scatter-transfer matrix is almost triangular since up-scattering occurs only among the last five groups. In addition the diagonal terms on this matrix are all zero (see section 2.5.1), so that the matrix may be compressed in memory to only 190 + 100 + 25 = 315 versus 625 as read from tape. These numbers represent respectively:

(a) The maximum number of non-zero elements for down-scattering within the first twenty groups;

(b) The maximum number of non-zero elements for down-scattering from the first twenty to the final five groups;

(c) The maximum number of non-zero elements coupling the final five groups.

All of the composition data are stored as a single array in fast memory with access via an input specified list of compositions. Thus, the fourth specified composition's data begins 440 x 3 = 1320 locations from the beginning of the array.

3.3 Consistency Requirements

Besides the table of Compositions needed to process the Composition Data Tape, the regional description of the reactor consists of:

(a) left-hand reactor boundary, $R_0 \geq 0$;

(b) right-hand region boundaries, $R_1 < R_2 < R_3 \ldots < R_N$;

(c) number of intervals in each region, $N_1 \neq 0, N_2 \neq 0, \ldots, N_N \neq 0$;

(d) regional material identification consisting of 2 words of BCD information which must either be identical to one of the names in the Composition table or the first of the two words must be (1)MIX(2);

(e) regional mixing densities defining how the material properties are to be computed if the identification begins with (1)MIX(2), at least one non-zero density out of NMIX possible;

(f) dimension for computing transverse leakage in each region, $H_1 \neq 0, H_2 \neq 0, \ldots H_N \neq 0$.

If all the above requirements are satisfied, the program proceeds to the actual one-dimensional diffusion calculation.

4.0 ONE-DIMENSIONAL CALCULATION

4.1 General

The reduction of the diffusion equation (2.1) to a set of algebraic equations using the central difference approximation has been covered in detail in a previous document* and will not be repeated here. As is well known, such a procedure produces a tri-diagonal matrix equation set for the space equations and such a system is well adapted for applying the Gauss** elimination scheme for matrix inversion.

* XDC 60-3-68

** See, for example, "Methods of Applied Mathematics", Hildebrand, F. B., Prentice-Hall, New Jersey, 1952

Assuming a known fission distribution (the first term on the right side of equation (2.1)), the energy matrix, i.e., the twenty-five-group equations, form an almost triangular set. Thus, except for the final five groups, inversion of the energy matrix can be accomplished by solving the individual-group equations in succession, and this leads to the familiar Gauss-Seidel iteration scheme for solving (2.1)*. Rather than resort to "inner" iterations required to obtain a consistent flux solution in the presence of the up-scattering in the final five groups, these latter are treated as a "single" group. The "forward elimination" in the space solution then requires inversion of a 5 x 5 matrix at each lattice point, although, of course, this is required only once per problem and the "back substitution" requires matrix multiplication at each lattice point. Such a procedure increases the required storage somewhat but is easily feasible when only a small number of groups are involved and more importantly yields easily predictable convergence rates which are now the same as the no "up-scattering" analysis. This latter point is very necessary for a "production" type analysis code.

4.2 Diffusion Difference Equations

If the differentials in the one-dimensional analogue of Equation (2.1) are replaced by central differences over a lattice, the resulting equation is a three-point algebraic equation. Although the program inserts equally spaced lattice points within a given region, no attempt is made to formulate the difference equation for this case. Instead, the equations are formulated for the case of possibly unequally spaced points spanning a boundary between material regions; all other ordinary points are simply special cases of the general equation. Thus, the basic** diffusion difference equation is

* See, for example, APEX 539, Program F_2

** The difference equation used for the "combined" five thermal groups is not exactly of this form, but the differences are only trivial for the present discussion.

$$D_2(N)\varphi_{n+1}^K(N) = \left[\beta_n D_1(N) + D_2(N) + \delta_n \Sigma_1'(N) + \gamma_n \Sigma_2'(N)\right]\varphi_n^K(N)$$

$$- \beta_n D_1(N)\varphi_{n-1}^K(N) - F_n^{K-1}(N) - S_n^K(N) \qquad (4.1)$$

In equation (4.1), the subscripts 1,2 refer to the left and right-hand material regions, respectively, while n-1, n, n+1 designate the three successive lattice points; the superscripts K, K-1 define the iteration sequence, while the primed symbols for the removal cross section include the trasverse leakage.

$$F_n^{K-1}(N) = \left[\delta_n S_1(N) \sum_{N'} \frac{\nu\Sigma_{f1}(N')}{\lambda^{K-1}}\right.$$

$$\left. + \gamma_n S_2(N) \sum_{N'} \frac{\nu\Sigma_{f2}(N')}{\lambda^{K-1}}\right]\varphi_n^{K-1}(N') \quad . \qquad (4.2)$$

$$S_n^K(N) = \left[\delta_n \sum_{N'<N} \Sigma_{s1}(N'/N) + \gamma_n \sum_{N'<N} \Sigma_{s2}(N'/N)\right]\varphi_n^K(N') \quad . \qquad (4.3)$$

The three geometric coefficients β_n, γ_n, δ_n do not depend on energy group or material properties. If the single space dimension is along a cartesian coordinate (slab geometry),

$$\beta_n = \frac{h_2}{h_1} \quad , \qquad (4.4)$$

$$\gamma_n = \frac{h_2^2}{2} \quad , \qquad (4.5)$$

$$\delta_n = \frac{h_1 h_2}{2} \qquad (4.6)$$

where h_1, h_2 are the lattice spacing to the left (n-1) and right (n+1) neighboring lattice points. For cylindrical geometry,

$$\beta_n = \frac{h_2}{h_1} \frac{1 + \left| \dfrac{r_n - \frac{h_1}{2}}{r_n + \frac{h_1}{2}} \right|}{1 + \left| \dfrac{r_n + \frac{h_2}{2}}{r_n - \frac{h_2}{2}} \right|} , \tag{4.7}$$

$$\gamma_n = \frac{h_2}{2} \frac{(r_n + \frac{h_2}{2}) - (r_n - \frac{h_2}{2}) \left| \dfrac{r_n - \frac{h_2}{2}}{r_n + \frac{h_2}{2}} \right|}{1 + \left| \dfrac{r_n - \frac{h_2}{2}}{r_n + \frac{h_2}{2}} \right|} , \tag{4.8}$$

$$\delta_n = \frac{h_2}{2} \frac{(r_n + \frac{h_1}{2}) - (r_n - \frac{h_1}{2}) \left| \dfrac{r_n - \frac{h_1}{2}}{r_n + \frac{h_1}{2}} \right|}{1 + \left| \dfrac{r_n + \frac{h_2}{2}}{r_n - \frac{h_2}{2}} \right|} . \tag{4.9}$$

The absolute value signs in 4.7, 4.8, 4.9 insure the proper numerical behavior for $r \to 0$, where r designates the distance (cm) of each lattice point from the origin. These equations are derived by requiring continuity of both flux and current across the region boundary.

Equation (4.1), which can be used for the interior points of the space lattice, must be supplemented by two additional equations for the exterior boundary points. These are obtained by using a Taylor expansion over a small interval near the boundary, retaining only the first derivative. Assuming the boundary conditions are given as right and left albedos A^-, A^+, one obtains then

$$\varphi_1(N) = \varphi_0(N) + \frac{h_-}{2D_1(N)}\left[\frac{1 - A^-(N)}{1 + A^-(N)}\right]\varphi_0(N) \quad , \tag{4.10}$$

$$\varphi_{N-1}(N) = \varphi_N(N) - \frac{h_+}{2D_N(N)}\left[\frac{1 - A^+(N)}{1 + A^+(N)}\right]\varphi_N(N) \quad , \tag{4.11}$$

where h_-, h_+ are assigned by the program as 10^{-3} times a normal interval in the external boundary regions.

4.3 Method of Solution

The tri-diagonal matrix equation set (4.1) for any one of the first twenty groups is solved by the familiar elimination, substitution technique. Thus, defining

$$V_1(N) = 1 + \frac{h_-}{2D_1(N)}\left[\frac{1 - A^-(N)}{1 + A^-(N)}\right] \tag{4.12}$$

$$W_1(N) = 0 \tag{4.13}$$

successive elimination of the n-1 component from equation (4.1) yields the recursion relations*

$$V_{n+1}(N) = \frac{1}{D_2(N)}\left[A_n(N) - \frac{\beta_n D_1(N)}{V_n(N)}\right] \quad , \tag{4.14}$$

$$W^K_{n+1}(N) = \frac{1}{D_2(N)}\left[F^{K-1}_n(N) + S^K_n(N) + \frac{\beta_n D_1(N) W^K_n(N)}{V_n(N)}\right] \quad , \tag{4.15}$$

---

* If the lattice point n is not actually a boundary point, then obviously $D_1(N) = D_2(N)$.

with

$$\varphi_n^K(N) = \frac{1}{V_{n+1}(N)}\left[\varphi_{n+1}^K(N) + W_{n+1}^K(N)\right] \quad , \tag{4.16}$$

$$A_n(N) = \beta_n D_1(N) + D_2(N) + \delta_n \Sigma_1'(N) + \gamma_n \Sigma_2'(N) \quad . \tag{4.17}$$

The right-hand boundary condition, equation (4.11), may be combined with equation (4.16) for the last two lattice points to yield

$$\varphi_n^K(N) = \frac{W_n^K(N)}{[B(N)V_n(N) - 1]} \quad , \tag{4.18}$$

where

$$B(N) = 1 + \frac{h_+}{2D_n(N)}\left[\frac{1 - A^+(N)}{1 + A^+(N)}\right] \quad . \tag{4.19}$$

It should be noted that $V_n(N)$ defined by equation (4.14) is iteration independent and need be evaluated only once per problem. The iteration sequence consists of successive solution of (4.15) and (4.16), supplemented by (4.18).

The last five groups, which are coupled by both "up" and "down" scattering are solved by defining, in analogy to (4.14), the matrix (5 x 5)

$$\left[V_{jk}\right]_{n+1} = \frac{1}{D_2(j)}\left\{\left[A_{jk}\right]_n - \beta_n D_1(j)\left[V_{jk}^{-1}\right]_n\right\} \tag{4.20}$$

where,

$$\left[A_{jk}\right]_n = \left[\beta_n D_1(j) + D_2(j) + \delta_n \Sigma_1'(j) + \gamma_n \Sigma_2'(j)\right]\delta_{jk}$$

$$- \left[\delta_n \Sigma_{s_1}(K/j) + \gamma_n \Sigma_{s_2}(K/j)\right] \tag{4.21}$$

where δ_{jk} is the Kronecker delta. Equation (4.20) is started with the diagonal matrix

$$\left[V_{jk}\right]_1 = \left\{1 + \frac{h}{2D_1(j)}\left[\frac{1 - A^-(j)}{1 + A^-(j)}\right]\right\}\delta_{jk} , \qquad (4.22)$$

in analogy to (4.12). Equation (4.15) now becomes

$$\left[W_j^K\right]_{n+1} = \frac{1}{D_2(j)}\left\{S_n^K(j) + \beta_n D_1(j)\left[V_{jk}^{-1}\right]_n\left[W_k^K\right]_n\right\} , \qquad (4.23)$$

where it is explicitly assumed that no fission emission occurs within the "thermal" groups and $S_n^K(j)$ now includes only the scattering from the higher twenty groups. Finally, the flux equations become,

$$\left[\varphi_k^K\right]_n = \left[V_{jk}^{-1}\right]_{n+1}\left\{\left[\varphi_k^K\right]_{n+1} + \left[W_k^K\right]_{n+1}\right\} \qquad (4.24)$$

and

$$\left[\varphi_j^K\right]_N = \left[\left\{\beta_k\delta_{jk} + V_{jk}^{-1}\right\}^{-1}_{jk}\right]_N\left[V_{k\ell}^{-1}\right]_N\left[W_\ell^{\ K}\right]_N . \qquad (4.25)$$

As before, equation (4.20) is iteration independent and need be solved only once; actually, only the inverse matrices V_{jk}^{-1} need be stored.

Since the basic neutron diffusion equation (2.1) is linear and homogeneous, the normalization of the flux solution is completely arbitrary. For convenience, the flux normalization is fixed by imposing the auxiliary condition

$$\lambda^K = \int r^\mu \, dr \sum_N \nu\Sigma_f(N)\varphi^K(N) . \qquad (4.26)$$

5.0 PROGRAM INPUT SHEETS

PROGRAM ODD

Twenty-Five Group, One-Dimensional Diffusion Code

ANP IBM-7090 Program Number 657

Name - 12 BCD Characters

2BNAM,2,	

Problem Identification - 18 BCD Characters

2BDENT,3,	

Date - 12 BCD Characters

2BDATE,2,	

Composition Data Tape Name - 12 BCD Characters

5CDTNAM,2,	

3CDT,	1 ,

This card must be punched if an existing composition data tape is to be used.

→ MØRE,	,

= 1 → The next case is a composition data preparation case.
= 2 → The next case is a regional data preparation case.

Composition Data Preparation Input

Composition Name - 12 BCD Characters

2CASEID,2,	(1)

Spectrum Code Number

3SPEC,	,

(May be given as zero for a non-fissionable composition)

Material Input Table*

RNDT Material Code Numbers

3CMAT,	,	,	,	,	,

Material Atom Density (barn cm)$^{-1}$ or Volume Fraction

3DMAT,	,	,	,	,	,

Material Weight (gm) - Give Corresponding DMAT = 0

3WMAT,	,	,	,	,	,

Material Temperature (^{o}F)

3TMAT,	,	,	,	,	,

Behrens Region Code: 0 - Fuel, 1 - Moderator

4NBEHR,	,	,	,	,	,

Type Resonance Calculation (Use only if NCØDE(5) = 2,3)

4IRES,	,	,	,	,	,

0 - Calculate resonance self-shielding factors for this material.
1 - Resonance self-shielding factors given for this material.

*NOTE: This table may be extended to 30 materials by use of page ODD - 3.

Materials Nos. 6 through 30

Material Input Table (continued)

N* RNDT Material Code Numbers

3CMAT,	=,	,	,	,	,	,

N Material Atom Density $(\text{barn cm})^{-1}$ or Volume Fraction

3DMAT,	=,	,	,	,	,	,

N Material Weight (gm) - Give Corresponding DMAT = 0

3WMAT,	=,	,	,	,	,	,

N Material Temperature ($^{\circ}$F)

3TMAT,	=,	,	,	,	,	,

N Behrens Region Code: 0 - Fuel, 1 - Moderator

4NBEHR,	=,	,	,	,	,	,

N Type Resonance Calculation (Use only if NCØDE(5) = 2,3)

4IRES,	=,	,	,	,	,	,

0 - Calculate resonance self-shielding factors for this material.
1 - Resonance self-shielding factors given for this material.

*N increases by 5 for each set used.

Material Cell Corrections*

Material No. 1

3GFAC,	,	,	,	,	,

3GFAC,	5 = ,	,	,	,	,	,
3GFAC,	10 = ,	,	,	,	,	,
3GFAC,	15 = ,	,	,	,	,	,
3GFAC,	20 = ,	,	,	,	,	,

*Cell corrections may be given at every level - when not given, g = 1.0.

Material Nos. 2 through 30

3GFAC,	N* = ,	,	,	,	,	,
3GFAC,	(N + 5) = ,	,	,	,	,	,
3GFAC,	(N + 10) = ,	,	,	,	,	,
3GFAC,	(N + 15) = ,	,	,	,	,	,
3GFAC,	(N + 20) = ,	,	,	,	,	,

*N = 25 × (Material Number - 1).

Composition Geometry*

Geometry for Volume Calculation

3GVØL,	,	,	,
	X, H, or R	Y or OD	Z or ID

Geometry for Size Correction to the Diffusion Coefficient

3GDIFC,	,	,	,
	X + 2S H + 2S R + S	Y + 2S D + 2S	Z + 2S

Geometry for Behrens' Correction

3GBEHR,	,	,	,	,
	D_1 or ℓ_{fuel}	D_2 or $\ell_{moderator}$	D_3 or VF_{fuel}	Q

Geometry for Transmission Calculation

3GTRAN,	,	,	,
	D_o	D_{ch}	ϵ

Fuel Region Thickness (for resonance self shielding calculation)

3FT,	,

This card is given in NCØDE(5) = 2

*NOTE: All dimensions are given in centimeters.

Spatial Self-Shielding Factors*

Material No. 1

3ELFAC,	,	,	,	,	,

3ELFAC,	5 = ,	,	,	,	,	,
3ELFAC,	10 = ,	,	,	,	,	,
3ELFAC,	15 = ,	,	,	,	,	,
3ELFAC,	20 = ,	,	,	,	,	,

*This table may be extended to provide spatial self-shielding factors at each resonance energy for this material. When not given, ELFAC = 1.0.

Material Nos. 2 through 20

3ELFAC,	N* =,	,	,	,	,	,
3ELFAC,	(N + 5) =,	,	,	,	,	,
3ELFAC,	(N + 10) =,	,	,	,	,	,
3ELFAC,	(N + 15) =,	,	,	,	,	,
3ELFAC,	(N + 20) =,	,	,	,	,	,

*N = (Material Number 1) × NCØDE(6).

Control Input

	#1	#2	#3	#4	#5	#6
4NCØDE,	,	,	,	,	,	,

→ MØRE,	,

Calculation Codes

NCØDE

#1 - Type Geometry
- 0 - Slab
- 1 - Cylinder
- 2 - Sphere

#2 - Behrens' Calculation
- 0 - No
- 1 - Isotropic
- 2 - Anisotropic

#3 - Transmission Calculation
- 0 - No
- 1 - Yes

#4 - Gamma Source Calculation
- 0 - No
- 1 - Yes

#5 - Resonance Calculation
- 0 - No
- 1 - Homogeneous
- 2 - Inhomogeneous (calculate slab geometry spatial self-shielding factors)
- 3 - Inhomogeneous (spatial self-shielding factors given as input)

#6 - Maximum Number of Self-Shielding Factors Given for Any One Material (enter only if NCØDE(5) = 3)

#7 - Type Output
- 0 - Normal
- 1 - Long
- 2 - Short

MØRE

0 - There are no more cases to be processed

-1 - The next case is a composition reference case

+1 - The next case is a composition change case

-2 - The next case is a regional reference case

+2 - The next case is a regional change case

Regional Data Preparation Input

Regional Case Identification - 12 BCD Characters

2CASEID,2,	①

Composition Table*

First Composition Name - 12 BCD Characters

5CØMP,2,	①

Second Composition Name - 12 BCD Characters

E23437,2,	①

Third Composition Name - 12 BCD Characters

E23435,2,	①

Fourth Composition Name - 12 BCD Characters

E23433,2,	①

Fifth Composition Name - 12 BCD Characters

E23431,2,	①

Sixth Composition Name - 12 BCD Characters

E23429,2,	①

Seventh Composition Name - 12 BCD Characters

E23427,2,	①

*NOTE: Mixable compositions (if any) must be listed first. This table may be extended to include 20 compositions, the absolute address decreasing by 2 for each additional composition.

Region Input

First Region

Composition Name - 12 BCD Characters*

5REG,2,	①

	R_O	Outer Radius Region 1	No. of Intervals**		Equiv. Perpendicular Dimension	
3R,	,	,	EN,	,	HE,	,

Enter "NMIX" Effective Composition Volume Fractions if this is a Mixable Region

3EFFV,	,	,	,	,	,

Second Region

Composition Name - 12 BCD Characters

E23397,2,	①

		Outer Radius Region 2	No. of Intervals			Equiv. Perpendicular Dimension		
3R,	2 =,	,	EN,	=,	,	HE,	=,	,

	N†	Enter "NMIX" Composition Volume Fractions if this is a Mixable Region				
3EFFV,	=,	,	,	,	,	,

*To define this region as a mixable region, enter the first 6 BCD characters as ①MIX ②.

**A negative number of intervals is given in those regions over which the power is to be integrated to obtain the "CORE" power.

†N = NMIX × (Mixable Region Number - 1).

Region Input (continued)*

Third Region

Composition Name - 12 BCD Characters

E23395,2,	①

		Outer Radius Region 3	No. of Intervals			Equiv. Perpendicular Dimension		
3R,	3=,	,	EN,	2=,	,	HE,	2=,	,

	N	Enter "NMIX" Composition Volume Fractions if this is a Mixable Region				
3EFFV,	=,	,	,	,	,	,

Fourth Region

Composition Name - 12 BCD Characters

E23393,2,	①

		Outer Radius Region 4	No. of Intervals			Equiv. Perpendicular Dimension		
3R,	4=,	,	EN,	3=,	,	HE,	3=,	,

	N	Enter "NMIX" Composition Volume Fractions if this is a Mixable Region				
3EFFV,	=,	,	,	,	,	,

*This table may be extended to include a maximum of 100 regions and 150 lattice points. The absolute address decreases by 2 for each additional region composition name.

FISSION SOURCE DISTRIBUTION**

F_n^+ - Fission Source on the Right at nth Lattice Point*

	F_1^+	F_2^+	F_3^+	F_4^+	F_5^+	F_6^+
3FP,=,	,	,	,	,	,	,

F_7^+	F_8^+	F_9^+	F_{10}^+	F_{11}^+	F_{12}^+	F_{13}^+
① ,	,	,	,	,	,	,

F_{14}^+	F_{15}^+	F_{16}^+	F_{17}^+	F_{18}^+	F_{19}^+	F_{20}^+
① ,	,	,	,	,	,	,

This table may be extended to provide a fission source on the right at each lattice point.

*The numerical solution technique employed does not allow for sources on external boundaries. F_1 refers to the source at a point interted by the program just inside the left boundary.

F_n^- - Fission Source on the Left at nth Lattice Point*

	F_1^-	F_2^-	F_3^-	F_4^-	F_5^-	F_6^-
3FM,=,	,	,	,	,	,	,

F_7^-	F_8^-	F_9^-	F_{10}^-	F_{11}^-	F_{12}^-	F_{13}^-
① ,	,	,	,	,	,	,

F_{14}^-	F_{15}^-	F_{16}^-	F_{17}^-	F_{18}^-	F_{19}^-	F_{20}^-
① ,	,	,	,	,	,	,

This table may be extended to provide a fission source on the left at each lattice point.

**To use this table to provide a source guess, both F^+ and F^- must be given at all points of interest. The program initializes F^+ and F^- to 1 at every lattice point and any input values are superimposed on this initialization.

Control Input

Albedo on the Left

	A_1	A_2	A_3	A_4	...	A_{25}
3ALFT,	,	,	,	,	...	,

Albedo on the Right

	A_1	A_2	A_3	A_4	...	A_{25}
3ARGT,	,	,	,	,	...	,

	Convergence Criterion $\|K^P - K^{P-1}\| < \epsilon$
3EPSK,	,

If not given $\epsilon = 1.0 \times 10^{-7}$

	Maximum Number of Iterations
4LMAX,	,

If not given LMAX = 100

	Number of Mixable Compositions
4NMIX,	,

	#1	#2	#3	#4	#5	#6
4NCØDE,	,	,	,	,	,	,

→ MØRE,	,

Calculation Codes

NCØDE

#1 - Number of Regions

#2 - Type Flux
- 0 - Direct
- 1 - Adjoint
- 2 - Adjoint and Direct

#3 - Type Geometry
- 0 - Slab
- 1 - Cylinder

#4 - Not Operative

#5 - Gradient Calculation
- 0 - No
- 1 - Yes

#6 - Type Output
- 0 - Normal
- 1 - Short

MØRE

0 - There are no more cases to be processed.

-2 - The next case is a regional reference case.

+2 - The next case is a regional change case.

6.0 PROGRAMMING AND OPERATING INSTRUCTIONS

Program ODD is designed to be run on an IBM 7090 using the FORTRAN monitor system and is presently written as five "chain" program blocks. The tape assignments given below could be easily modified if desired.

TAPE	UNIT	TAPE	UNIT
A-1	System	B-1	Utility
A-2	Input	B-2	Utility
A-3	Output	B-3	Composition Data Tape
A-4	Chain Tape	B-5	Utility
A-5	RNDT		

A listing of the input and output for a sample case are given in the following pages.

```
2BNAM,2,F.D.WENSTRUP
2BDENT,3,URANYL-F CANS
2BDATE,2,3/15/61
5CDTNAM,2,UCRL BEO-C U
*MORE,-1,
2CASEID,2, H/U 43.9
3SPEC,500.0,
3CMAT,92.235,92.238,1.10,8.16,
3DMAT,1.3786-3,9.6185-5,6.0521 2,3.3210-2,
3TMAT,68.0,68.0,68.0,68.0,
3GVOL,32.3,25.4,0.0,
3GDIFC,32.3,25.4,
4NCODE,1,0,0,0,0,0,1,
*MORE,-1,
2CASEID,2, H/U 62.7
3SPEC,500.0,
3CMAT,92.235,92.238,1.10,8.16,
3DMAT,1.0147-3,7.0796-5,6.3622 2,3.3982-2,
3TMAT,68.0,68.0,68.0,68.0,
3GVOL,31.7,25.4,0.0,
3GDIFC,31.7,25.4,
4NCODE,1,0,0,0,0,0,1,
*MORE,-2,
2CASEID,2, H32.3-D25.4
5COMP,2, H/U 43.9
5REG,2, H/U 43.9
```

```
3R,0.0,16.15,EN,-20,HE,25.4,
3ALFT,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,
 1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,
3ARGT,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
3EPSK,1.0-5,
4NMIX,0,
4NCODE,1,0,0,0,0,0,
→MORE,0,
```

OUTPUT - PROGRAM ODD

```
4-766        F.D.WENSTRUP                       ODD
                PUT RNDT 207 ON A-5
CHARGE 54323, SEQUENCE 4-766, CHANNELS , TAPES   , MODE 1, UNIT 4314
DATE 05/13/61, PROG. NO.  657, BG. 4315, START 14.30  STOP
START TIME AFTER INSTRUCTIONS ON 1 STOP COMMENT CARD FOLLOWED    14.300
```

```
---------------------
$       XEQ
$       CHAIN(1,B1)
---------------------
```

```
IN PROGRAM RNDT4 ,THERE WAS A
CHECKSUM ERROR, CARD ORIGIN  000426
      $       CHAIN(2,B1)
      EXIT    30474      (TES)   30472      CHAIN   30236      COS     30070
      SIN     30074      SQRT    30031      LOG     27740      E3COMP  27523
      E3      27142      EXP     27046      BESJ    25212      BESI    25216
      BESK    25222      BESY    25226      BSF     25064      FSFBT   25066
      FSFDT   25066      MOVE    24752      (EFT)   24741      (STB)   24663
      (WLR)   24705      (TSB)   24620      (RLR)   24641      (BST)   24565
      (WER)   24507      (WTC)   24541      (RWT)   24471      (RER)   24437
      (RDC)   24462      (SPH)   24145      NOPAGE  23603      ANPIPM  23637
      (STH)   24054      (STHM)  24057      RESTC   23542      LINES   23552
      PAGES   23544      NEWSET  23557      HDING   23566      NOHEAD  23605
      COLUMN  23575      BOTTOM  23612      WOT     22556      ERROR   22330
      ERRORA  22327      (DIP)   21111      (IOB)   20422      (EXB)   20474
      (IOH)   16620      (FIL)   20230      (RTN)   20241      (IOU)   16602
      (TRC)   16541      (IOS)   16453      (RDS)   16530      (WRS)   16531
      (BSR)   16532      (WEF)   16533      (REW)   16534      (ETT)   16535
      (RCH)   16536      (TEF)   16537      (TCO)   16540      (FPT)   16427
      RSS     16000      PSI     14371      ERRCDP  14210      ENDCDP  14026
      WOTCD   11566      WTCD    11400      GRPAR   11030      PLATE   10741
      ANULUS  10601      ROD     10271      BEHR    07524      HETRES  07225
      HOMRES  07115      MIX     05617      NANDW   05464      THERM   04774
      AUXND   03012      RNDT4   02344      RNDT3   01730      RNDT2   01404
      RNDT1   01205      CID     01017      START   00475      000000  00174
```

$ CHAIN(3,81)

EXIT	12753	CHAIN	12516	(WER)	12445	(WTC)	12477
(TES)	12433	(TSB)	12377	(RLR)	12420	(RWT)	12364
(RER)	12332	(RDC)	12355	(SPH)	12040	NOPAGE	11476
ANPIPM	11532	(STH)	11747	(STHM)	11752	RESTO	11435
LINES	11445	PAGES	11437	NEWSET	11452	HDING	11461
NOHEAD	11500	COLUMN	11470	BOTTOM	11505	WOT	10451
ERROR	10223	ERRORA	10222	(DIP)	07004	(IOB)	06315
(EXB)	06367	(IOH)	04513	(FIL)	06123	(RTN)	06134
(IOU)	04475	(TRC)	04434	(IOS)	04346	(RDS)	04423
(WRS)	04424	(BSR)	04425	(WEF)	04426	(REW)	04427
(ETT)	04430	(RCH)	04431	(TEF)	04432	(TCO)	04433
(FPT)	04322	POMIX	03604	PCKDT	03147	REGCK	02740
000000	00163						

$ CHAIN(4,B1)

EXIT	11025	CHAIN	10570	(TES)	10565	(WER)	10516
(WTC)	10550	NOPAGE	10147	ANPIPM	10203	(STH)	10420
(STHM)	10423	RESTO	10106	LINES	10116	PAGES	10110
NEWSET	10123	HDING	10132	NOHEAD	10151	COLUMN	10141
BOTTOM	10156	ERROR	07040	ERRORA	07037	(IOH)	05226
(FIL)	06636	(RTN)	06647	(IOU)	05210	(TRC)	05147
(IOS)	05061	(RDS)	05136	(WRS)	05137	(BSR)	05140
(WEF)	05141	(REW)	05142	(ETT)	05143	(RCH)	05144
(TEF)	05145	(TCO)	05146	(FPT)	05035	TMIX	04305
RPAR	03674	RANDC	03545	HOMRC	02304	MATINV	01553
GCOE	00231	000000	00152				

$	CHAIN(5,B1)						
EXIT	07477	(IES)	07475	CHAIN	07241	(FPT)	07215
STINT	07117	CTINT	07010	TMIX	06254	RPAR	05643
PMIX	05372	TSPAR	05100	SPAR	04343	POWER	03664
SORRC	00664	000000	00155				

$ DATA
EXECUTION

EXIT	15256	CHAIN	15021	(TES)	15016	(WER)	14747
(WTC)	15001	(STB)	14662	(WLR)	14704	(RWT)	14646
(EFT)	14637	(SPH)	14351	NOPAGE	14007	ANPIPM	14043
(STH)	14260	(STHM)	14263	RESTO	13746	LINES	13756
PAGES	13750	NEWSET	13763	HDING	13772	NOHEAD	14011
COLUMN	14001	BOTTOM	14016	WOT	12762	(IOB)	12272
(EXB)	12344	(IOH)	10470	(FIL)	12100	(RTN)	12111
(IOU)	10452	(TRC)	10411	(IOS)	10323	(RDS)	10400
(WRS)	10401	(BSR)	10402	(WEF)	10403	(REW)	10404
(ETT)	10405	(RCH)	10406	(TEF)	10407	(TCO)	10410
(FPT)	10277	STINT	10201	CTINT	10072	TMIX	07336
TSPAR	07044	SPAR	06307	RPAR	05676	GPHI	02073
PREP	01242	000000	00163				

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION DATA PREPARATION

CALCULATION REQUEST SUMMARY

GEOMETRY - CYLINDER
H = 3.23000E 01 OD = 2.54000E 01 ID = 0.
NO BEHRENS CALCULATION
NO TRANSMISSION CALCULATION
NO GAMMA SOURCE CALCULATION
NO RESONANCE SELF-SHIELDING CALCULATION
GEOMETRY FOR SIZE CORRECTION TO THE DIFFUSION COEFFICIENT
H+2S = 3.23000E 01 D+2S = 2.54000E 01

COMPOSITION VOLUME IN CC - 1.636665E 04
COMPOSITION SPECTRUM CODE NO. - 500.0000

MATERIAL CODE NO.	MATERIAL WEIGHT	DENSITY OR VOLUME FRACTION	MATERIAL TEMP	BEHRENS REGION NO.
92.2350	8.805351E 03	1.378600E-03	68.00	0
92.2380	6.222101E 02	9.618500E-05	68.00	0
1.1000	1.657261E 03	6.052100E-02	68.00	0
8.1600	1.443849E 04	3.321000E-02	68.00	0

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

MATERIAL CELL CORRECTIONS

	CODE NO.	CODE NO.	CODE NO.	CODE NO.	CODE NO.
	92.2350	92.2380	1.1000	8.1600	0.

GROUP	G-FACTOR	G-FACTOR	G-FACTOR	G-FACTOR	G-FACTOR
1	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
2	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
3	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
4	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
5	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
6	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
7	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
8	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
9	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
10	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
11	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
12	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
13	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
14	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
15	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
16	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
17	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
18	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
19	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
20	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
21	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
22	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
23	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
24	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
25	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

GROUP	ENERGY	DELTA(U)	1/V-FACTORS
1	1.28403E 07	0.50000E-00	5.04280E-05
2	7.78801E 06	0.50000E-00	6.47508E-05
3	4.72367E 06	0.50000E 00	8.31417E-05
4	2.86505E 06	0.50000E-00	1.06756E-04
5	1.73774E 06	0.50000E 00	1.37078E-04
6	1.05399E 06	0.50000E-00	1.76011E-04
7	6.39279E 05	0.50000E-00	2.26003E-04
8	3.87742E 05	0.50000E-00	2.90193E-04
9	2.35177E 05	0.75000E 00	3.97938E-04
10	1.11090E 05	0.10000E 01	6.12145E-04
11	4.08677E 04	1.00000E 00	1.02080E-03
12	1.50344E 04	1.00000E 00	1.68301E-03
13	5.53084E 03	1.00000E 00	2.77481E-03
14	2.03468E 03	1.00000E 00	4.57489E-03
15	7.48518E 02	0.13250E 01	8.24544E-03
16	1.98958E 02	0.12750E 01	1.57732E-02
17	5.55951E 01	0.95000E 00	2.73051E-02
18	2.15009E 01	0.97500E 00	4.42043E-02
19	8.10998E 00	0.11000E 01	7.44599E-02
20	2.69958E 00	1.00000E 00	1.25598E-01
21	9.93119E-01	0.87500E 00	2.00217E-01
22	4.13994E-01	1.00000E 00	3.20725E-01
23	1.52300E-01	0.11475E 01	5.50453E-01
24	4.83444E-02	0.64750E 00	8.54416E-01
25	2.53012E-02	0.	

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION CROSS SECTIONS

GROUP	DIFFUSION	SCATTER	TRANSPORT	ABSORPTION	EXTRAPOLATION
1	3.60162E 00	1.00311E-01	4.72123E-02	1.10046E-02	1.22044E 01
2	3.15268E 00	1.35316E-01	6.64681E-02	7.51575E-03	9.60344E 00
3	2.52505E 00	2.03631E-01	1.02086E-01	2.73757E-03	6.77808E 00
4	2.58202E 00	2.18315E-01	1.02007E-01	2.01356E-03	6.83038E 00
5	1.77691E 00	3.12930E-01	1.63264E-01	1.97172E-03	4.29991E 00
6	1.33978E 00	4.30918E-01	2.28479E-01	1.87911E-03	3.08432E 00
7	1.04922E 00	6.05835E-01	3.01468E-01	1.99963E-03	2.34127E 00
8	1.06129E 00	6.14190E-01	2.97898E-01	2.20649E-03	2.36751E 00
9	9.62075E-01	7.62692E-01	3.32337E-01	2.57028E-03	2.12148E 00
10	7.88076E-01	9.90150E-01	4.10431E-01	3.17925E-03	1.71780E 00
11	6.82448E-01	1.18173E 00	4.75210E-01	5.15264E-03	1.47909E 00
12	6.27363E-01	1.29340E 00	5.16540E-01	7.29688E-03	1.35634E 00
13	6.02984E-01	1.34165E 00	5.35334E-01	1.02165E-02	1.30235E 00
14	5.91190E-01	1.35417E 00	5.41412E-01	1.52348E-02	1.27639E 00
15	5.71209E-01	1.35661E 00	5.43895E-01	3.25353E-02	1.23259E 00
16	5.45812E-01	1.36358E 00	5.50943E-01	5.27245E-02	1.17697E 00
17	4.91141E-01	1.37851E 00	5.65984E-01	1.05876E-01	1.05751E 00
18	4.71039E-01	1.35501E 00	5.42163E-01	1.58754E-01	1.01367E 00
19	5.36322E-01	1.37063E 00	5.45393E-01	6.91760E-02	1.15609E 00
20	5.33938E-01	1.39995E 00	5.56170E-01	6.12710E-02	1.15072E 00
21	4.48030E-01	1.39701E 00	6.23888E-01	1.13308E-01	9.63787E-01
22	3.21576E-01	1.43967E 00	7.36959E-01	2.93442E-01	6.89537E-01
23	2.27863E-01	1.57053E 00	9.91251E-01	4.66227E-01	4.87486E-01
24	1.57444E-01	1.81354E 00	1.31218E 00	8.00685E-01	3.36274E-01
25	1.42079E-01	2.45675E 00	9.17502E-01	1.42571E 00	3.03216E-01

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION GROUP PARAMETERS

GROUP	DIFFUSION RADIAL	DIFFUSION LONGITUDINAL	REMOVAL (ABSP+SCAT)	FISSION	SOURCE
1	3.60162E 00	3.60162E 00	7.82298E-02	1.00015E-02	6.02440E-03
2	3.15268E 00	3.15268E 00	8.99118E-02	6.49052E-03	5.61236E-02
3	2.52505E 00	2.52505E 00	1.16516E-01	5.17266E-03	1.63906E-01
4	2.58202E 00	2.58202E 00	1.47959E-01	5.17609E-03	2.31561E-01
5	1.77691E 00	1.77691E 00	2.01002E-01	4.75155E-03	2.10909E-01
6	1.33978E 00	1.33978E 00	2.71337E-01	4.34236E-03	1.47657E-01
7	1.04922E 00	1.04922E 00	3.52373E-01	4.35245E-03	8.81369E-02
8	1.06129E 00	1.06129E 00	4.20239E-01	4.78751E-03	4.77978E-02
9	9.62075E-01	9.62075E-01	4.69241E-01	5.53517E-03	3.16200E-02
10	7.88076E-01	7.88076E-01	5.61889E-01	7.26133E-03	1.25488E-02
11	6.82448E-01	6.82448E-01	6.84003E-01	9.85706E-03	2.88050E-03
12	6.27363E-01	6.27363E-01	7.53355E-01	1.34878E-02	6.48500E-04
13	6.02984E-01	6.02984E-01	7.84531E-01	1.82338E-02	1.45100E-04
14	5.91190E-01	5.91190E-01	7.95716E-01	2.61328E-02	3.24000E-05
15	5.71209E-01	5.71209E-01	7.14795E-01	5.34903E-02	7.95000E-06
16	5.45812E-01	5.45812E-01	7.48766E-01	8.09990E-02	1.02000E-06
17	4.91141E-01	4.91141E-01	9.03333E-01	1.61183E-01	9.50000E-08
18	4.71039E-01	4.71039E-01	9.47776E-01	2.31836E-01	0.
19	5.36322E-01	5.36322E-01	8.28550E-01	5.74768E-02	0.
20	5.33938E-01	5.33938E-01	8.71232E-01	1.08649E-01	0.
21	4.48030E-01	4.48030E-01	1.45643E 00	2.29546E-01	0.
22	3.21576E-01	3.21576E-01	1.02928E 00	5.82001E-01	0.
23	2.27863E-01	2.27863E-01	1.10060E 00	9.59469E-01	0.
24	1.57444E-01	1.57444E-01	1.90553E 00	1.62850E 00	0.
25	1.42079E-01	1.42079E-01	2.52952E 00	2.88837E 00	0.

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	1	2	3	4	5
1	0.	2.55239E-02	1.64232E-02	1.06366E-02	6.41333E-03
2	0.	0.	3.72629E-02	1.64852E-02	1.07438E-02
3	0.	0.	0.	5.31826E-02	2.33545E-02
4	0.	0.	0.	0.	6.52125E-02
5	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	6	7	8	9	10
1	3.46500E-03	1.98663E-03	1.15359E-03	8.84117E-04	4.73704E-04
2	7.27088E-03	4.42036E-03	2.59008E-03	1.97719E-03	1.05374E-03
3	1.45997E-02	9.01956E-03	5.46511E-03	4.37225E-03	2.41216E-03
4	3.15499E-02	1.94064E-02	1.18232E-02	9.55766E-03	5.33427E-03
5	9.48208E-02	4.09636E-02	2.49704E-02	2.02895E-02	1.14040E-02
6	0.	1.31074E-01	5.44909E-02	4.43639E-02	2.50322E-02
7	0.	0.	1.70749E-01	9.48864E-02	5.36323E-02
8	0.	0.	0.	2.39260E-01	1.13104E-01
9	0.	0.	0.	0.	3.02024E-01
10	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	11	12	13	14	15
1	1.68677E-04	6.11985E-05	2.23950E-05	8.22177E-06	3.51036E-06
2	3.76255E-04	1.36707E-04	5.00518E-05	1.83788E-05	7.84353E-06
3	8.70718E-04	3.17593E-04	1.16448E-04	4.27832E-05	1.82718E-05
4	1.93962E-03	7.09627E-04	2.60489E-04	9.57466E-05	4.08980E-05
5	4.16660E-03	1.52752E-03	5.61159E-04	2.06325E-04	8.81413E-05
6	9.17257E-03	3.36708E-03	1.23756E-03	4.55108E-04	1.94435E-04
7	1.96767E-02	7.22648E-03	2.65653E-03	9.76995E-04	4.17409E-04
8	4.15342E-02	1.52595E-02	5.61030E-03	2.06340E-03	8.81579E-04
9	1.04117E-01	3.82690E-02	1.40722E-02	5.17592E-03	2.21144E-03
10	3.58430E-01	1.26607E-01	4.65709E-02	1.71317E-02	7.31997E-03
11	0.	4.34252E-01	1.54616E-01	5.68800E-02	2.43040E-02
12	0.	0.	4.77045E-01	1.70049E-01	7.26594E-02
13	0.	0.	0.	4.95097E-01	2.05001E-01
14	0.	0.	0.	0.	5.77123E-01
15	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	16	17	18	19	20
1	9.15487E-07	2.17692E-07	8.55015E-08	3.45456E-08	1.08958E-08
2	2.04397E-06	4.86039E-07	1.90898E-07	7.71294E-08	2.43269E-08
3	4.76568E-06	1.13327E-06	4.45108E-07	1.79839E-07	5.67218E-08
4	1.06678E-05	2.53685E-06	9.96380E-07	4.02572E-07	1.26973E-07
5	2.29916E-05	5.46761E-06	2.14747E-06	8.67653E-07	2.73661E-07
6	5.07194E-05	1.20617E-05	4.73738E-06	1.91407E-06	6.03703E-07
7	1.08885E-04	2.58941E-05	1.01703E-05	4.10914E-06	1.29603E-06
8	2.29969E-04	5.46896E-05	2.14801E-05	8.67869E-06	2.73729E-06
9	5.76880E-04	1.37190E-04	5.38832E-05	2.17707E-05	6.86655E-06
10	1.90954E-03	4.54120E-04	1.78361E-04	7.20642E-05	2.27293E-05
11	6.34017E-03	1.50780E-03	5.92207E-04	2.39272E-04	7.54673E-05
12	1.89546E-02	4.50773E-03	1.77047E-03	7.15330E-04	2.25618E-04
13	5.34784E-02	1.27181E-02	4.99518E-03	2.01823E-03	6.36555E-04
14	1.46534E-01	3.48483E-02	1.36871E-02	5.53006E-03	1.74420E-03
15	4.94869E-01	1.14919E-01	4.51359E-02	1.82365E-02	5.75184E-03
16	0.	4.31552E-01	1.64726E-01	6.65550E-02	2.09917E-02
17	0.	0.	5.02864E-01	1.96531E-01	6.19867E-02
18	0.	0.	0.	5.31642E-01	1.62695E-01
19	0.	0.	0.	0.	4.85162E-01
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 43.9 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	21	22	23	24	25
1	3.69773E-09	1.67092E-09	6.63758E-10	0.	0.
2	8.25588E-09	3.73065E-09	1.48196E-09	0.	0.
3	1.92498E-08	8.69857E-09	3.45542E-09	7.65946E-10	8.40998E-10
4	4.30910E-08	1.94719E-08	7.73501E-09	1.71458E-09	1.88259E-09
5	9.28730E-08	4.19672E-08	1.66711E-08	3.69539E-09	4.05749E-09
6	2.04880E-07	9.25808E-08	3.67768E-08	8.15213E-09	8.95093E-09
7	4.39839E-07	1.98753E-07	7.89528E-08	1.75011E-08	1.92159E-08
8	9.28960E-07	4.19776E-07	1.66752E-07	3.69631E-08	4.05850E-08
9	2.33032E-06	1.05302E-06	4.18301E-07	9.27227E-08	1.01808E-07
10	7.71370E-06	3.48565E-06	1.38464E-06	3.06926E-07	3.37001E-07
11	2.56115E-05	1.15733E-05	4.59737E-06	1.01908E-06	1.11893E-06
12	7.65684E-05	3.45996E-05	1.37443E-05	3.04664E-06	3.34517E-06
13	2.16029E-04	9.76189E-05	3.87782E-05	8.59575E-06	9.43802E-06
14	5.91934E-04	2.67482E-04	1.06255E-04	2.35529E-05	2.58608E-05
15	1.95202E-03	8.82074E-04	3.50395E-04	7.76703E-05	8.52809E-05
16	7.12400E-03	3.21918E-03	1.27879E-03	2.83462E-04	3.11237E-04
17	2.10366E-02	9.50596E-03	3.77615E-03	8.37040E-04	9.19058E-04
18	5.52144E-02	2.49501E-02	9.91120E-03	2.19696E-03	2.41224E-03
19	1.59903E-01	7.22568E-02	2.87033E-02	6.36251E-03	6.98595E-03
20	4.78738E-01	2.09372E-01	8.31712E-02	1.84361E-02	2.02426E-02
21	0.	1.34312E 00	2.04168E-01	4.14875E-02	3.15918E-02
22	7.83944E-03	0.	5.39276E-01	1.07142E-01	8.15823E-02
23	1.46459E-06	4.82709E-02	0.	3.41489E-01	2.44615E-01
24	2.53682E-07	8.00763E-03	5.12924E-01	0.	5.83916E-01
25	2.22090E-07	7.00911E-03	4.25485E-01	6.71316E-01	0.

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION DATA PREPARATION

CALCULATION REQUEST SUMMARY

GEOMETRY - CYLINDER
H = 3.17000E 01 OD = 2.54000E 01 ID = 0.
NO BEHRENS CALCULATION
NO TRANSMISSION CALCULATION
NO GAMMA SOURCE CALCULATION
NO RESONANCE SELF-SHIELDING CALCULATION
GEOMETRY FOR SIZE CORRECTION TO THE DIFFUSION COEFFICIENT
H+2S = 3.17000E 01 D+2S = 2.54000E 01

COMPOSITION VOLUME IN CC - 1.606263E 04
COMPOSITION SPECTRUM CODE NO. - 500.0000

MATERIAL CODE NO.	MATERIAL WEIGHT	DENSITY OR VOLUME FRACTION	MATERIAL TEMP	BEHRENS REGION NO.
92.2350	6.360669E 03	1.014700E-03	68.00	0
92.2380	4.494643E 02	7.079600E-05	68.00	0
1.1000	1.709814E 03	6.362200E-02	68.00	0
8.1600	1.449969E 04	3.398200E-02	68.00	0

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

MATERIAL CELL CORRECTIONS

	CODE NO.	CODE NO.	CODE NO.	CODE NO.	CODE NO.
	92.2350	92.2380	1.1000	8.1600	0.
GROUP	G-FACTOR	G-FACTOR	G-FACTOR	G-FACTOR	G-FACTOR
1	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
2	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
3	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
4	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
5	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
6	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
7	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
8	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
9	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
10	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
11	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
12	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
13	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
14	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
15	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
16	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
17	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
18	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
19	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
20	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
21	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
22	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
23	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
24	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00
25	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00	1.00000E 00

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

GROUP	ENERGY	DELTA(U)	1/V-FACTORS
1	1.28403E 07	0.50000E-00	5.04280E-05
2	7.78801E 06	0.50000E-00	6.47508E-05
3	4.72367E 06	0.50000E 00	8.31417E-05
4	2.86505E 06	0.50000E-00	1.06756E-04
5	1.73774E 06	0.50000E 00	1.37078E-04
6	1.05399E 06	0.50000E-00	1.76011E-04
7	6.39279E 05	0.50000E-00	2.26003E-04
8	3.87742E 05	0.50000E-00	2.90193E-04
9	2.35177E 05	0.75000E 00	3.97938E-04
10	1.11090E 05	0.10000E 01	6.19145E-04
11	4.08677E 04	1.00000E 00	1.02080E-03
12	1.50344E 04	1.00000E 00	1.68301E-03
13	5.53084E 03	1.00000E 00	2.77481E-03
14	2.03468E 03	1.00000E 00	4.57489E-03
15	7.48518E 02	0.13250E 01	8.24544E-03
16	1.98958E 02	0.12750E 01	1.57732E-02
17	5.55951E 01	0.95000E 00	2.73051E-02
18	2.15009E 01	0.97500E 00	4.42043E-02
19	8.10998E 00	0.11000E 01	7.44599E-02
20	2.69958E 00	1.00000E 00	1.25598E-01
21	9.93119E-01	0.87500E 00	2.00217E-01
22	4.13994E-01	1.00000E 00	3.20725E-01
23	1.52300E-01	0.11475E 01	5.50453E-01
24	4.83444E-02	0.64750E 00	8.54416E-01
25	2.53012E-02	0.	

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION CROSS SECTIONS

GROUP	DIFFUSION	SCATTER	TRANSPORT	ABSORPTION	EXTRAPOLATION
1	3.59745E 00	1.02588E-01	4.80994E-02	1.04899E-02	1.21268E 01
2	3.13710E 00	1.38474E-01	6.76556E-02	7.09649E-03	9.50475E 00
3	2.50010E 00	2.08956E-01	1.04128E-01	2.26648E-03	6.67796E 00
4	2.55278E 00	2.25426E-01	1.04368E-01	1.48559E-03	6.71209E 00
5	1.74553E 00	3.23947E-01	1.67534E-01	1.45594E-03	4.20440E 00
6	1.31081E 00	4.46644E-01	2.34825E-01	1.38898E-03	3.00787E 00
7	1.02439E 00	6.27710E-01	3.09973E-01	1.47896E-03	2.28125E 00
8	1.03508E 00	6.38668E-01	3.06749E-01	1.63257E-03	2.30396E 00
9	9.36832E-01	7.94336E-01	3.42637E-01	1.89434E-03	2.06222E 00
10	7.66014E-01	1.03284E 00	4.23702E-01	2.34397E-03	1.66766E 00
11	6.62418E-01	1.23414E 00	4.91562E-01	3.79900E-03	1.43431E 00
12	6.08686E-01	1.35148E 00	5.34975E-01	5.38143E-03	1.31487E 00
13	5.85643E-01	1.40206E 00	5.54591E-01	7.53733E-03	1.26395E 00
14	5.76251E-01	1.41446E 00	5.60223E-01	1.12424E-02	1.24330E 00
15	5.62126E-01	1.41624E 00	5.62042E-01	2.39995E-02	1.21237E 00
16	5.43766E-01	1.42132E 00	5.67214E-01	3.89072E-02	1.17221E 00
17	5.02686E-01	1.43223E 00	5.78261E-01	7.81019E-02	1.08248E 00
18	4.86907E-01	1.41512E 00	5.60789E-01	1.17129E-01	1.04806E 00
19	5.34789E-01	1.43247E 00	5.65116E-01	5.13877E-02	1.15247E 00
20	5.30284E-01	1.46286E 00	5.76009E-01	4.58919E-02	1.14246E 00
21	4.51656E-01	1.45923E 00	6.46662E-01	8.46650E-02	9.71521E-01
22	3.36925E-01	1.50365E 00	7.65106E-01	2.18016E-01	7.22697E-01
23	2.40799E-01	1.64087E 00	1.03208E 00	3.46655E-01	5.15327E-01
24	1.69342E-01	1.89600E 00	1.36913E 00	5.94755E-01	3.61783E-01
25	1.65362E-01	2.57214E 00	9.54203E-01	1.05847E 00	3.53014E-01

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION GROUP PARAMETERS

GROUP	DIFFUSION RADIAL	DIFFUSION LONGITUDINAL	REMOVAL (ABSP+SCAT)	FISSION	SOURCE
1	3.59745E 00	3.59745E 00	7.99500E-02	7.36148E-03	6.02440E-03
2	3.13710E 00	3.13710E 00	9.23853E-02	4.77726E-03	5.61236E-02
3	2.50010E 00	2.50010E 00	1.20458E-01	3.80727E-03	1.63906E-01
4	2.55278E 00	2.55278E 00	1.53647E-01	3.80979E-03	2.31561E-01
5	1.74553E 00	1.74553E 00	2.09181E-01	3.49731E-03	2.10909E-01
6	1.31081E 00	1.31081E 00	2.82924E-01	3.19614E-03	1.47657E-01
7	1.02439E 00	1.02439E 00	3.67741E-01	3.20356E-03	8.81369E-02
8	1.03508E 00	1.03508E 00	4.39503E-01	3.52378E-03	4.77978E-02
9	9.36832E-01	9.36832E-01	4.91553E-01	4.07409E-03	3.16200E-02
10	7.66014E-01	7.66014E-01	5.89096E-01	5.34460E-03	1.25488E-02
11	6.62418E-01	6.62418E-01	7.16997E-01	7.25516E-03	2.88050E-03
12	6.08686E-01	6.08686E-01	7.89215E-01	9.92752E-03	6.48500E-04
13	5.85643E-01	5.85643E-01	8.21060E-01	1.34208E-02	1.45100E-04
14	5.76251E-01	5.76251E-01	8.31240E-01	1.92347E-02	3.24000E-05
15	5.62126E-01	5.62126E-01	7.40854E-01	3.93708E-02	7.95000E-06
16	5.43766E-01	5.43766E-01	7.70220E-01	5.96182E-02	1.02000E-06
17	5.02686E-01	5.02686E-01	9.15849E-01	1.18636E-01	9.50000E-08
18	4.86907E-01	4.86907E-01	9.46091E-01	1.70640E-01	0.
19	5.34789E-01	5.34789E-01	8.49245E-01	4.23050E-02	0.
20	5.30284E-01	5.30284E-01	8.96882E-01	7.99697E-02	0.
21	4.51656E-01	4.51656E-01	1.49582E 00	1.68954E-01	0.
22	3.36925E-01	3.36925E-01	9.90881E-01	4.28374E-01	0.
23	2.40799E-01	2.40799E-01	1.01229E 00	7.06204E-01	0.
24	1.69342E-01	1.69342E-01	1.75379E 00	1.19863E 00	0.
25	1.65362E-01	1.65362E-01	2.21742E 00	2.12594E 00	0.

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	1	2	3	4	5
1	0.	2.66407E-02	1.70863E-02	1.09460E-02	6.50062E-03
2	0.	0.	3.88165E-02	1.71992E-02	1.10488E-02
3	0.	0.	0.	5.53842E-02	2.43535E-02
4	0.	0.	0.	0.	6.80202E-02
5	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	6	7	8	9	10
1	3.46884E-03	1.98666E-03	1.16222E-03	9.01595E-04	4.89991E-04
2	7.38590E-03	4.47258E-03	2.62960E-03	2.02483E-03	1.09192E-03
3	1.50909E-02	9.27411E-03	5.62096E-03	4.51822E-03	2.51117E-03
4	3.29482E-02	2.01831E-02	1.22804E-02	9.94504E-03	5.57315E-03
5	9.87089E-02	4.28654E-02	2.60910E-02	2.12062E-02	1.19433E-02
6	0.	1.36442E-01	5.71198E-02	4.64906E-02	2.62551E-02
7	0.	0.	1.77753E-01	9.95454E-02	5.62860E-02
8	0.	0.	0.	2.50120E-01	1.18754E-01
9	0.	0.	0.	0.	3.16640E-01
10	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.
13	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM / TO	11	12	13	14	15
1	1.76144E-04	6.41709E-05	2.35198E-05	8.64003E-06	3.68979E-06
2	3.93156E-04	1.43376E-04	5.25685E-05	1.93137E-05	8.24434E-06
3	9.11540E-04	3.33330E-04	1.22340E-04	4.49653E-05	1.92065E-05
4	2.03350E-03	7.45201E-04	2.73726E-04	1.00638E-04	4.29914E-05
5	4.37260E-03	1.60470E-03	5.89758E-04	2.16876E-04	9.26544E-05
6	9.63203E-03	3.53804E-03	1.30075E-03	4.78397E-04	2.04393E-04
7	2.06671E-02	7.59403E-03	2.79226E-03	1.02700E-03	4.38788E-04
8	4.36322E-02	1.60366E-02	5.89707E-03	2.16903E-03	9.26736E-04
9	1.09399E-01	4.02210E-02	1.47919E-02	5.44094E-03	2.32472E-03
10	3.76219E-01	1.33086E-01	4.89560E-02	1.80093E-02	7.69501E-03
11	0.	4.56067E-01	1.62538E-01	5.97945E-02	2.55493E-02
12	0.	0.	5.01036E-01	1.78762E-01	7.63824E-02
13	0.	0.	0.	5.19998E-01	2.15505E-01
14	0.	0.	0.	0.	6.06219E-01
15	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	16	17	18	19	20
1	9.62361E-07	2.28847E-07	8.98824E-08	3.63156E-08	1.14541E-08
2	2.14863E-06	5.10943E-07	2.00679E-07	8.10314E-08	2.55733E-08
3	5.00975E-06	1.19134E-06	4.67915E-07	1.89054E-07	5.96282E-08
4	1.12142E-05	2.66683E-06	1.04743E-06	4.23199E-07	1.33478E-07
5	2.41694E-05	5.74776E-06	2.25750E-06	9.12110E-07	2.87683E-07
6	5.33179E-05	1.26797E-05	4.98011E-06	2.01214E-06	6.34635E-07
7	1.14463E-04	2.72209E-05	1.06914E-05	4.31968E-06	1.36244E-06
8	2.41751E-04	5.74919E-05	2.25807E-05	9.12337E-06	2.87754E-06
9	6.06436E-04	1.44220E-04	5.66441E-05	2.28862E-05	7.21838E-06
10	2.00738E-03	4.77388E-04	1.87500E-04	7.57567E-05	2.38939E-05
11	6.66503E-03	1.58506E-03	6.22551E-04	2.51532E-04	7.93341E-05
12	1.99258E-02	4.73870E-03	1.86118E-03	7.51983E-04	2.37178E-04
13	5.62185E-02	1.33697E-02	5.25113E-03	2.12164E-03	6.69171E-04
14	1.54042E-01	3.66338E-02	1.43884E-02	5.81342E-03	1.83357E-03
15	5.19862E-01	1.20807E-01	4.74486E-02	1.91709E-02	6.04656E-03
16	0.	4.53272E-01	1.73166E-01	6.99652E-02	2.20672E-02
17	0.	0.	5.28060E-01	2.06601E-01	6.51628E-02
18	0.	0.	0.	5.58394E-01	1.71032E-01
19	0.	0.	0.	0.	5.09596E-01
20	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.

H/U 62.7 F.D.WENSTRUP URANYL-F CANS

COMPOSITION SCATTER TRANSFER MATRIX

FROM \ TO	21	22	23	24	25
1	3.88720E-09	1.75654E-09	6.97768E-10	0.	0.
2	8.67889E-09	3.92180E-09	1.55790E-09	0.	0.
3	2.02362E-08	9.14428E-09	3.63247E-09	8.05192E-10	8.84090E-10
4	4.52989E-08	2.04696E-08	8.13134E-09	1.80243E-09	1.97905E-09
5	9.76316E-08	4.41176E-08	1.75253E-08	3.88474E-09	4.26539E-09
6	2.15378E-07	9.73245E-08	3.86612E-08	8.56983E-09	9.40956E-09
7	4.62376E-07	2.08937E-07	8.29982E-08	1.83978E-08	2.02005E-08
8	9.76559E-07	4.41285E-07	1.75296E-07	3.88570E-08	4.26645E-08
9	2.44972E-06	1.10697E-06	4.39735E-07	9.74737E-08	1.07025E-07
10	8.10894E-06	3.66425E-06	1.45559E-06	3.22652E-07	3.54268E-07
11	2.69238E-05	1.21663E-05	4.83294E-06	1.07129E-06	1.17626E-06
12	8.04917E-05	3.63724E-05	1.44486E-05	3.20274E-06	3.51657E-06
13	2.27098E-04	1.02621E-04	4.07651E-05	9.03619E-06	9.92161E-06
14	6.22264E-04	2.81187E-04	1.11699E-04	2.47597E-05	2.71858E-05
15	2.05204E-03	9.27270E-04	3.68349E-04	8.16500E-05	8.96506E-05
16	7.48902E-03	3.38412E-03	1.34431E-03	2.97986E-04	3.27185E-04
17	2.21145E-02	9.99303E-03	3.96963E-03	8.79928E-04	9.66149E-04
18	5.80435E-02	2.62285E-02	1.04190E-02	2.30953E-03	2.53584E-03
19	1.68097E-01	7.59591E-02	3.01740E-02	6.68352E-03	7.34390E-03
20	5.02796E-01	2.20100E-01	8.74327E-02	1.93808E-02	2.12798E-02
21	0.	1.41115E 00	2.14630E-01	4.36132E-02	3.32105E-02
22	8.08653E-03	0.	5.66384E-01	1.12632E-01	8.57624E-02
23	1.53964E-06	5.06579E-02	0.	3.57889E-01	2.57089E-01
24	2.66681E-07	8.41789E-03	5.37966E-01	0.	6.12646E-01
25	2.33470E-07	7.36824E-03	4.47201E-01	7.04384E-01	0.

UCRL BEO-C-U F.D.WENSTRUP URANYL-F CANS

INDEX RECORD

COMPOSITION DATA TAPE UCRL BEO-C-U

2 COMPOSITIONS 5 RECORDS

DESIGNATION	RECORD NO.
H/U 43.9	1
H/U 62.7	3

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

CALCULATION SUMMARY

NUMBER OF GROUPS = 25
NUMBER OF REGIONS = 1
TOTAL NUMBER OF INTERVALS = 20
NUMBER OF COMPOSITIONS = 1
MAXIMUM NUMBER OF ITERATIONS = 99
CONVERGENCE FACTOR = 9.9999999E-06

DIRECT FLUX CALCULATION
SLAB GEOMETRY

LEFT-HAND BOUNDARY 0. RIGHT-HAND BOUNDARY 1.6150000E 01

GROUP	LEFT ALBEDO	GROUP	RIGHT ALBEDO
1	1.0000000E 00	1	0.
2	1.0000000E 00	2	0.
3	1.0000000E 00	3	0.
4	1.0000000E 00	4	0.
5	1.0000000E 00	5	0.
6	1.0000000E 00	6	0.
7	1.0000000E 00	7	0.
8	1.0000000E 00	8	0.
9	1.0000000E 00	9	0.
10	1.0000000E 00	10	0.
11	1.0000000E 00	11	0.
12	1.0000000E 00	12	0.
13	1.0000000E 00	13	0.
14	1.0000000E 00	14	0.
15	1.0000000E 00	15	0.
16	1.0000000E 00	16	0.
17	1.0000000E 00	17	0.
18	1.0000000E 00	18	0.
19	1.0000000E 00	19	0.
20	1.0000000E 00	20	0.
21	1.0000000E 00	21	0.
22	1.0000000E 00	22	0.
23	1.0000000E 00	23	0.
24	1.0000000E 00	24	0.
25	1.0000000E 00	25	0.

REGIONAL DATA

REGION	NUMBER OF INTERVALS	RIGHT-HAND BOUNDARY	BUCKLING DIMENSION	COMPOSITION IDENTIFICATION
1	-20	1.6150000E 01	2.5400000E 01	H/U 43.9

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

COMPOSITIONS

H/U 43.9

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

RADIUS	FISSION SOURCE	EXTERNAL SOURCE
0.	1.42297E 00	0.
0.001	1.42297E 00	0.
0.807	1.41965E 00	0.
1.615	1.40970E 00	0.
2.422	1.39316E 00	0.
3.230	1.37009E 00	0.
4.037	1.34058E 00	0.
4.845	1.30475E 00	0.
5.652	1.26272E 00	0.
6.460	1.21463E 00	0.
7.267	1.16062E 00	0.
8.075	1.10083E 00	0.
8.882	1.03537E 00	0.
9.690	9.64312E-01	0.
10.497	8.87632E-01	0.
11.305	8.05215E-01	0.
12.112	7.16788E-01	0.
12.920	6.21870E-01	0.
13.727	5.19644E-01	0.
14.535	4.08541E-01	0.
15.342	2.84680E-01	0.
16.149	1.35596E-01	0.
16.150	1.35407E-01	0.

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

RELATIVE FLUX DISTRIBUTIONS

RADIUS	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
0.	3.48386E-03	3.15030E-02	8.75931E-02	1.21304E-01	1.14933E-01
0.001	3.48386E-03	3.15030E-02	8.75931E-02	1.21304E-01	1.14933E-01
0.807	3.47631E-03	3.14329E-02	8.73926E-02	1.21026E-01	1.14667E-01
1.615	3.45369E-03	3.12230E-02	8.67916E-02	1.20193E-01	1.13868E-01
2.422	3.41615E-03	3.08744E-02	8.57935E-02	1.18310E-01	1.12541E-01
3.230	3.36393E-03	3.03892E-02	8.44034E-02	1.16883E-01	1.10692E-01
4.037	3.29738E-03	2.97706E-02	8.26290E-02	1.14424E-01	1.08328E-01
4.845	3.21694E-03	2.90223E-02	8.04778E-02	1.11446E-01	1.05462E-01
5.652	3.12316E-03	2.81492E-02	7.79679E-02	1.07965E-01	1.02106E-01
6.460	3.01670E-03	2.71569E-02	7.51076E-02	1.04003E-01	9.82758E-02
7.267	2.89834E-03	2.60522E-02	7.19160E-02	9.75817E-02	9.39904E-02
8.075	2.76896E-03	2.48430E-02	6.84130E-02	9.47301E-02	8.92706E-02
8.882	2.62961E-03	2.35383E-02	6.46214E-02	8.94303E-02	8.41405E-02
9.690	2.48145E-03	2.21486E-02	6.05683E-02	8.38702E-02	7.86277E-02
10.497	2.32586E-03	2.06860E-02	5.62852E-02	7.79443E-02	7.27646E-02
11.305	2.16437E-03	1.91647E-02	5.18094E-02	7.17553E-02	6.65894E-02
12.112	1.99882E-03	1.76012E-02	4.71861E-02	6.53669E-02	6.01489E-02
12.920	1.83132E-03	1.60153E-02	4.24702E-02	5.88569E-02	5.35014E-02
13.727	1.66439E-03	1.44307E-02	3.77304E-02	5.23220E-02	4.67221E-02
14.535	1.50106E-03	1.28764E-02	3.30530E-02	4.58847E-02	3.99105E-02
15.342	1.34502E-03	1.13887E-02	2.85504E-02	3.97031E-02	3.32029E-02
16.149	1.20116E-03	1.00164E-02	2.43786E-02	3.39970E-02	2.68039E-02
16.150	1.20103E-03	1.00151E-02	2.43747E-02	3.39916E-02	2.67978E-02

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

RELATIVE FLUX DISTRIBUTIONS

RADIUS	GROUP 6	GROUP 7	GROUP 8	GROUP 9	GROUP 10
0.	9.34928E-02	7.23887E-02	5.82887E-02	6.31644E-02	5.97096E-02
0.001	9.34928E-02	7.23887E-02	5.82887E-02	6.31644E-02	5.97096E-02
0.807	9.32756E-02	7.22205E-02	5.81531E-02	6.30176E-02	5.95708E-02
1.615	9.26245E-02	7.17162E-02	5.77469E-02	6.25773E-02	5.91545E-02
2.422	9.15424E-02	7.08780E-02	5.70718E-02	6.18455E-02	5.84626E-02
3.230	9.00339E-02	6.97096E-02	5.61306E-02	6.08254E-02	5.74980E-02
4.037	8.81056E-02	6.82158E-02	5.49273E-02	5.95212E-02	5.62649E-02
4.845	8.57659E-02	6.64031E-02	5.34670E-02	5.79384E-02	5.47683E-02
5.652	8.30248E-02	6.42791E-02	5.17559E-02	5.60837E-02	5.30145E-02
6.460	7.98941E-02	6.18524E-02	4.98009E-02	5.39646E-02	5.10106E-02
7.267	7.63871E-02	5.91331E-02	4.76100E-02	5.15897E-02	4.87648E-02
8.075	7.25187E-02	5.61320E-02	4.51919E-02	4.89685E-02	4.62857E-02
8.882	6.83056E-02	5.28607E-02	4.25561E-02	4.61111E-02	4.35827E-02
9.690	6.37661E-02	4.93318E-02	3.97127E-02	4.30281E-02	4.06655E-02
10.497	5.89207E-02	4.55583E-02	3.66721E-02	3.97305E-02	3.75436E-02
11.305	5.37927E-02	4.15538E-02	3.34455E-02	3.62295E-02	3.42258E-02
12.112	4.84092E-02	3.73322E-02	3.00443E-02	3.25356E-02	3.07187E-02
12.920	4.28028E-02	3.29076E-02	2.64804E-02	2.86582E-02	2.70246E-02
13.727	3.70144E-02	2.82936E-02	2.27658E-02	2.46036E-02	2.31368E-02
14.535	3.10968E-02	2.35025E-02	1.89126E-02	2.03727E-02	1.90321E-02
15.342	2.51232E-02	1.85448E-02	1.49332E-02	1.59564E-02	1.46551E-02
16.149	1.92105E-02	1.34376E-02	1.08482E-02	1.13341E-02	9.89648E-03
16.150	1.92047E-02	1.34324E-02	1.08441E-02	1.13294E-02	9.89141E-03

RELATIVE FLUX DISTRIBUTIONS

RADIUS	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15
0.	4.76137E-02	4.21665E-02	3.95485E-02	3.80251E-02	4.75149E-02
0.001	4.76137E-02	4.21665E-02	3.95485E-02	3.80251E-02	4.75149E-02
0.807	4.75029E-02	4.20684E-02	3.94564E-02	3.79365E-02	4.74042E-02
1.615	4.71709E-02	4.17742E-02	3.91805E-02	3.76711E-02	4.70724E-02
2.422	4.66190E-02	4.12853E-02	3.87218E-02	3.72299E-02	4.65209E-02
3.230	4.58496E-02	4.06037E-02	3.80822E-02	3.66148E-02	4.57519E-02
4.037	4.48659E-02	3.97322E-02	3.72646E-02	3.58283E-02	4.47685E-02
4.845	4.36720E-02	3.86745E-02	3.62721E-02	3.48736E-02	4.35748E-02
5.652	4.22729E-02	3.74349E-02	3.51088E-02	3.37545E-02	4.21754E-02
6.460	4.06742E-02	3.60183E-02	3.37793E-02	3.24753E-02	4.05756E-02
7.267	3.88822E-02	3.44302E-02	3.22887E-02	3.10409E-02	3.87812E-02
8.075	3.69038E-02	3.26767E-02	3.06424E-02	2.94562E-02	3.67979E-02
8.882	3.47463E-02	3.07637E-02	2.88458E-02	2.77260E-02	3.46315E-02
9.690	3.24169E-02	2.86974E-02	2.69040E-02	2.58549E-02	3.22866E-02
10.497	2.99223E-02	2.64830E-02	2.48212E-02	2.38460E-02	2.97662E-02
11.305	2.72683E-02	2.41240E-02	2.25995E-02	2.17001E-02	2.70696E-02
12.112	2.44575E-02	2.16207E-02	2.02372E-02	1.94140E-02	2.41909E-02
12.920	2.14872E-02	1.89670E-02	1.77257E-02	1.69776E-02	2.11160E-02
13.727	1.83439E-02	1.61458E-02	1.50460E-02	1.43714E-02	1.78203E-02
14.535	1.49950E-02	1.31211E-02	1.21627E-02	1.15631E-02	1.42667E-02
15.342	1.13728E-02	9.82642E-03	9.01817E-03	8.50676E-03	1.04087E-02
16.149	7.35135E-03	6.15254E-03	5.53460E-03	5.15480E-03	6.20725E-03
16.150	7.34700E-03	6.14858E-03	5.53090E-03	5.15128E-03	6.20286E-03

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

RELATIVE FLUX DISTRIBUTIONS

RADIUS	GROUP 16	GROUP 17	GROUP 18	GROUP 19	GROUP 20
0.	4.22351E-02	2.80081E-02	2.48784E-02	2.68059E-02	2.25045E-02
0.001	4.22351E-02	2.80081E-02	2.48784E-02	2.68059E-02	2.25045E-02
0.807	4.21367E-02	2.79428E-02	2.48203E-02	2.67433E-02	2.24520E-02
1.615	4.18416E-02	2.77471E-02	2.46465E-02	2.65559E-02	2.22945E-02
2.422	4.13512E-02	2.74217E-02	2.43574E-02	2.62443E-02	2.20328E-02
3.230	4.06673E-02	2.69680E-02	2.39543E-02	2.58097E-02	2.16678E-02
4.037	3.97927E-02	2.63879E-02	2.34387E-02	2.52539E-02	2.12009E-02
4.845	3.87310E-02	2.56834E-02	2.28128E-02	2.45789E-02	2.06339E-02
5.652	3.74861E-02	2.48574E-02	2.20787E-02	2.37873E-02	1.99687E-02
6.460	3.60626E-02	2.39128E-02	2.12391E-02	2.28817E-02	1.92076E-02
7.267	3.44655E-02	2.28527E-02	2.02968E-02	2.18649E-02	1.83528E-02
8.075	3.26997E-02	2.16803E-02	1.92542E-02	2.07395E-02	1.74063E-02
8.882	3.07696E-02	2.03983E-02	1.81139E-02	1.95077E-02	1.63697E-02
9.690	2.86787E-02	1.90087E-02	1.68772E-02	1.81708E-02	1.52440E-02
10.497	2.64287E-02	1.75121E-02	1.55444E-02	1.67286E-02	1.40285E-02
11.305	2.40177E-02	1.59069E-02	1.41137E-02	1.51787E-02	1.27211E-02
12.112	2.14393E-02	1.41881E-02	1.25802E-02	1.35154E-02	1.13171E-02
12.920	1.86799E-02	1.23461E-02	1.09350E-02	1.17298E-02	9.80935E-03
13.727	1.57179E-02	1.03656E-02	9.16385E-03	9.80897E-03	8.18909E-03
14.535	1.25230E-02	8.22439E-03	7.24651E-03	7.73914E-03	6.44829E-03
15.342	9.06000E-03	5.89188E-03	5.15484E-03	5.51284E-03	4.58632E-03
16.149	5.30128E-03	3.32509E-03	2.85174E-03	3.15390E-03	2.62493E-03
16.150	5.29737E-03	3.32236E-03	2.84930E-03	3.15152E-03	2.62294E-03

H32.3-D25.4 E.D.WENSTRUP URANYL-F CANS

RELATIVE FLUX DISTRIBUTIONS

RADIUS	GROUP 21	GROUP 22	GROUP 23	GROUP 24	GROUP 25
0.	1.19717E-02	2.39704E-02	2.21491E-02	7.71569E-03	5.12916E-03
0.001	1.19717E-02	2.39704E-02	2.21491E-02	7.71569E-03	5.12916E-03
0.807	1.19438E-02	2.39144E-02	2.20974E-02	7.69768E-03	5.11718E-03
1.615	1.18600E-02	2.37467E-02	2.19424E-02	7.64367E-03	5.08128E-03
2.422	1.17208E-02	2.34678E-02	2.16846E-02	7.55388E-03	5.02159E-03
3.230	1.15266E-02	2.30788E-02	2.13252E-02	7.42865E-03	4.93835E-03
4.037	1.12782E-02	2.25813E-02	2.08653E-02	7.26846E-03	4.83186E-03
4.845	1.09765E-02	2.19770E-02	2.03067E-02	7.07387E-03	4.70251E-03
5.652	1.06226E-02	2.12680E-02	1.96514E-02	6.84557E-03	4.55075E-03
6.460	1.02176E-02	2.04565E-02	1.89012E-02	6.58426E-03	4.37705E-03
7.267	9.76274E-03	1.95450E-02	1.80584E-02	6.29065E-03	4.18189E-03
8.075	9.25903E-03	1.85353E-02	1.71247E-02	5.96539E-03	3.96569E-03
8.882	8.70735E-03	1.74291E-02	1.61015E-02	5.60893E-03	3.72876E-03
9.690	8.10809E-03	1.62269E-02	1.49893E-02	5.22146E-03	3.47123E-03
10.497	7.46098E-03	1.49281E-02	1.37871E-02	4.80266E-03	3.19289E-03
11.305	6.76476E-03	1.35299E-02	1.24924E-02	4.35161E-03	2.89313E-03
12.112	6.01694E-03	1.20270E-02	1.10999E-02	3.86646E-03	2.57074E-03
12.920	5.21368E-03	1.04111E-02	9.60074E-03	3.34410E-03	2.22367E-03
13.727	4.34991E-03	8.66933E-03	7.97940E-03	2.77900E-03	1.84833E-03
14.535	3.41969E-03	6.78015E-03	6.20376E-03	2.15916E-03	1.43702E-03
15.342	2.41531E-03	4.69427E-03	4.19085E-03	1.44969E-03	9.67191E-04
16.149	1.31846E-03	2.26719E-03	1.70780E-03	5.21858E-04	3.46810E-04
16.150	1.31727E-03	2.26435E-03	1.70478E-03	5.20523E-04	3.45827E-04

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

ITERATION	EIGENVALUE
1	1.5555020E 01
2	1.0206854E 00
3	1.0347557E 00
4	1.0400402E 00
5	1.0421952E 00
6	1.0430922E 00
7	1.0434676E 00
8	1.0436248E 00
9	1.0436908E 00
10	1.0437184E 00
11	1.0437300E 00
12	1.0437348E 00

H32.3-D25.4 F.D.WENSTRUP URANYL-F CANS

AVERAGES - REGION NO 1

VOLUME FRACTION 0.1000000E 01
(REGION/CORE) AVERAGE POWER 1.0000000E 00

GROUP	AVERAGE FLUX
1	0.2615795E-02
2	0.2337613E-01
3	0.6395762E-01
4	0.8859464E-01
5	0.8278365E-01
6	0.6693763E-01
7	0.5166679E-01
8	0.4159723E-01
9	0.4504021E-01
10	0.4250901E-01
11	0.3384519E-01
12	0.2993027E-01
13	0.2803485E-01
14	0.2692147E-01
15	0.3359191E-01
16	0.2981577E-01
17	0.1974807E-01
18	0.1752461E-01
19	0.1886650E-01
20	0.1582470E-01
21	0.8413460E-02
22	0.1681920E-01
23	0.1551648E-01
24	0.5402672E-02
25	0.3591940E-02

```
---------------------------------------------------------------------------------
+ THIS PROGRAM PROCESSED ALL AVAILABLE CARDS
STOP TIME BEFORE MACHINE RESTORED T STANDARD SET-UP  14.360
---------------------------------------------------------------------------------
RESTORE MACHINE TO STANDARD SET UP - - - PUSH START.
                                                              STOP 14.37
```

7.0 UNASSEMBLED PROGRAM LISTING

```
*       CHAIN(1,B1)                     BLOCK CDP
C
*       657                     CONTROL PROG.
C
        COMMON Q
C
        DIMENSION Q(13764)
C
        DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
       1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
       2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
       3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),FG(25),FV(24),
       4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
       5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
       6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
       7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
       8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
        EQUIVALENCE (Q(2),BDATF),(Q(6),BDENT),(Q(9),BNAM),
       1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
       2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
       3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
       4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
       5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
       6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
       7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
       8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
       9(Q(9254),IMAT),(Q(9284),FG),(Q(9309),FV),(Q(9333),DELTAU)
C
        EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
       1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
       2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
       3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
       4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
       5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
       6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
       7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
       8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
       9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
    1   CONTINUE
        CALL START
        IF (XABSF(MORE)-1) 5, 5, 128
    5   CONTINUE
        IF DIVIDE CHECK 6, 6
    6   CONTINUE
        CALL CID
   10   CONTINUE
        IF (NDT) 30, 30, 15
   15   CONTINUE
        CALL RNDT1
   20   CONTINUE
```

```
      CALL RNDT2
   25 CONTINUE
      CALL RNDT3
   30 CONTINUE
      DO 65 I=1,30
      IF (CMAT(I)) 35, 65, 35
   35 CONTINUE
      IF (ABSF(CMAT(I))-1.0E+6) 40, 45, 45
   40 CONTINUE
      CALL RNDT4
      GO TO 50
   45 CONTINUE
      MN=I
      CALL AUXND
   50 CONTINUE
      CALL THERM
   55 CONTINUE
      CALL NANDW
   60 CONTINUE
      CALL MIX
   65 CONTINUE
      REWIND NDT
      REWIND KTAPE
      IF (SENSE LIGHT 3) 66, 66
   66 CONTINUE
      IF (NCODE(5)-1) 68, 67, 68
   67 CONTINUE
      CALL HOMRES
   68 CONTINUE
      IF (NCODE(2)) 70, 75, 70
   70 CONTINUE
      CALL BEHR
   75 CONTINUE
      NGT=NCODE(3)+1
      GO TO (100,80,85,90), NGT
   80 CONTINUE
      CALL ROD
      GO TO 100
   85 CONTINUE
      CALL ANULUS
      GO TO 100
   90 CONTINUE
      CALL PLATE
  100 CONTINUE
      CALL GRPAR
  105 CONTINUE
      CALL WTCD
  110 CONTINUE
      CALL WOTCD
  115 CONTINUE
      IF (XABSF(MORE)-1) 130, 120, 125
  120 CONTINUE
      KASE=MORE
      GO TO 5
  125 CONTINUE
```

```
      CALL ENDCDP
      CALL PAGES(NPAGE)
      DO 126 I=1,15000
      CDTNAM(I)=0.0
126   CONTINUE
128   CONTINUE
      CALL CHAIN(2,B1)
130   CONTINUE
      CALL ENDCDP
      CALL EXIT
      END(0,0,0)
```

```
*      657                    SUBROUTINE START
C
       SUBROUTINE START
C
       COMMON Q
C
       DIMENSION Q(13764)
C
       DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
      1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
      2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
      3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
      4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
      5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
      6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
      7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
      8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
       EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
      1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
      2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
      3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
      4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
      5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
      6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
      7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
      8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
      9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
       EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
      1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
      2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
      3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
      4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
      5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
      6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
      7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
      8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
      9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
       CALL MOVE(-12,72H
      1                                   ,CASEID)
       DO 5 I=1,314
       CDT(I)=0.0
     5 CONTINUE
       NPAGE=1
       NWOT=2
       NDT=8
       KDT=9
       ITAPE=5
       JTAPE=6
       KTAPE=7
       REWIND NDT
       REWIND KDT
       REWIND ITAPE
```

```
      REWIND JTAPE
      REWIND KTAPE
      READ DIP BNAM,BDATE,BDENT,CDT,CDTNAM,
     1NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,NWOT
      IF (SENSE LIGHT 1) 10, 15
   10 CONTINUE
      CALL ERRORA
      CALL EXIT
   15 CONTINUE
      CALL HDING(Q(12))
      IF (CDT(1)) 20, 60, 20
   20 CONTINUE
      CALL FSFBT(KDT,1)
      BACKSPACE KDT
      BACKSPACE KDT
      READ TAPE KDT, (CDT(I),I=1,303)
      IF ((CDTNAM(1) CDT(1))+(CDTNAM(2)-CDT(2))) 25, 30, 25
   25 CONTINUE
      CALL ERRORA
      CALL EXIT
   30 CONTINUE
      IF (XABSF(MORE)-1) 35, 40, 45
   35 CONTINUE
      CALL ERRORA
      CALL EXIT
   40 CONTINUE
      NRCDT=NCDT(3)
      BACKSPACE KDT
      GO TO 70
   45 CONTINUE
      REWIND KDT
      DO 50 I=1,15000
      CDTNAM(I)=0.0
   50 CONTINUE
      GO TO 90
   60 CONTINUE
      IF (XABSF(MORE)-1) 65, 70, 65
   65 CONTINUE
      CALL ERRORA
      CALL EXIT
   70 CONTINUE
      DO 75 I=1,1500
      DO 75 J=1,4
      RDATA(I,J)=1.0
   75 CONTINUE
      DO 80 I=1,25
      DO 80 J=1,30
      GFAC(I,J)=1.0
   80 CONTINUE
      DO 85 I=1,6690
      CMAT(I)=0.0
   85 CONTINUE
   90 CONTINUE
      RETURN
      END(0,0,0)
```

```
*        657                      SUBROUTINE CID
C
      SUBROUTINE CID
C
      COMMON Q,IRES
C
      DIMENSION Q(13764),IRES(30)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),FG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),FXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),FG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      IF (KASE) 1, 1, 20
    1 CONTINUE
      DO 2 IR=1,30
      IRES(IR)=0
    2 CONTINUE
      DO 5 I=1,1500
      DO 5 I=1,4
      RDATA(I,J)=1.0
    5 CONTINUE
      DO 10 I=1,25
      DO 10 J=1,30
      GFAC(I,J)=1.0
   10 CONTINUF
      DO 15 I=1,6690
      CMAT(I)=0.0
```

```
15 CONTINUE
   GO TO 23
20 CONTINUE
   DO 22 I=1,1730
   IMAT(I)=0
22 CONTINUE
23 CONTINUE
   READ DIP CASEID,CMAT,DMAT,ELFAC,GBEHR,GDIFC,GFAC,
  1GTRAN,GVOL,NBEHR,IRES,NCODE,SPEC,TMAT,WMAT,FT,MORE
   IF (SENSE LIGHT 1) 25, 30
25 CONTINUE
   CALL ERRORA
   CALL ERRCDP
30 CONTINUE
   CALL HDING(Q(12))
   RETURN
   END(0,0,0)
```

```
*       657                    SUBROUTINE RNDT1
C
        SUBROUTINE RNDT1
C
        COMMON Q,IRES
C
        DIMENSION Q(13764),IRES(30)
C
        DIMENSION CDT(303),NCDT(303),CDTNAM(2),FLFAC(1500,4),
       1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
       2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
       3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
       4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
       5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
       6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
       7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
       8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
        EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
       1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
       2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
       3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
       4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
       5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
       6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
       7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
       8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
       9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
        EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
       1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
       2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
       3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
       4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
       5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
       6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
       7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
       8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
       9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
        NPASS=1
      1 CONTINUE
        REWIND NDT
        READ TAPE NDT, (RNDT(I),I=1,2000)
        NMAT=0
        DO 35 J=1,30
        IF (CMAT(J)) 5, 35, 5
      5 CONTINUE
        NMAT=NMAT+1
        IF (ABSF(CMAT(J))-1.0E+6) 7, 25, 25
      7 CONTINUE
        K=2
     10 CONTINUE
        IF (RNDT(4*K-1)-CMAT(J)) 12, 30, 12
     12 CONTINUE
```

```
      K=K+1
      IF (K-500) 10, 15, 15
   15 CONTINUE
      IF (NPASS-2)17, 20, 20
   17 CONTINUE
      NPASS=2
      GO TO 1
   20 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   25 CONTINUE
      IMAT(J)=J+3000
      GO TO 35
   30 CONTINUE
      IMAT(J)=NRNDT(4*K)
   35 CONTINUE
      RETURN
      END(0,0,0)
```

```
*       657                      SUBROUTINE RNDT2
C
        SUBROUTINE RNDT2
C
        COMMON Q,IRES
C
        DIMENSION Q(13764),IRES(30)
C
        DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
       1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
       2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
       3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
       4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
       5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
       6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
       7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
       8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
        EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
       1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
       2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
       3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
       4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
       5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
       6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
       7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
       8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
       9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
        EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
       1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
       2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
       3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
       4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
       5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
       6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
       7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
       8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
       9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
        DIMENSION FU(143)
C
        READ TAPE NDT, (FU(I),I=1,143)
        DO 10 I=1,24
        EG(I)=EU(I+69)
        FV(I)=EU(I+119)
     10 CONTINUE
        EG(25)=EU(94)
        DO 20 I=1,24
        DELTAU(I)=LOGF(EG(I)/EG(I+1))
        IF DIVIDE CHECK 15, 20
     15 CONTINUE
        CALL ERRORA
        CALL ERRCDP
     20 CONTINUE
```

```
DELTAU(25)=0.0
NREC=2
RETURN
END(0,0,0)
```

```
*       657                         SUBROUTINE RNDT3
C
        SUBROUTINE RNDT3
C
        COMMON Q,IRES
C
        DIMENSION Q(13764),IRES(30)
C
        DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
       1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
       2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
       3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
       4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
       5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
       6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
       7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
       8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
        EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
       1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
       2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
       3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
       4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
       5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
       6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
       7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
       8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
       9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
        EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
       1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
       2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
       3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
       4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
       5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
       6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
       7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
       8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
       9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
        DIMENSION SP(40)
C
        ISPEC=0
        IF (SPEC) 1, 70, 5
      1 CONTINUE
        READ DIP SP
        IF (SENSE LIGHT 1) 2, 45
      2 CONTINUE
        CALL ERRORA
        CALL ERRCDP
      5 CONTINUE
        NPASS=1
      7 CONTINUE
        K=2
     10 CONTINUE
```

```
      IF (RNDT(4*K-1)-SPEC) 12, 25, 12
   12 CONTINUE
      K=K+1
      IF (K-500) 10, 15, 15
   15 CONTINUE
      IF (NPASS-2) 17, 20, 20
   17 CONTINUE
      NPASS=2
      GO TO 7
   20 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   25 CONTINUE
      ISPEC=NRNDT(4*K)
      NRS=ISPEC-NREC-1
      IF (NRS) 30, 32, 27
   27 CONTINUE
      DO 28 I=1,NRS
      READ TAPE NDT
   28 CONTINUE
      GO TO 32
   30 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   32 CONTINUE
      READ TAPE NDT, (SP(I),I=1,40)
      IF (SPEC-SP(4)) 35, 40, 35
   35 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   40 CONTINUE
      DO 42 I=1,25
      SP(I)=SP(I+4)
   42 CONTINUE
   45 CONTINUE
      DO 47 I=1,25
      S(I)=SP(I)*DELTAU(I)
   47 CONTINUE
      IF(ISPEC) 50, 70, 50
   50 CONTINUE
      NREC=ISPEC
      J=1
      DO 60 I=1,30
      IF (IMAT(I)) 60, 60, 52
   52 CONTINUE
      IF (IMAT(I)-IMAT(J)) 55, 60, 60
   55 CONTINUE
      J=I
   60 CONTINUE
      IF (NREC-IMAT(J)) 70, 62, 65
   62 CONTINUE
      BACKSPACE NDT
      NREC=NREC-1
      GO TO 70
   65 CONTINUE
```

```
      REWIND NDT
      NREC=0
   70 CONTINUE
      RETURN
      END(0,0,0)
```

```
      SUBR)UTINE RNDT4
C
      COMMON Q,IRES
C
      DIMENSION Q(13764),IRES(30)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
    1 CONTINUE
      MN=1
      DO 15 I=1,30
      IF (IMAT(I)) 15, 15, 5
    5 CONTINUE
      IF (IMAT(I)-3000) 10, 15, 15
   10 CONTINUE
      IF (IMAT(I)-IMAT(MN)) 12, 15, 15
   12 CONTINUE
      MN=I
   15 CONTINUE
      NRS=IMAT(MN)-NREC-1
   16 CONTINUE
      IF (NRS) 80, 20, 17
   17 DO 18 I=1,NRS
```

```
      READ TAPE NDT
   18 CONTINUE
   20 CONTINUE
      DO 32 J=1,2780
      SIG(J)=0.0
   32 CONTINUE
      READ TAPE NDT, (SIG(I),I=1,520)
      NREC=IMAT(MN)
      IF(CMAT(MN)-SIG(4)) 25, 30, 25
   25 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   30 CONTINUE
      IF (SIG(510)) 40, 40, 35
   35 CONTINUE
      MOMIN=NSIG(510)
      MOMAX=NSIG(511)
      MOPMAX=NSIG(512)
      READ TAPE NDT, ((TRASIG(I,J),J=MOMIN,MOPMAX),I=MOMIN,MOMAX)
      NREC=NREC+1
   40 CONTINUE
      IF (SIG(513)) 50, 50, 45
   45 CONTINUE
      READ TAPE NDT
      NREC=NREC+1
   50 CONTINUE
      IF (SIG(516)) 60, 60, 55
   55 CONTINUE
      NRES=NSIG(516)
      NTRES=5*NRES
      READ TAPE NDT, (RES(I),I=1,NTRES)
      NREC=NREC+1
   60 CONTINUE
      IF (NCODE(4)) 75, 75, 65
   65 CONTINUE
      IF (SIG(517)) 75, 75, 70
   70 CONTINUE
      MGMIN=NSIG(517)
      MGMAX=NSIG(518)
      MGPMAX=NSIG(519)
      READ TAPE NDT, ((FNGAM(I,J),J=MGMIN,MGPMAX),I=MGMIN,MGMAX)
      NREC=NREC+1
   75 CONTINUE
      DF=SIG(209)
      NW=NSIG(520)
   80 CONTINUE
      IMAT(MN)=MN+3000
      RETURN
      END
```

```
      SUBROUTINE AUXND
C
      COMMON Q,IRES
C
      DIMENSION Q(13764),IRES(30)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(1=762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      DIMENSION SS(34),XISS(34),STR(34),SA(34),XISS1(34),
     1SNF(34),TM4500(30),TM4000(30),TM3500(30),TM3000(30),TM2500(30),
     2TM2000(30),TM1500(30),TM1000(30),TM500(30),TM68(30)
C
    1 CONTINUE
      MN=MN
      IF (KASE) 5, 5, 65
    5 CONTINUE
      DO 7 I=1,34
      SS(I)=0.0
      XISS(I)=0.0
      STR(I)=0.0
      SA(I)=0.0
      XISS1(I)=0.0
      SNF(I)=0.0
```

```
    7 CONTINUE
      DO 10 I=1,30
      TM4500(I)=0.0
      TM4000(I)=0.0
      TM3500(I)=0.0
      TM3000(I)=0.0
      TM2500(I)=0.0
      TM2000(I)=0.0
      TM1500(I)=0.0
      TM1000(I)=0.0
      TM500(I)=0.0
      TM68(I)=0.0
   10 CONTINUE
      DF=0.0
      MOMIN=0
      MOMAX=0
      MOPMAX=0
      M1MIN=0
      M1MAX=0
      M1PMAX=0
      NRES=0
      MGMIN=0
      MGMAX=0
      MGPMAX=0
      NW=0
      READ DIP CODE, SS, XISS, STR, SA, XISS1, SNF, DF,
     1 TM4500, TM4000, TM3500, TM3000, TM2500, TM2000,
     2 TM1500, TM1000, TM500, TM68, MOMIN, MOMAX,
     3 MOPMAX, M1MIN, M1MAX, M1PMAX, MGMIN, MGMAX,
     4 MGPMAX, TRASIG, RES, ENGAM
      IF (SENSE LIGHT 1) 15, 20
   15 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   20 CONTINUE
      IF (CODE-CMAT(MN)) 22, 25, 22
   22 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   25 CONTINUE
      SIG(4)=CODE
      DO 30 I=1,34
      SIG(I+4)=SS(I)
      SIG(I+38)=XISS(I)
      SIG(I+72)=STR(I)
      SIG(I+106)=SA(I)
      SIG(I+140)=XISS1(I)
      SIG(I+174)=SNF(I)
   30 CONTINUE
      SIG(209)=DF
      DO 35 I=1,30
      SIG(I+209)=TM4500(I)
      SIG(I+239)=TM4000(I)
      SIG(I+269)=TM3500(I)
      SIG(I+299)=TM3000(I)
```

```
      SIG(I+329)=TM2500(I)
      SIG(I+359)=TM2000(I)
      SIG(I+389)=TM1500(I)
      SIG(I+419)=TM1000(I)
      SIG(I+449)=TM500(I)
      SIG(I+479)=TM68(I)
   35 CONTINUE
      NSIG(510)=MOMIN
      NSIG(511)=MOMAX
      NSIG(512)=MOPMAX
      NSIG(513)=M1MIN
      NSIG(514)=M1MAX
      NSIG(515)=M1PMAX
      NSIG(516)=NRES
      NSIG(517)=MGMIN
      NSIG(518)=MGMAX
      NSIG(519)=MGPMAX
      NSIG(520)=NW
      WRITE TAPE ITAPE, (SIG(I),I=1,520)
      IF (MOMIN) 45, 45, 40
   40 CONTINUE
      MMAX=(MOMAX-MOMIN+1)*(MOPMAX-MOMIN 1)
      WRITE TAPE ITAPE, (TRASIG(I),I=1,MMAX)
   45 CONTINUE
      IF (NRES) 55, 55, 50
   50 CONTINUE
      NTRES=5*NRES
      WRITE TAPE ITAPE, (RES(I),I=1,NTRES)
   55 CONTINUE
      IF (MGMIN) 100, 100, 60
   60 CONTINUE
      MMAX=(MGMAX-MGMIN+1)*(MGPMAX-MGMIN 1)
      WRITE TAPE ITAPE, (ENGAM(I),I=1,MMAX)
      GO TO 100
   65 CONTINUE
      READ TAPE ITAPE, (SIG(I),I=1,520)
      IF (SIG(4)-CMAT(MN)) 67, 68, 67
   67 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   68 CONTINUE
      IF (SIG(510)) 75, 75, 70
   70 CONTINUE
      MOMIN=NSIG(510)
      MOMAX=NSIG(511)
      MOPMAX=NSIG(512)
      READ TAPE ITAPE, ((TRASIG(I,J),J=MOMIN,MOPMAX),I=MOMIN,MOMAX)
   75 CONTINUE
      IF (SIG(516)) 85, 85, 80
   80 CONTINUE
      NRES=NSIG(516)
      NTRES=5*NRES
      READ TAPE ITAPE, (RES(I),I=1,NTRES)
   85 CONTINUE
      IF (SIG(517)) 95, 95, 90
```

```
 90 CONTINUE
    MGMIN=NSIG(517)
    MGMAX=NSIG(518)
    MGPMAX=NSIG(519)
    READ TAPE ITAPE, ((ENGAM(I,J),J=MGMIN,MGPMAX),I=MGMIN,MGMAX)
 95 CONTINUE
100 CONTINUE
    RETURN
    END(0,0,0)
```

657 SUBROUTINE THERM

```
      SUBROUTINE THERM
C
      COMMON Q,IRES
C
      DIMENSION Q(13764),IRES(30)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
    1 CONTINUE
      MN=MN
      TEMP=TMAT(MN)
      TMAT(MN)=ABSF(TMAT(MN))
      IF(TMAT(MN)) 4, 2, 4
    2 CONTINUE
      CALL ERRORA
      CALL ERRCDP
    4 CONTINUE
      IF (TMAT(MN)-SIG(480)) 5, 6, 7
    5 CONTINUE
      TMAT(MN)=SIG(480)
    6 CONTINUE
      NTM=480
      GO TO 60
```

```
 7 CONTINUE
   IF (TMAT(MN)-SIG(450)) 10, 14, 15
10 CONTINUE
   IF ((TMAT(MN)-SIG(480))-(SIG(450)-TMAT(MN))) 5, 12, 12
12 CONTINUE
   TMAT(MN)=SIG(450)
14 CONTINUE
   NTM=450
   GO T) 60
15 CONTINUE
   IF (TMAT(MN)-SIG(420)) 16, 19, 20
16 CONTINUE
   IF ((TMAT(MN)-SIG(450))-(SIG(420)-TMAT(MN))) 12, 18, 18
18 CONTINUE
   TMAT(MN)=SIG(420)
19 CONTINUE
   NTM=420
   GO TO 60
20 CONTINUE
   IF (TMAT(MN)-SIG(390)) 21, 24, 25
21 CONTINUE
   IF ((TMAT(MN)-SIG(420))-(SIG(390)-TMAT(MN))) 18, 23, 23
23 CONTINUE
   TMAT(MN)=SIG(390)
24 CONTINUE
   NTM=390
   GO TO 60
25 CONTINUE
   IF (TMAT(MN)-SIG(360)) 26, 29, 30
26 CONTINUE
   IF ((TMAT(MN)-SIG(390))-(SIG(360)-TMAT(MN))) 23, 28, 28
28 CONTINUE
   TMAT(MN)=SIG(360)
29 CONTINUE
   NTM=360
   GO TO 60
30 CONTINUE
   IF (TMAT(MN)-SIG(330)) 31, 34, 35
31 CONTINUE
   IF ((TMAT(MN)-SIG(360))-(SIG(330)-TMAT(MN))) 28, 33, 33
33 CONTINUE
   TMAT(MN)=SIG(330)
34 CONTINUE
   NTM=330
   GO TO 60
35 CONTINUE
   IF (TMAT(MN)-SIG(300)) 36, 39, 40
36 CONTINUE
   IF ((TMAT(MN)-SIG(330))-(SIG(300)-TMAT(MN))) 33, 38, 38
38 CONTINUE
   TMAT(MN)=SIG(300)
39 CONTINUE
   NTM=300
   GO TO 60
40 CONTINUE
```

```
      IF (TMAT(MN)-SIG(270)) 41, 44, 45
   41 CONTINUE
      IF ((TMAT(MN)-SIG(300))-(SIG(270)-TMAT(MN))) 38, 43, 43
   43 CONTINUE
      TMAT(MN)=SIG(270)
   44 CONTINUE
      NTM=270
      GO TO 60
   45 CONTINUE
      IF (TMAT(MN)-SIG(240)) 46, 49, 50
   46 CONTINUE
      IF ((TMAT(MN)-SIG(270))-(SIG(240)-TMAT(MN))) 43, 48, 48
   48 CONTINUE
      TMAT(MN)=SIG(240)
   49 CONTINUE
      NTM=240
      GO TO 60
   50 CONTINUE
      IF (TMAT(MN)-SIG(210)) 51, 54, 55
   51 CONTINUE
      IF ((TMAT(MN)-SIG(240))-(SIG(210)-TMAT(MN))) 48, 55, 55
   55 CONTINUE
      TMAT(MN)=SIG(210)
   54 CONTINUE
      NTM=210
   60 CONTINUE
      A1=SIG(NTM+5)+SIG(NTM+6) SIG(NTM+7)+SIG(NTM+8)+SIG(NTM 9)
      B1=SIG(NTM+10) SIG(NTM+11)+SIG(NTM 12)+SIG(NTM+13)+SIG(NTM+14)
      C1=SIG(NTM+15) SIG(NTM+16)+SIG(NTM 17)+SIG(NTM+18)+SIG(NTM+19)
      D1=SIG(NTM+20) SIG(NTM+21)+SIG(NTM 22)+SIG(NTM+23)+SIG(NTM+24)
      SIG(93)=SIG(93)/SIG(25)*A1
      SIG(94)=SIG(94)/SIG(26)*B1
      SIG(95)=SIG(95)/SIG(27)*C1
      SIG(96)=SIG(96)/SIG(28)*D1
      SIG(97)=SIG(NTM+2)
      IF DIVIDE CHECK 65, 70
   65 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   70 CONTINUE
      SIG(25)=A1
      SIG(26)=B1
      SIG(27)=C1
      SIG(28)=D1
      SIG(29)=SIG(NTM+1)
      SIG(131)=SIG(NTM+3)
      SIG(199)=SIG(NTM+4)
      TMAT(MN)=TEMP
      RETURN
      END(0,0,0)
```

```
*      657                      SUBROUTINE NANDW
C
       SUBROUTINE NANDW
C
       COMMON Q,IRES
C
       DIMENSION Q(13764),IRES(30)
C
       DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
      1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
      2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
      3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),FG(25),FV(24),
      4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
      5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
      6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
      7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
      8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
       EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
      1(Q(11),CASID),(Q(12),CASFID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
      2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
      3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
      4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
      5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
      6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
      7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
      8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
      9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
       EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
      1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
      2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
      3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
      4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
      5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
      6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
      7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
      8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
      9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
       MN=MN
       IF (NCODE(1)-1) 5, 10, 15
     5 CONTINUE
       VCOMP=GVOL(1)*GVOL(2)*GVOL(3)
       GO TO 25
    10 CONTINUE
       VCOMP=.78539816*GVOL(1)*(GVOL(2)**2-GVOL(3)**2)
       GO TO 25
    15 CONTINUE
       VCOMP=4.1887902*GVOL(1)**3
    25 CONTINUE
       IF (DMAT(MN)) 45, 30, 45
    30 CONTINUE
       DMAT(MN)=WMAT(MN)/DF/VCOMP
       IF DIVIDE CHECK 35, 40
```

```
35 CONTINUE
   CALL ERRORA
   CALL ERRCDP
40 CONTINUE
   GO TO 50
45 CONTINUE
   WMAT(MN)=DMAT(MN)*DF*VCOMP
50 CONTINUE
   RETURN
   END(0,0,0)
```

```
*      657                    SUBROUTINE MIX
C
       SUBROUTINE MIX
C
       COMMON Q,IRES
C
       DIMENSION Q(13764),IRES(30)
C
       DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
      1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
      2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
      3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
      4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
      5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
      6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
      7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
      8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
       EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
      1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
      2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
      3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
      4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
      5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
      6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
      7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
      8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
      9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
       EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
      1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
      2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
      3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
      4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
      5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
      6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
      7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
      8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
      9(Q(13761),DE),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
     1 CONTINUE
       MN=MN
       IF (TMAT(MN)) 5, 10, 10
     5 CONTINUE
       READ DIP SIG,TRASIG,RES,ENGAM,DE,NRES,
      1MOMIN,MOMAX,MOPMAX,MGMIN,MGMAX,MGPMAX,S,BETA,TM,DELTAU
       IF (SENSE LIGHT 1) 8, 10
     8 CONTINUE
       CALL ERRORA
       CALL ERRCDP
    10 CONTINUE
       DO 15 I=1,25
       SIGS(I)=SIGS(I)+DMAT(MN)*GFAC(I,MN)*SIG(I+4)
       SIGTR(I)=SIGTR(I)+DMAT(MN)*GFAC(I,MN)*SIG(I+72)
       SIGA(I)=SIGA(I)+DMAT(MN)*GFAC(I,MN)*SIG(I+106)
```

```
      SIGFN(I)=SIGFN(I)+DMAT(MN)*GFAC(I,MN)*SIG(I+174)
   15 CONTINUE
      IA=4
      DO 20 I=21,25
      DO 20 J=21,25
      IA=IA+1
      IB=NTM+IA
      TRASIG(I,J)=SIG(IB)
   20 CONTINUE
      IF (MOMIN) 30, 25, 30
   25 CONTINUE
      IA=20
      GO TO 35
   30 CONTINUE
      IA=MOMIN-1
      IF (IA) 35, 42, 35
   35 CONTINUE
      DO 40 I=1,IA
      TRASIG(I,I+1)=SIG(I+38)/DELTAU(I)
      TRASIG(I,I)=SIG(I+4)-SIG(I+38)/DELTAU(I)
      IF DIVIDE CHECK 37, 38
   37 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   38 CONTINUE
   40 CONTINUE
   42 CONTINUE
      IF (MOMIN) 45, 75, 45
   45 CONTINUE
      IF (MOMAX-MOPMAX) 50, 55, 60
   50 CONTINUE
      IA=MOMAX+1
      GO TO 65
   55 CONTINUE
      TRASIG(MOMAX,MOMAX+1)=SIG(MOMAX+38)/DELTAU(MOMAX)
      IF DIVIDE CHECK 57, 58
   57 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   58 CONTINUE
      IA=MOMAX+1
      GO TO 65
   60 CONTINUE
      TRASIG(MOPMAX,MOPMAX+1)=SIG(MOPMAX 38)/DELTAU(MOPMAX)
      IF DIVIDE CHECK 62, 63
   62 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   63 CONTINUE
      IA=MOPMAX+1
   65 CONTINUE
      DO 70 I=IA,20
      TRASIG(I,I+1)=SIG(I+38)/DELTAU(I)
      TRASIG(I,I)=SIG(I+4)-SIG(I+38)/DELTAU(I)
      IF DIVIDE CHECK 67, 68
```

```
   67 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   68 CONTINUE
   70 CONTINUE
   75 CONTINUE
      DO 80 I=1,25
      DO 80 J=1,25
      SIGST(I,J)=SIGST(I,J)+DMAT(MN)*GFAC(I,MN)*TRASIG(I,J)
   80 CONTINUE
      IF (NCODE(2)) 85, 125, 85
   85 CONTINUE
      IF (NBEHR(MN)) 100, 90, 100
   90 CONTINUE
      DO 95 I=1,25
      BFSIG(I)=BFSIG(I)+DMAT(MN)*GFAC(I,MN)*SIG(I+106)
   95 CONTINUE
      GO TO 125
  100 CONTINUE
      IF (NCODE(2)) 115, 105, 105
  105 CONTINUE
      DO 110 I=1,25
      BMSIG(I)=BMSIG(I)+DMAT(MN)*GFAC(I,MN)*
     1(SIG(I+4)+SIG(I+106))
  110 CONTINUE
  115 CONTINUE
      DO 120 I=1,25
      BMSIG(I)=BMSIG(I)+DMAT(MN)*GFAC(I,MN)*
     1(SIG(I+72)+SIG(I+106))
  120 CONTINUE
  125 CONTINUE
      IF (NCODE(4)) 145, 145, 130
  130 CONTINUE
      IF (MGMIN) 135, 145, 135
  135 CONTINUE
      NTNG=NTM/30+18
      DO 137 J=1,18
      ENGAM(25,J)=ENGAM(NTNG,J)
  137 CONTINUE
      DO 140 I=1,25
      DO 140 J=1,18
      SIGNG(I,J)=SIGNG(I,J)+DMAT(MN)*GFAC(I,MN)*ENGAM(I,J)
  140 CONTINUE
  145 CONTINUE
      IF (NCODE(5)-1) 180, 148, 175
  148 CONTINUE
      IF (SENSE LIGHT 3) 160, 150
  150 CONTINUE
      NRES1=0
      DO 155 I=1,1500
      DO 155 J=1,4
      RDATA(I,J)=0.0
  155 CONTINUE
  160 CONTINUE
      NRES2=NRES1+NRES
```

```
      NRES1=NRES1+1
      I=0
      DO 170 K=NRES1,NRES2
      I=I+1
      IA=I NRES
      IB=I 2*NRES
      IC=I 3*NRES
      ID=I 4*NRES
      RDATA(K,1)=RES(I)
      RDATA(K,2)=DMAT(MN)*RES(IA)
      RDATA(K,3)=DMAT(MN)*RES(IA)*RES(ID)
      RDATA(K,4)=DMAT(MN)*RES(IB)*PSI(RES(IC)*((TMAT(MN)-32.)*
     15./9.+273.13),0)
  170 CONTINUE
      NRES1=NRES2
      SENSE LIGHT 3
      GO TO 180
  175 CONTINUE
      DO 176 I=1,1500
      RDATA(I,4)=0.0
  176 CONTINUE
      I=0
      DO 178 K=1,NRES
      I=I+1
      IA=I NRES
      IB=I 2*NRES
      IC=I 3*NRES
      ID=I 4*NRES
      KA=K 200
      KB=K 400
      KC=K 600
      RDATA(K,4)=RES(I)
      RDATA(KA,4)=DMAT(MN)*RES(IA)
      RDATA(KB,4)=RES(IC)*((TMAT(MN)-32.)*5./9.+273.13)
      RDATA(KC,4)=DMAT(MN)*RES(IB)*FT
  178 CONTINUE
      CALL HETRES
  180 CONTINUE
      RETURN
```

```
*        657                       SUBROUTINE HOMRES
C
         SUBROUTINE HOMRES
C
         COMMON Q,IRES
C
         DIMENSION Q(13764),IRES(30)
C
         DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
        1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
        2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
        3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
        4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
        5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
        6DIFFR(25),DIFFZ(25),SIGR(25),S(25),FXTRAP(25),
        7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
        8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
         EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
        1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
        2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
        3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
        4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
        5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
        6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
        7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
        8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
        9(Q(9254),IMAT),(Q(9284),FG),(Q(9309),FV),(Q(9333),DELTAU)
C
         EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
        1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
        2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
        3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
        4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
        5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
        6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
        7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
        8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
        9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
         DO 20 K=1,20
         DO 15 I=1,1500
         IF (RDATA(I,1) FG(K+1)) 15, 10, 10
      10 CONTINUE
         IF (RDATA(I,4)) 15, 15, 11
      11 CONTINUE
         SIGA(K)=SIGA(K)-1.0/DELTAU(K)*(1.0/(1.0+SIGS(K)/RDATA(I,4)))*
        1RDATA(I,2)
         SIGFN(K)=SIGFN(K)-1.0/DELTAU(K)*(1.0/(1.0+SIGS(K)/RDATA(I,4)))*
        1RDATA(I,3)
         RDATA(I,1)=0.0
      15 CONTINUE
      20 CONTINUE
      25 CONTINUE
         RETURN
```

END(0,0,0)

```
*       657                    SUBROUTINE HETRES
C
      SUBROUTINE HETRES
C
      COMMON Q,IRES
C
      DIMENSION Q(13764),IRES(30)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),FT),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      MN=MN
      IF (IRES(MN)) 50, 5, 25
    5 CONTINUE
      DO 20 K=1,20
      DO 15 I=1,200
      IA=I 200
      IB=I 400
      IC=I 600
      IF (RDATA(I,4) EG(K+1)) 15, 10, 10
   10 CONTINUE
      SIGA(K)=SIGA(K)-RDATA(IA,4)/DELTAU(K)*(1.0-
     1RSS(RDATA(IC,4),RDATA(IB,4)))
      SIGFN(K)=SIGFN(K)-RDATA(IA,4)/DELTAU(K)*(1.0
     1RSS(RDATA(IC,4),RDATA(IB,4)))
   14 CONTINUE
```

```
      RDATA(I,4)=0.0
   15 CONTINUE
   20 CONTINUE
      GO TO 50
   25 CONTINUE
      DO 45 K=1,20
      DO 40 I=1,200
      IA=I 200
      IF (RDATA(I,4) EG(K+1)) 40, 30, 30
   30 CONTINUE
      IB=I (MN-1)*NCODE(6)
      SIGA(K)=SIGA(K)-RDATA(IA,4)/DELTAU(K)*(1.0-ELFAC(IB))
      SIGFN(K)=SIGFN(K)-RDATA(IA,4)/DELTAU(K)*(1.0 ELFAC(IB))
      RDATA(I,4)=0.0
   40 CONTINUE
   45 CONTINUE
   50 CONTINUE
      RETURN
      END
```

```
*       657                  SUBROUTINE BEHR
C
      SUBROUTINE BEHR
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      DIMENSION FX(25),WHY(25)
C
      IF (GBEHR(4)) 25, 5, 25
    5 CONTINUE
      IF (ABSF(GBEHR(3)-GBEHR(2))-0.1*GBEHR(2)) 10, 15, 15
   10 CONTINUE
      ELF=(GBEHR(2)**2-GBEHR(1)**2)/GBEHR(1)
      ELM=(GBEHR(3)**2-GBEHR(2)**2+GBEHR(1)**2)/GBEHR(1)
      IF DIVIDE CHECK 12, 13
   12 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   13 CONTINUE
      GO TO 20
   15 CONTINUE
```

```
      ELF=GBEHR(2)-GBEHR(1)
      ELM=(GBEHR(3)**2-GBEHR(2)**2+GBEHR(1)**2)/(GBEHR(2)+GBEHR(1))
      IF DIVIDE CHECK 17, 18
   17 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   18 CONTINUE
   20 CONTINUE
      VFF=(GBEHR(2)**2-GBEHR(1)**2)/GBEHR(3)**2
      IF DIVIDE CHECK 22, 23
   22 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   23 CONTINUE
      QFAC=1.3333333
      GO TO 30
   25 CONTINUE
      ELF=GBEHR(1)
      ELM=GBEHR(2)
      VFF=GBEHR(3)
      QFAC=GBEHR(4)
   30 CONTINUE
      VFM=1.0-VFF
      IF (NCODE(2)-1) 60, 35, 45
   35 CONTINUE
      QMR=0.50*QFAC
      QMZ=QMR
      DO 40 I=1,25
      EX(I)=ELF*BFSIG(I)/VFF
      WHY(I)=ELM*BMSIG(I)/VFM
      IF DIVIDE CHECK 36, 37
   36 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   37 CONTINUE
      EPSR(I)=VFF**2*EXPF(-EX(I))*(WHY(I)/(EXPF(WHY(I))-1.0)
     1QMR*WHY(I)-1.0)
      IF DIVIDE CHECK 38, 39
   38 CONTINUE
      CALL ERRORA
      CALL ERRCDP
   39 CONTINUE
      EPSZ(I)=EPSR(I)
   40 CONTINUE
      GO TO 60
   45 CONTINUE
      QMR=0.3750*QFAC
      QMZ=).750*QFAC
      DO 50 I=1,25
      EX(I)=ELF*BFSIG(I)/VFF
      WHY(I)=ELM*BMSIG(I)/VFM
      IF DIVIDE CHECK 46, 47
   46 CONTINUE
      CALL ERRORA
      CALL ERRCDP
```

```
 47 CONTINUE
    EPSR(I)=VFF**2*EXPF(-EX(I))*(WHY(I)/(EXPF(WHY(I))-1.0)
   1QMR*WHY(I)-1.0)
    EPSZ(I)=VFF**2*EXPF(-EX(I))*(WHY(I)/(EXPF(WHY(I))-1.0)
   1QMZ*WHY(I)-1.0)
    IF DIVIDE CHECK 48, 49
 48 CONTINUE
    CALL ERRORA
    CALL ERRCDP
 49 CONTINUE
 50 CONTINUE
 60 CONTINUE
    RETURN
    END(0,0,0)
```

657 SUBROUTINE ROD

```
      SUBROUTINE ROD
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBFHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBFHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      RD=GTRAN(1)/GTRAN(2)
      DO 12 I=1,25
      TPA=SIGS(I)/(SIGS(I)+SIGA(I))
      TPOT=GTRAN(1)/2.0*(SIGS(I)+SIGA(I))
      IF (20.-TPOT) 1, 1, 2
    1 CONTINUE
      TPG=1.0
      GO TO 11
    2 CONTINUE
      BIO=BESIF(TPOT,0)
      IF (SENSE LIGHT 1) 3, 4
    3 CONTINUE
      CALL ERRORA
      CALL ERRCDP
    4 CONTINUE
```

```
      BI1=BESIF(TPOT,1)
      IF (SENSE LIGHT 1) 5, 6
    5 CONTINUF
      CALL FRRORA
      CALL ERRCDP
    6 CONTINUE
      BK0=BESKF(TPOT,0)
      IF (SENSE LIGHT 1) 7, 8
    7 CONTINUE
      CALL ERRORA
      CALL ERRCDP
    8 CONTINUE
      BK1=BESKF(TPOT,1)
      IF (SENSE LIGHT 1) 9, 10
    9 CONTINUE
      CALL FRRORA
      CALL FRRCDP
   10 CONTINUE
      TPG=1.3333333*TPOT**2*(BI0*BK1-BI1*BK0+BI1*BK1/TPOT+
     1(TPOT+TPOT)*(BI0*BK0+BI1*BK1)-2.0)
   11 CONTINUE
      TFAC(I)=1.0-(RD*((1.0-TPA)*TPG/(1.0-TPA*(1.0 TPG/
     1(TPOT+TPOT)))))
   12 CONTINUE
      RETURN
      END(0,0,0)
```

```
*.    657                    SUBROUTINE ANULUS
C
      SUBROUTINE ANULUS
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),FLFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBFHR(30),GVOL(3),GBFHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),FLFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBFHR),(Q(7227),GVOL),(Q(7230),GBFHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      RD=GTRAN(1)/GTRAN(2)
      DO 5 I=1,25
      TPA=SIGS(I)/(SIGS(I)+SIGA(I))
      TPOT=GTRAN(3)*(SIGS(I)+SIGA(I))
      EF1=F3(TPOT)
      EF2=F3(TPOT+TPOT)
      TPK=(1.0-EF2-EF2)/TPOT
      TPF=(EF2-EF1-EF1+0.5)/(TPOT+TPOT)
      TFAC(I)=1.0-(RD*(1.0-TPA)*TPOT*TPK)/(1.0-TPA*TPF)
    5 CONTINUE
      RETURN
      END(0,0,0)
```

```
*       657                    SUBROUTINE PLATE
C
        SUBROUTINE PLATE
C
        COMMON Q
C
        DIMENSION Q(13764)
C
        DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
       1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
       2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
       3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
       4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
       5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
       6DIFFR(25),DIFFZ(25),SIGR(25),S(25),FXTRAP(25),
       7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
       8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
        EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
       1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
       2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
       3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
       4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
       5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
       6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
       7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
       8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
       9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
        EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
       1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
       2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
       3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
       4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
       5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
       6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
       7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
       8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
       9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
        DO 5 I=1,25
        TPA=SIGA(I)/SIGS(I)
        TPOT=GTRAN(1)*(SIGS(I)+SIGA(I))
        TFAC(I)=1.0-2.0*TPA*TPOT*E3COMP(TPOT)/
       1(TPA*TPOT+E3COMP(TPOT))
      5 CONTINUE
        RETURN
        END(0,0,0)
```

```
      SUBROUTINE GRPAR
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODF(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATF),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      DIMENSION CAPPA(25)
C
      DO 60 I=1,25
      IF (GDIFC(1)) 10, 5, 10
    5 CONTINUE
      DIFFC(I)=1.0/(3.0*(SIGTR(I)+SIGA(I)))
      GO TO 50
   10 CONTINUE
      EXTRAP(I)=0.71050/(SIGTR(I)+SIGA(I))
      NGT=NCODE(1)+1
      GO TO (15,20,25), NGT
   15 CONTINUE
      CAPPA(I)=9.87/(GDIFC(1)+2.0*EXTRAP(I))**2+
     19.87/(GDIFC(2) 2.0*EXTRAP(I))**2+9.87/(GDIFC(3)+2.0*EXTRAP(I))**2
      GO TO 30
```

```
 20 CONTINUE
    CAPPA(I)=9.87/(GDIFC(1)+2.0*EXTRAP(I))**2+
   123.13/(GDIFC(2)+2.0*EXTRAP(I))**2
    GO TO 30
 25 CONTINUE
    CAPPA(I)=9.87/(GDIFC(1)+EXTRAP(I))**2
 30 CONTINUE
    ALPH=CAPPA(I)/(SIGS(I)+SIGA(I))**2
    IF (ALPH-1.0E-11) 35, 40, 40
 35 CONTINUE
    EPS=0.0
    GO TO 45
 40 CONTINUE
    EPS=0.26001*ALPH+0.043502*ALPH**2+0.0048942*ALPH**3
 45 CONTINUE
    DIFFC(I)=1.0/(3.0*(SIGTR(I)+SIGA(I)+EPS*(SIGS(I)+SIGA(I))))
 50 CONTINUE
    DIFFR(I)=(1.0+EPSR(I))*DIFFC(I)
    DIFFZ(I)=(1.0+EPSZ(I))*DIFFC(I)
    SIGR(I)=SIGA(I)+SIGS(I)-SIGST(I,I)
    SIGST(I,I)=0.0
 60 CONTINUE
    RETURN
    END(0,0,0)
```

```
*        657                    SUBROUTINE WTCD
C
      SUBROUTINE WTCD
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      IF (CDT(1)) 10, 5, 10
    5 CONTINUE
      CDT(1)=CDTNAM(1)
      CDT(2)=CDTNAM(2)
      NRCDT=1
   10 CONTINUE
      NN=NRCDT+(NRCDT-1)/2+3
      CDT(NN)=CASEID
      CDT(NN+1)=CASID
      NCDT(NN+2)=NRCDT
      WRITE TAPE KDT, (DIFFR(I),DIFFZ(I),SIGR(I),SIGFN(I),
     1S(I),I=1,25),((SIGST(I,J),J=1,25),I=1,25)
      NRCDT=NRCDT+1
      IF (NCODE(4)) 20, 20, 15
   15 CONTINUE
```

```
      WRITE TAPE KDT, ((SIGNG(I,J),J=1,18),I=1,25)
      GO TO 25
   20 CONTINUE
      WRITE TAPE KDT, SIGNG(1,1)
   25 CONTINUE
      NRCDT=NRCDT+1
      RETURN
      END(0,0,0)
```

```
*       657                       SUBROUTINE WOTCD
C
        SUBROUTINE WOTCD
C
        COMMON Q
C
        DIMENSION Q(13764)
C
        DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
       1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
       2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
       3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
       4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
       5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
       6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
       7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
       8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
        EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
       1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
       2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
       3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
       4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
       5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
       6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
       7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
       8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
       9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
        EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
       1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
       2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
       3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
       4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
       5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
       6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
       7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
       8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
       9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
        CALL WOT(NWOT)
        PRINT 1000
        IF (NCODE(1)-1) 5, 10, 15
      5 CONTINUE
        PRINT 1001
        PRINT 2001, GVOL(1),GVOL(2),GVOL(3)
        GO TO 20
     10 CONTINUF
        PRINT 1002
        PRINT 2002, GVOL(1),GVOL(2),GVOL(3)
        GO T) 20
     15 CONTINUE
        PRINT 1003
        PRINT 2003, GVOL(1)
     20 CONTINUE
```

```
      IF (NCODE(2)-1) 25, 30, 35
   25 CONTINUE
      PRINT 1005
      GO TO 40
   30 CONTINUE
      PRINT 1006
      GO TO 32
   35 CONTINUE
      PRINT 1007
   32 CONTINUE
      IF (GBEHR(4)) 33, 34, 33
   33 CONTINUE
      PRINT 2006, GBEHR(1),GBEHR(2),GBEHR(3),GBEHR(4)
      GO TO 40
   34 CONTINUE
      PRINT 2007, GBEHR(1),GBEHR(2),GBEHR(3)
   40 CONTINUE
      NGT=NCODE(3)+1
      GO TO (45,50,55,60), NGT
   45 CONTINUE
      PRINT 1010
      GO TO 65
   50 CONTINUE
      PRINT 1011
      GO TO 61
   55 CONTINUE
      PRINT 1012
      GO TO 61
   60 CONTINUE
      PRINT 1013
   61 CONTINUE
      IF (NCODE(3)-2) 62, 63, 64
   62 CONTINUE
      PRINT 2011, GTRAN(1),GTRAN(2)
      GO TO 65
   63 CONTINUE
      PRINT 2012, GTRAN(1),GTRAN(2),GTRAN(3)
      GO TO 65
   64 CONTINUE
      PRINT 2013, GTRAN(1)
   65 CONTINUE
      IF (NCODE(4)) 70, 70, 75
   70 CONTINUE
      PRINT 1015
      GO TO 80
   75 CONTINUE
      PRINT 1016
   80 CONTINUE
      IF (NCODE(5)) 90, 85, 90
   85 CONTINUE
      PRINT 1020
      GO TO 95
   90 CONTINUE
      PRINT 1021
   95 CONTINUE
```

```
      IF (GDIFC(1)) 96, 100, 96
   96 CONTINUE
      PRINT 1022
      IF (NCODE(1)-1) 97, 98, 99
   97 CONTINUE
      PRINT 1023, GDIFC(1),GDIFC(2),GDIFC(3)
      GO TO 100
   98 CONTINUF
      PRINT 1024, GDIFC(1),GDIFC(2)
      GO TO 100
   99 CONTINUE
      PRINT 1025, GDIFC(I)
  100 CONTINUE
      PRINT 1026, VCOMP,SPEC
      PRINT 1030
      DO 110 I=1,30
      IF (CMAT(I)) 105, 110, 105
  1C5 CONTINUE
      PRINT 1031, CMAT(I),WMAT(I),DMAT(I),TMAT(I),NBEHR(I)
  110 CONTINUE
      IF (NCODE(7)-1) 111, 115, 138
  111 CONTINUE
      DO 114 J=1,25
      K=26 J
      DO 113 I=1,30
      IF (CMAT(I)) 112, 113, 112
  112 CONTINUE
      IF (GFAC(K,I)-1.0) 115, 113, 115
  113 CONTINUE
  114 CONTINUE
      PRINT 1034
      GO TO 130
  115 CONTINUF
      I1=0
      I2=0
      DO 120 K=1,6
      I1=I2+1
      I2=5*K
      PRINT 1035, (CMAT(I),I=I1,I2)
      PRINT 1036, (I,(GFAC(I,J),J=I1,I2),I=1,25)
      IF (CMAT(5*K+1)) 120, 130, 120
  120 CONTINUE
  130 CONTINUF
      IF (NCODE(7)-1) 132, 131, 138
  131 CONTINUE
      PRINT 1040, (I,EG(I),DELTAU(I),FV(I),I=1,24)
      PRINT 1041, EG(25),DELTAU(25)
  132 CONTINUE
      IF (NCODE(2)) 134, 133, 134
  133 CONTINUE
      IF (NCODF(3)) 134, 135, 134
  134 CONTINUE
      PRINT 1045, (I,TFAC(I),EPSR(I),EPSZ(I),BFSIG(I),BMSIG(I),I=1,25)
  135 CONTINUF
      IF (NCODE(7)-1) 138, 136, 138
```

```
  136 CONTINUE
      PRINT 1050, (I,DIFFC(I),SIGS(I),SIGTR(I),SIGA(I),EXTRAP(I),I=1,25)
  138 CONTINUE
      PRINT 1055, (I,DIFFR(I),DIFFZ(I),SIGR(I),SIGFN(I),S(I),I=1,25)
      IF (NCODE(7)-1) 139, 139, 170
  139 CONTINUE
      DO 140 J=1,25,5
      J1=J 1
      J2=J 2
      J3=J 3
      J4=J 4
      PRINT 1060, J,J1,J2,J3,J4,(I,SIGST(I,J),SIGST(I,J1),SIGST(I,J2),
     1SIGST(I,J3),SIGST(I,J4),I=1,25)
  140 CONTINUE
      IF (NCODE(4)) 170, 170, 150
  150 CONTINUE
      DO 160 J=1,15,5
      J1=J 1
      J2=J 2
      J3=J 3
      J4=J 4
      PRINT 1065, J,J1,J2,J3,J4,(I,SIGNG(I,J),SIGNG(I,J1),SIGNG(I,J2),
     1SIGNG(I,J3),SIGNG(I,J4),I=1,25)
  160 CONTINUE
  170 CONTINUE
      RETURN
C
 1000 FORMAT(1H1//18X,34H   COMPOSITION DATA PREPARATION   //29H  CALCUL
     1ATION REQUEST SUMMARY)
C
 1001 FORMAT(/17H  GEOMETRY - SLAB)
C
 2001 FORMAT(6H  X = 1PE12.5,7H   Y = 1PE12.5,7H   Z = 1PE12.5)
C
 1002 FORMAT(/21H  GEOMETRY - CYLINDER)
C
 2002 FORMAT(6H  H = 1PE12.5,8H   OD = 1PE12.5,8H   ID = 1PE12.5)
C
 1003 FORMAT(/19H  GEOMETRY - SPHERE)
C
 2003 FORMAT(6H  R = 1PE12.5)
C
 1005 FORMAT(24H  NO BEHRENS CALCULATION)
C
 1006 FORMAT(31H  ISOTROPIC BEHRENS CALCULATION)
C
 2006 FORMAT(7H  LF = 1PE12.5,7H  LM = 1PE12.5,7H  VF = 1PE12.5,6H  Q =
     11PE12.5)
C
 1007 FORMAT(33H  ANISOTROPIC BEHRENS CALCULATION)
C
 2007 FORMAT(7H  D1 = 1PE12.5,8H   D2 = 1PE12.5,8H   D3 = 1PE12.5)
C
 1010 FORMAT(29H  NO TRANSMISSION CALCULATION)
C
```

```
 1011 FORMAT(30H  ROD TRANSMISSION CALCULATION)
C
 2011 FORMAT(6H  D = 1PE12.5,9H   DCH = 1PE12.5)
C
 1012 FORMAT(34H  ANNULUS TRANSMISSION CALCULATION)
C
 2012 FORMAT(7H  OD = 1PE12.5,9H   DCH = 1PE12.5,7H  T = 1PE12.5)
C
 1013 FORMAT(32H  PLATE TRANSMISSION CALCULATION)
C
 2013 FORMAT(6H  T = 1PE12.5)
C
 1015 FORMAT(29H  NO GAMMA SOURCE CALCULATION)
C
 1016 FORMAT(26H  GAMMA SOURCE CALCULATION)
C
 1020 FORMAT(41H  NO RESONANCE SELF-SHIELDING CALCULATION)
C
 1021 FORMAT(38H  RESONANCE SELF-SHIELDING CALCULATION)
C
 1022 FORMAT(59H  GEOMETRY FOR SIZE CORRECTION TO THE DIFFUSION COEFFICI
     1ENT)
C
 1023 FORMAT(9H  X+2S = 1PE12.5,9H  Y+2S = 1PE12.5,9H  Z+2S = 1PE12.5)
C
 1024 FORMAT(9H  H+2S = 1PE12.5,10H   D+2S = 1PE12.5)
C
 1025 FORMAT(8H  R+S = 1PE12.5)
C
 1026 FORMAT(/29H  COMPOSITION VOLUME IN CC - 1PE13.6/34H  COMPOSITION S
     1PECTRUM CODE NO. - 0PF9.4)
C
 1030 FORMAT  (/10H  MATERIAL5X,8HMATERIAL6X,10HDENSITY OR4X,8HMATERIAL5
     1X,7HBEHRENS/10H  CODE NO.6X,6HWEIGHT5X,15HVOLUME FRACTION3X,4HTEMP
     26X,10HREGION NO./)
C
 1031 FORMAT(0PF11.4,1P2E15.6,0PF10.2,I9)
C
 1034 FORMAT(////60H  CELL CORRECTIONS FOR ALL MATERIALS AT ALL LEVELS A
     1RE UNITY)
C
 1035 FORMAT(1H1///23X,25HMATERIAL CELL CORRECTIONS///10X,8HCODE NO.5X,8
     1HCODE NO.5X,8HCODE NO.5X,8HCODE NO.5X,8HCODE NO.//0PF18.4,0P4F13.4
     2)
C
 1036 FORMAT(///7H  GROUP3X,8HG-FACTOR5X,8HG-FACTOR5X,8HG-FACTOR5X,8HG F
     1ACTOR5X,8HG-FACTOR//(I6,1PE14.5,1P4E13.5))
C
 1040 FORMAT(1H1///7H  GROUP4X,6HENERGY6X,8HDELTA(U)3X,11H1/V-FACTORS//(
     1I6,1PE14.5,0PE13.5,1PE13.5))
C
 1041 FORMAT(6H    251PF14.5,1PE13.5)
C
 1045 FORMAT(1H1///8X,63HTRANSMISSION BEHRENS FAC. BEHRENS FAC. BEHRENS
     1FUEL BEHRENS MOD/7H  GROUP3X,7HFACTORS7X,6HRADIAL4X,12HLONGITUDINA
```

```
     2L3X,9HX-SECTION4X,9HX-SECTION//(I6,1PE14.5,1P4E13.5))
C
 1050 FORMAT(1H1///23X,26HCOMPOSITION CROSS SECTIONS///18H  GROUP  DIFFU
     1SION5X,7HSCATTER5X,9HTRANSPORT4X,24HABSORPTION EXTRAPOLATION//(I6,
     21PE14.5,1P4E13.5))
C
 1055 FORMAT(1H1///22X,28HCOMPOSITION GROUP PARAMETERS///9X,9HDIFFUSION4
     1X,9HDIFFUSION5X7HREMOVAL/7H  GROUP3X,6HRADIAL5X,24HLONGITUDINAL (A
     2BSP+SCAT)4X,7HFISSION7X,6HSOURCE//(I6,1PE14.5,1P4E13.5))
C
 1060 FORMAT(1H1///18X,35HCOMPOSITION SCATTER TRANSFER MATRIX///7X,2HTOI
     15,4I13/5H FROM/(I4,1PE15.5,1P4E13.5))
C
 1065 FORMAT(1H1///18X,35HCOMPOSITION N-GAMMA TRANSFER MATRIX///7X,2HTOI
     15,4I13/5H FROM/(I4,1PE15.5,1P4E13.5))
C
      END
```

* 657 SUBROUTINE ENDCDP

```
      SUBROUTINE ENDCDP
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),ELFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),EXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     8(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
      NCO=(NRCDT-1)/2
      NCDT(3)=NRCDT
      WRITE TAPE KDT, (CDT(I),I=1,303)
      END FILE KDT
      REWIND KDT
      CALL WOT(NWOT)
      CASEID=CDT(1)
      CASID=CDT(2)
      CALL HDING(Q(12))
      MI=3 3*NCO
      PRINT 1000, NCDT(1),NCDT(2),NCO,NCDT(3),(NCDT(I),I=4,MI)
      RETURN

 000  FORMAT(1H1///30X,12HINDEX RECORD//18X,22HCOMPOSITION DATA TAPE 2A6
     1///I21,20H COMPOSITIONS        I3,8H RECORDS///18X,11HDESIGNATION13
```

```
     2X,10HRECORD NO.//(18X,2A6,I18))
C
      END(0,0,0)
```

657 SUBROUTINE ERRCDP

```
      SUBROUTINE ERRCDP
C
      COMMON Q
C
      DIMENSION Q(13764)
C
      DIMENSION CDT(303),NCDT(303),CDTNAM(2),FLFAC(1500,4),
     1RDATA(1500,4),GFAC(25,30),CMAT(30),DMAT(30),WMAT(30),
     2TMAT(30),NBEHR(30),GVOL(3),GBEHR(4),GTRAN(3),GDIFC(3),
     3NCODE(10),RNDT(2000),NRNDT(2000),IMAT(30),EG(25),FV(24),
     4DELTAU(25),SIGS(25),SIGTR(25),SIGA(25),SIGFN(25),
     5BFSIG(25),BMSIG(25),SIGST(25,25),SIGNG(25,25),DIFFC(25),
     6DIFFR(25),DIFFZ(25),SIGR(25),S(25),FXTRAP(25),
     7EPSR(25),EPSZ(25),TFAC(25),SIG(520),NSIG(520),
     8TRASIG(25,25),RES(1000),ENGAM(34,18)
C
      EQUIVALENCE (Q(2),BDATE),(Q(6),BDENT),(Q(9),BNAM),
     1(Q(11),CASID),(Q(12),CASEID),(Q(13),CDT,NCDT),(Q(316),NPAGE),
     2(Q(317),NWOT),(Q(318),NDT),(Q(319),KDT),(Q(320),ITAPE),
     3(Q(321),JTAPE),(Q(322),KTAPE),(Q(323),MORE),(Q(324),CDTNAM),
     4(Q(326),NRCDT),(Q(327),ELFAC,RDATA),(Q(6327),GFAC),
     5(Q(7077),CMAT),(Q(7107),DMAT),(Q(7137),WMAT),(Q(7167),TMAT),
     6(Q(7197),NBEHR),(Q(7227),GVOL),(Q(7230),GBEHR),(Q(7234),GTRAN),
     7(Q(7237),GDIFC),(Q(7240),SPEC),(Q(7241),NCODE),(Q(7251),KASE),
     8(Q(7252),VCOMP),(Q(7253),RNDT,NRNDT),(Q(9253),NREC),
     9(Q(9254),IMAT),(Q(9284),EG),(Q(9309),FV),(Q(9333),DELTAU)
C
      EQUIVALENCE (Q(9358),SIGS),(Q(9383),SIGTR),(Q(9408),SIGA),
     1(Q(9433),SIGFN),(Q(9458),BFSIG),(Q(9483),BMSIG),
     2(Q(9508),SIGST),(Q(10133),SIGNG),(Q(10758),DIFFC),
     3(Q(10783),DIFFR),(Q(10808),DIFFZ),(Q(10833),SIGR),(Q(10858),S),
     4(Q(10883),TM),(Q(10884),EXTRAP),(Q(10909),EPSR),
     5(Q(10934),EPSZ),(Q(10959),TFAC),(Q(10984),SIG,NSIG),
     6(Q(11504),TRASIG),(Q(12129),MOMIN),(Q(12130),MOMAX),
     7(Q(12131),MOPMAX),(Q(12132),RES),(Q(13132),NRES),(Q(13133),ENGAM),
     3(Q(13758),MGMIN),(Q(13759),MGMAX),(Q(13760),MGPMAX),
     9(Q(13761),DF),(Q(13762),NW),(Q(13763),NTM),(Q(13764),MN)
C
    5 CONTINUE
      CALL WOT(NWOT)
      CASEID=CDT(1)
      CASID=CDT(2)
      CALL HDING(Q(12))
      NCO=(NRCDT-1)/2
      NCDT(3)=NRCDT
      WRITE TAPE KDT, (CDT(I),I=1,303)
      END FILE KDT
      REWIND KDT
   10 CONTINUE
      MI=3 3*NCO
      PRINT 1000, NCDT(1),NCDT(2),NCO,NCDT(3),(NCDT(I),I=4,MI)
      CALL EXIT
      RETURN
```

```
C
 1000 FORMAT(1H1///30X,12HINDEX RECORD//18X,22HCOMPOSITION DATA TAPE 2A6
     1///I21,20H COMPOSITIONS        I3,8H RECORDS///18X,11HDESIGNATION13
     2X,10HRECORD NO.//(18X,2A6,I18))
C
      END(0,0,0)
```

657 FUNCTION RSS

```
      FUNCTION RSS(TAU,THETA)
C
C     THIS PROGRAM COMPUTES THE SELF-SHIELDING FACTORS
C     FOR A RESONANCE ABSORBING SLAB
C     THIS ROUTINE REQUIRES THE ENCLOSURE OF
C     ERROR,SQRT,EXP,E3COMP,E3,LOG,PSI,SIN,COS
C
      DIMENSION A(15),H(15)
C
      A(1)=0.095012510
      A(2)=0.28160355
      A(3)=0.45801678
      A(4)=0.61787624
      A(5)=0.75540441
      A(6)=0.86563120
      A(7)=0.94457502
      A(8)=0.98940093
      A(9)=0.19304368
      A(10)=1.0266649
      A(11)=2.5678767
      A(12)=4.9003531
      A(13)=8.1821534
      A(14)=12.734180
      A(15)=19.395728
C
      H(1)=0.18945061
      H(2)=0.18260342
      H(3)=0.16915652
      H(4)=0.14959599
      H(5)=0.12462897
      H(6)=0.095158512
      H(7)=0.062253524
      H(8)=0.027152459
      H(9)=0.40931895
      H(10)=0.42183128
      H(11)=0.14712635
      H(12)=0.20633514E-1
      H(13)=0.10740101E-2
      H(14)=0.15865464E-4
      H(15)=0.31703155E-7
C
      IF(TAU) 100,105,110
  100 CALL ERROR
  105 RSS=1.0
      GO TO 50
  110 CONTINUE
C
      XHALF= 1.0+(1.5+0.01*THETA)*SQRTF(TAU+THETA)
C
      SUM=0
      DO 15 J=1,5
      VALUE=0
      DO 12 N=1,8
```

```
      VALUF=VALUE+H(N)*E3COMP(TAU*PSI(THETA,XHALF*(A(N)+FLOATF(J-1))))
   12 CONTINUE
      SUM=SUM+VALUE*XHALF
   15 CONTINUE
      VALUF=0
      DO 20 N=9,15
      VALUF=VALUE+EXPF(A(N))*H(N)*F3COMP(TAU*PSI(THETA,A(N)+5.0*XHALF))
   20 CONTINUE
      RSS=((VALUE+SUM)*0.63661977)/TAU
C
   50 CONTINUE
      RETURN
      END(0,0,0)
```

```
*       657                      FUNCTION PSI

        FUNCTION PSI(THETA,DELTA)
C
C       THIS PROGRAM COMPUTES THE DOPPLER BROADENING
C       FUNCTION FOR NEUTRON ABSORPTION CROSS SECTIONS
C       THIS ROUTINE REQUIRES THE ENCLOSURE OF
C       ERROR,SQRT,EXP,LOG,SIN,COS
C
        DIMENSION XK120(101)
C
        IF(THETA-0.20) 6,6,14
C
      6 SUM1=THETA/50.0
        SUM2=SQRTF(SUM1+SUM1)
        XK120(1)=DELTA 50.0*SUM2
        DO 7 M=1,100
        XK120(M+1)=XK120(1)+FLOATF(M)*SUM2
      7 CONTINUE
C
        DO 8 M=1,101
        XK120(M)=1.0/(1.0+XK120(M)*XK120(M))
      8 CONTINUE
C
        MAX=99
      9 DO 10 M=1,MAX
        XK120(M)=0.5*(XK120(M)+XK120(M+2))
     10 CONTINUE
        IF(MAX-1) 13,13,11
     11 MAX=MAX-2
        GO TO 9
     13 CONTINUE
        PSI=XK120(1)
        GO TO 220
C
     14 CONTINUE
C
        T100=SQRTF(THETA)
        T200=2.0*THETA
        T400=4.0*THETA
        X100=DELTA/(2.0*T100)
        X110=X100*X100
        X200=X100/T100
        X300=EXPF(-X110)
C
        IF(THETA-2.0) 150,160,160
    150 SUM1=26.25*LOGF(1.0+THETA-0.05*THETA**2-0.01*THETA**3)
        IF(DELTA-SUM1) 170,155,155
    155 PSI=(1.0/(1.0+DELTA*DELTA))*EXPF(6.0*THETA/(1.0+DELTA*DELTA))
        GO TO 220
    160 SUM1=18.75*SQRTF(THETA)
        IF(DELTA-SUM1) 170,155,155
    170 CONTINUE
C
C       COMPUTE SERIES NUMBER 1
```

```
C
      SUM1=-1.0/T200
      EN=2.0
      UTERM=SUM1/(T200*(2.0*EN 1.0))
   12 SR1=SUM1+UTERM
      IF(ABSF(SUM1/SR1-1.0)-0.00000001) 20,20,15
   15 SUM1=SR1
      EN=EN+1.0
      UTERM=UTERM/(T200*(2.0*EN-1.0))
      GO TO 12
   20 CONTINUE
C
      IF(DELTA) 24,22,24
C
   22 SR2=0
      SR3=0
      SR4=0
      SR5=0
      GO TO 120
C
   24 CONTINUE
C
C     COMPUTE SERIES NUMBER 2
C
      XTERM=-1.0
      AMOUNT=0
      USTART=1.0/T200
      DO 50 M=1,1000
      EM=FLOATF(M)
      USTART=USTART/(T200*(2.0*EM+1.0))
      SUM1=USTART
      EN=EM+1.0
      UTERM=USTART/(T200*(2.0*EN+1.0))
   25 SUM2=SUM1+UTERM
      IF(ABSF(SUM1/SUM2-1.0)-0.00000001) 40,40,30
   30 SUM1=SUM2
      EN=EN+1.0
      UTERM=UTERM/(T200*(2.0*EN+1.0))
      GO TO 25
   40 XTERM=(-XTERM*X110)/EM
      VALUE=XTERM*SUM2
      SR2=AMOUNT+VALUE
      IF(ABSF(ABSF(AMOUNT/SR2) 1.0)-0.00000001) 55,55,45
   45 AMOUNT=SR2
   50 CONTINUE
   55 CONTINUE
C
C     COMPUTE SERIES NUMBER 3
C
      SUM1=1.0
      EN=1.0
      UTERM=1.0/T400
   58 SR3=SUM1+UTERM
      IF(ABSF(SUM1/SR3-1.0)-0.00000001) 65,65,60
   60 EN=EN+1.0
```

```
      SUM1=SR3
      UTERM=UTERM/(T400*EN)
      GO TO 58
   65 CONTINUE
C
C     COMPUTE SERIES NUMBER 4
C
      SUM1=X100
      EN=1.0
      UTERM=((2.0*EN 1.0)/(EN*(2.0*EN+1.0)))*X110*SUM1
   70 SR4=SUM1+UTERM
      IF(ABSF(SUM1/SR4-1.0)-0.00000001) 75,75,73
   73 EN=EN+1.0
      SUM1=SR4
      UTERM=((2.0*EN 1.0)/(EN*(2.0*EN+1.0)))*X110*UTERM
      GO TO 70
   75 CONTINUE
C
C     COMPUTE SERIES NUMBER 5
C
      XTERM=X100/X110
      AMOUNT=0
      USTART=0.5
      DO 100 M=1,1000,2
      EM=FLOATF(M)
      USTART=USTART/(EM*(EM+1.0)*THETA)
      SUM1=USTART
      EN=0.5*(EM+1.0)+1.0
      UTERM=USTART/(T400*EN)
   78 SUM2=SUM1+UTERM
      IF(ABSF(SUM1/SUM2-1.0)-0.00000001) 85,85,80
   80 EN=EN+1.0
      SUM1=SUM2
      UTERM=UTERM/(T400*EN)
      GO TO 78
   85 XTERM=-XTERM*X110
      VALUE=XTERM*SUM2
      SR5=AMOUNT+VALUE
      IF(ABSF(ABSF(AMOUNT/SR5) 1.0)-0.00000001) 105,105,90
   90 AMOUNT=SR5
  100 CONTINUE
  105 CONTINUE
C
  120 CONTINUE
C
      PSI=((0.88622695*X300*EXPF(1.0/T400)+T100*
     1(SR1 SR2))*COSF(X200)+(X300*SR3*SR4+SR5)*
     2SINF(X200))/T100
C
  220 CONTINUE
C
      RETURN

      END(0,0,0)
```

```
*     CHAIN(2,B1)                  BLOCK FDP
C
*     657             CONTROL PROGRAM - FDP
C
C     PROGRAM FPREP      THOMAS A HOFFMAN
C     THIS PROGRAM IS PART OF THE REACTOR PHYSICS ONE DIMENSIONAL
C     DIFFUSION CALCULATION-PROGRAM ODD-ANP NO. 657
C
C     COMMON FOR PROGRAM FPREP
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,COMP,
     1REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,SEXP,
     2FM,FP,NR,TEMP,NRSAV,NRPRES,NTWORD,N1WORD,N2WORD,NOGPS,NOGPCN,
     3NCOMP,NRSPAS,ISAIR
C
C     DIMENSION FOR PROGRAM FPREP
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN
     1(100),HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
     2SEXP(150),FM(150),FP(150),NR(20),TEMP(1000),NCDT(303)
C
C     EQUIVALENCE FOR FPREP
      EQUIVALENCE (Q(12),CASEID),(Q(9),BNAME),(Q(6),BDENT),(Q(2),BDATE),
     1(CDT,NCDT)
C
C     BEGIN EXECUTABLE PART OF PROGRAM FPREP
C
C     PRESET VALUES FOR NUMBER OF ITERATIONS,CONVERGENCE FACTOR,
C     WRITE OUTPUT CONTROL,NUMBER OF GROUPS AND NUMBER OF TYPES
C     OF GROUP CONSTANTS
C
      SENSE LIGHT 0
      IF (MORE) 1, 500, 502
  500 CONTINUE
      GO TO 900
  502 CONTINUE
      SENSE LIGHT 3
      GO TO 2
    1 CONTINUE
      LMAX=99
      EPSK=1.0E-7
      NWOT=2
C
C     PRESET FISSION DENSITIES LEFT AND RIGHT TO ONE
C
  300 DO 301 I=1,150
      FM(I)=1.0
      FP(I)=1.0
  301 CONTINUE
C
C     SET PAGE NUMBERING
C
    2 CALL NEWSET (NPAGE+1)
      NOGPS=25
      NOGPCN=5
C
C     READ INPUT DATA
```

```
    3 CONTINUE
      READ DIP CASEID,CDT,NDT,ITAPE,JTAPE,KTAPE,MORE,COMP,REG,NMIX,
     1R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,SEXP,EM,EP,NWOT,NOGPS,
     2NOGPCN,KDT,END
      IF (SENSE LIGHT 1) 900,4
C
C     SET PAGE HEADING AND WRITE OUTPUT CONTROL
C
    4 CALL HDING (Q(12))
      CALL WOT(NWOT)
C
C     BEGIN INPUT CONSISTENCY CHECK,PRESET ERROR INDICATOR
C
    5 ISAIR=0
      PRINT 6
    6 FORMAT (1H1)
      IF (NCODE(1)) 7,8,9
    7 PRINT 10
   10 FORMAT (6X,43HTHE NUMBER OF REGIONS IS A NEGATIVE NUMBER.)
      GO TO 900
    8 PRINT 11
   11 FORMAT (6X,30HTHE NUMBER OF REGIONS IS ZERO.)
      GO TO 900
    9 IF (NCODE(1)-100) 100,100,13
   13 PRINT 14
   14 FORMAT (6X,47HTHE NUMBER OF REGIONS IS MORE THAN ONE HUNDRED.)
      GO TO 900
C
C     DETERMINE NUMBER OF COMPOSITIONS
C
  100 NCOMP=0
      J=1
      DO 101 I=1,20
      IF (COMP(J)) 102,103,102
  102 NCOMP=NCOMP+1
      J=J+2
  101 CONTINUE
  103 IF (NCOMP) 104,105,12
  104 PRINT 106
  106 FORMAT (6X,62HTHE NUMBER OF COMPOSITIONS IS CALCULATED AS A NEGATI
     1VE NUMBER.)
      GO TO 900
  105 PRINT 107
  107 FORMAT (6X,49HTHE NUMBER OF COMPOSITIONS IS CALCULATED AS ZERO.)
      GO TO 900
C
C     CHECK REGIONAL AGAINST COMPOSITION DATA
C
   12 CALL REGCK (8H MIX    ,NCODE,NCOMP,REG,COMP,ISAIR)
C
C     CHECK COMPOSITION AGAINST INDEX DATA

   24 I=NCDT(3)
      J=1
```

```
      DO 25 K=1,NCOMP
      L=4
      DO 26 M=1,I
      IF ((COMP(J)-CDT(L))+(COMP(J+1)-CDT(L+1))) 27,28,27
   27 L=L+3
   26 CONTINUE
      ISAIR=1
      PRINT 29,COMP(J),COMP(J+1)
   29 FORMAT (6X,12HCOMPOSITION 2A6,38H NOT PRESENT ON COMPOSITION DATA
     1TAPE.)
   28 J=J+2
   25 CONTINUE
C
C     CHECK NUMBER OF MIXABLES WITH NUMBER OF COMPOSITIONS
C
   30 IF (NMIX-NCOMP) 33,33,31
   31 PRINT 32,NMIX,NCOMP
   32 FORMAT (6X,I2,60H COMPOSITIONS TO BE MIXED. MAXIMUM ALLOWABLE IN T
     1HIS CASE ISI3,1H.)
      ISAIR=1
C
C     CHECK NUMBER OF RADII WITH NUMBER OF REGIONS
C
   33 J=0
      I1=NCODE(1)
      DO 34 I=1,I1
      IF (R(I+1)) 35,36,35
   35 J=J+1
   34 CONTINUE
   36 IF (J-NCODE(1)) 37,38,37
   37 ISAIR=1
      PRINT 39,NCODE(1),J
   39 FORMAT (6X,21HNUMBER OF REGIONS IS I3,20H.NUMBER OF RADII IS I3,16
     1H PLUS INNERMOST.)
C
C     CHECK IF RADII ARE MONOTONICALLY INCREASING
C
   38 A=R(1)
      I1=NCODE(1)
      DO 40 I=1,I1
      J=I-1
      IF (A-R(I+1)) 41,42,42
   42 PRINT 44,J,A,I,R(I+1)
   44 FORMAT (6X,7HREGIONI3,8H RADIUS=1PE12.7,9H, REGION I3,8H RADIUS=1P
     1E12.7,1H.)
      ISAIR=1
   41 A=R(I)
   40 CONTINUE
C
C     CHECK NUMBER OF DIMENSIONS WITH NUMBER OF REGIONS

   47 J=0
      I1=NCODE(1)
      DO 48 I=1,I1
      IF (HE(I)) 49,50,49
```

```
   49 J=J+1
   48 CONTINUE
   50 IF (NCODE(1)-J) 51,52,51
   51 PRINT 53,J,NCODE(1)
   53 FORMAT (6X,28HNUMBER OF DIMENSIONS EQUALS I3,26H NUMBER OF REGIONS
     1 EQUALS I3,1H.)
      ISAIR=1
C
C     CHECK NUMBER OF INTERVALS WITH NUMBER OF REGIONS
C
   52 J=0
      I1=NCODE(1)
      DO 54 I=1,I1
      IF (FN(I)) 55,56,55
   55 J=J+1
   54 CONTINUE
   56 IF (NCODE(1)-J) 57,401,57
   57 PRINT 59,J,NCODE(1)
   59 FORMAT (6X,30HNUMBER OF SETS OF INTERVALS = I3,22H, NUMBER OF REGI
     1ONS  = I3,1H.)
C
C     CHECK TOTAL NUMBER OF INTERVALS
C
  401 TOTAL=0.0
      I1=NCODE(1)
      DO 400 I=1,I1
      TOTAL=TOTAL+ABSF(EN(I))
  400 CONTINUE
      IF (TOTAL-147.0) 58,58,402
  402 ITOTAL=TOTAL
      PRINT 403,ITOTAL
  403 FORMAT (6X,28HTOTAL NUMBER OF INTERVALS = I3,31H, TOTAL ALLOWABLE
     1NUMBER = 147.)
      ISAIR=1
C
C     DETERMINE IF ANY ERRORS
C
   58 IF (ISAIR) 901,60,200
   60 CONTINUE
      IF (SENSE LIGHT 3) 200, 510
  510 CONTINUE
C
C     GENERATE TABLE OF INDEX RECORD NUMBERS CORRESPONDING TO
C    1COMPOSITIONS
C
      I=NCDT(3)
      J=1
      DO 61 K=1,NCOMP
      L=4
      DO 62 M=1,I
      IF ((COMP(J)-CDT(L))+(COMP(J+1)-CDT(L+1))) 63,64,63
   63 L=L+3
   62 CONTINUE
      GO TO 902
   64 NR(K)=NCDT(L+2)
```

```
      J=J+2
   61 CONTINUE
C
C     INITIALIZE FOR PROCESS COMPOSITION COMPOSITION DATA TAPE
C     SUBROUTINE
C
      NRSAV=0
      NRSPAS=0
      N1WORD=NOGPS*NOGPCN
      N2WORD=NOGPS*NOGPS
      NTWORD=N1WORD+N2WORD
C
C     ENTER LOOP
C
   65 DO 66 I=1,NCOMP
      CALL PCKDT (NRSAV,NRSPAS,NR,KDT,NCOMP,D,TEMP,NOGPS,NOGPCN,
     1NRPRES,NTWORD,N1WORD,N2WORD,ISAIR)
      IF (ISAIR) 903,66,200
   66 CONTINUE
      REWIND KDT
C
C     PRINT OUT
C
  200 ITOTAL=TOTAL
      IF (ISAIR) 907,255,256
  256 PRINT 257
  257 FORMAT (1H1)
  255 PRINT 201,NOGPS,NCODE(1),ITOTAL,NCOMP,LMAX,EPSK
  201 FORMAT (1H024X,19HCALCULATION SUMMARY///25X,18HNUMBER OF GROUPS =I
     13,/25X,19HNUMBER OF REGIONS =I4,/25X,27HTOTAL NUMBER OF INTERVALS
     2=I4,/25X,24HNUMBER OF COMPOSITIONS =I3,/25X,30HMAXIMUM NUMBER OF I
     3TERATIONS =I4,/25X20HCONVERGENCE FACTOR =1PE14.7//)
  202 IF (NCODE(2)) 904,204,203
  203 PRINT 205
  205 FORMAT (25X,24HADJOINT FLUX CALCULATION)
      GO TO 207
  204 PRINT 206
  206 FORMAT (25X,23HDIRECT FLUX CALCULATION)
  207 IF (NCODE(3)) 905,209,208
  208 PRINT 210
  210 FORMAT (25X,20HCYLINDRICAL GEOMETRY)
      GO TO 212
  209 PRINT 211
  211 FORMAT (25X,13HSLAB GEOMETRY)
C
C     PRINT BOUNDARIES AND ALBEDOS
C
  212 I1=NCODE(1)
      DO 213 I=1,I1
      IF (R(I+1)) 213,214,213
  213 CONTINUE
      I=NCODE(1)
  214 PRINT 215,R(1),R(I+1)
  215 FORMAT (1H0/2X,18HLEFT-HAND BOUNDARY1PE14.7,3X,19HRIGHT-HAND BOUND
     1ARY1PE14.7//)
```

```
  216 PRINT 217
  217 FORMAT (8X,20HGROUP      LEFT ALBEDO15X,21HGROUP      RIGHT ALBEDO)
      DO 218 I=1,NOGPS
      PRINT 219,I,ALFT(I),I,ARGT(I)
  219 FORMAT (9X,I2,1PE18.7,I17,1PE19.7)
  218 CONTINUE
C
C     PAGE 2 REGIONAL DATA
C
  220 PRINT 221
  221 FORMAT (1H1///26X,13HREGIONAL DATA///12X,9HNUMBER OF5X,10HRIGHT-HA
     1ND8X,8HBUCKLING7X,11HCOMPOSITION/2X,6HREGION4X,9HINTERVALS6X,8HBOU
     2NDARY9X,9HDIMENSION4X,14HIDENTIFICATION)
      J=1
      I1=NCODE(1)
      DO 222 I=1,I1
      L=FN(I)
      IF (I-35*(I/35)) 223,224,223
  223 PRINT 225,I,L,R(I+1),HF(I),REG(J),REG(J+1)
  225 FORMAT (I6,I12,1PE20.7,1PE17.7,3X,2A6)
      J=J+2
      GO TO 222
  224 PRINT 226,I,L,R(I+1),HF(I),REG(J),REG(J+1)
  226 FORMAT (1H1///26X,13HREGIONAL DATA///12X,9HNUMBER OF5X,10HRIGHT-HA
     1ND8X,8HBUCKLING7X,11HCOMPOSITION/2X,6HREGION4X,9HINTERVALS6X,8HBOU
     2NDARY9X,9HDIMENSION4X,14HIDENTIFICATION/I6,I12,1PE20.7,1PE17.7,3X,
     32A6)
      J=J+2
  222 CONTINUE
C
C     TEST IF MIXABLES AND PRINT NEXT PAGE
C
C
C     PRINT COMPOSITIONS
C
  228 PRINT 230
  230 FORMAT (1H1///28X,12HCOMPOSITIONS///)
      J=1
      DO 231 I=1,NCOMP
      PRINT 232,COMP(J),COMP(J 1)
  232 FORMAT (29X,2A6)
      J=J+2
  231 CONTINUE
C
C     PRINT MIXABLES IF ANY
C
  227 IF (NMIX) 906,280,229
  229 CALL POMIX (6H MIX   ,NCODE,REG,NMIX,COMP,EFFV,ISAIR,NCOMP)
C
C     TEST IF D IS TO BE PRINTED
C
  280 IF (NCODE(2)-10) 250,275,250
C
C     PRINT OUT D TABLE
C
```

```
  275 PRINT 276
  276 FORMAT (1H1//)
      I=0
  285 DO 277 J=1,440
      K=(I*440)+J
      L=((I+1)*440)+J
      M=((I+2)*440)+J
      N=((I+3)*440)+J
      PRINT 278,D(K),D(L),D(M),D(N)
  278 FORMAT (8X,1PE13.7,1PE15.7,1PE15.7,1PE15.7)
  277 CONTINUE
      I=I+4
      IF (NCOMP-I) 250,250,279
  279 PRINT 284
  284 FORMAT (1H1//)
      GO TO 285
C
C     DETERMINE IF ERROR
C
  250 IF (ISAIR) 900,251,900
C
C     CLEAR FPREP COMMON LEAVE FN COMMON ALONE
C
  251 DO 252 I=1,1029
      NR(I)=0
  252 CONTINUE
C
C     SET UP PAGE NUMBER FOR FN
C
  253 CALL PAGES(NPAGE)
C
C     BRING IN FN
C
  254 CONTINUE
      CALL CHAIN(3,B1)
C
C     FINAL STOP FOR ERRORS
C
  900 REWIND KDT
      CONTINUE
      CALL EXIT
C
C     ISAIR IS NEGATIVE.STATEMENT 58.
C
  901 CALL ERRORA
      ISAIR=1
      GO TO 200
C
C     COMPOSITION CANNOT BE FOUND IN INDEX.CONSISTENCY CHECK HAS
C     FAILED TO DIAGNOSE PROPERLY.STATEMENTS 60-64.
C
  902 CALL ERRORA
      ISAIR=1
      GO TO 200
C
```

```
C      ISAIR IS NEGATIVE COMING FROM PCKDT SUBROUTINE.STATEMENTS
       65-66 AND PCKDT.
C
  903 CALL ERRORA
       ISAIR=1
       GO TO 200
C
C      NCODF(3) IS NEGATIVE.STATEMENT 202.
C
  904 CALL ERRORA
       ISAIR=1
       GO TO 207
C
C      NCODF(3) IS NEGATIVE.STATEMENT 207.
C
  905 CALL ERRORA
       ISAIR=1
       GO TO 212
C
C      NMIX IS NEGATIVE.STATEMENT 227.
C
  906 CALL ERRORA
       ISAIR=1
       GO TO 250
C
C      ISAIR IS NEGATIVE.STATEMENT 200
C
  907 CALL ERRORA
       ISAIR=1
       GO TO 256
       END (0,0,0)
```

```
*        657              PROGRAM ODD        HOFFMAN
C
         SUBROUTINE REGCK (A,NCODE,NCOMP,REG,COMP,ISAIR)
C
C        DIMENSION FOR REGCK SUBROUTINE
         DIMENSION REG(200),COMP(40),NCODE(20)
C
C        BEGIN EXECUTABLE PART OF SUBROUTINE REGCK
C
       1 I=1
         I1=NCODE(1)
         DO 2 J=1,I1
         K=1
         DO 3 L=1,NCOMP
         IF (REG(I)-A) 4,5,4
       4 IF ((REG(I)-COMP(K))+(REG(I+1)-COMP(K+1))) 6,5,6
       6 K=K+2
       3 CONTINUE
         ISAIR=1
         PRINT 7,J
       7 FORMAT (6X,22HCOMPOSITION IN REGION I3,32H NOT GIVEN IN COMPOSITIO
        1N INPUT.)
       5 I=I+2
       2 CONTINUE
         RETURN
         END (0,0,0)
```

```
      SUBROUTINE PCKDT (NRSAV,NRSPAS,NR,KDT,NCOMP,D,TEMP,NOGPS,
     1NOGPCN,NRPRES,NTWORD,N1WORD,N2WORD,ISAIR)
C
C     DIMENSION FOR PCKDT SUBROUTINE
      DIMENSION NR(20),D(8800),TEMP(1000)
C
C     BEGIN EXECUTABLE PART OF SUBROUTINE PCKDT
C
    1 DO 2 I=1,NTWORD
      TEMP(I)=0.0
    2 CONTINUE
C
C     FIND NEXT RECORD TO PROCESS
C
      I=1
    6 DO 3 J=1,NCOMP
      IF (NR(I)-NR(J)) 3,3,4
    3 CONTINUE
      GO TO 5
    4 I=I+1
      GO TO 6
C
C     DETERMINE RECORD SPACING
C
    5 NRPRES=NR(I)
      NR(I)=NR(I)+1000
      NRSPAS=NRPRES-NRSAV-1
      IF (NRSPAS) 900,7,8
C
C     SPACE TAPE
C
    8 DO 9 J=1,NRSPAS
      READ TAPE KDT
    9 CONTINUE
C
C     READ RECORD INTO TEMP
C
    7 READ TAPE KDT,(TEMP(J),J=1,NTWORD)
      NRSAV=NRPRES
C
C     FIND POSITION OF COMPOSITION IN D TABLE
C
   10 J=I-1
      K=J*440
C
C     TRANSFER GROUP CONSTANTS INTO D TABLE
C
   11 DO 12 L=1,N1WORD
      M=L+K
      D(M)=TEMP(L)
   12 CONTINUE
C
C     I=COMPOSITION POSITION
```

```
C       J=COMPOSITION POSITION LESS ONE
C       K=INITIAL ADDRESS OF I COMPOSITION IN TABLE D
C
     13 L=K+N1WORD+1
        M=N1WORD-NOGPS
C
C       L=INITIAL MATRIX ADDRESS OF I COMPOSITION IN TABLE D
C       M=INITIAL MATRIX ADDRESS OF TEMP LESS THE NUMBER OF
C       GROUPS PLUS ONE
C
C       INITIALIZE FOR LOOP TO TRANSFER FULL TEMP MATRIX TO REDUCED
C       TABLE D MATRIX
C
     14 I1=NOGPS-5
        I2=2
        DO 15 I3=1,I1
        DO 16 I4=I2,NOGPS
        I5=M I4+(I3*NOGPS)
        D(L)=TEMP(I5)
        L=L+1
     16 CONTINUE
        I2=I2+1
     15 CONTINUE
C
C       REVERSE FOR GROUPS 21 THROUGH 25
C
     17 I1=I1+1
        I2=21
        DO 18 I3=I1,NOGPS
        DO 19 I4=I2,NOGPS
        I5=M I4+(I3*NOGPS)
        D(L)=TEMP(I5)
        L=L+1
     19 CONTINUE
     18 CONTINUE
        GO TO 20
    900 CALL ERRORA
        ISAIR=1
        REWIND KDT
     20 RETURN
        END (0,0,0)
```

```
*       657             PROGRAM ODD        HOFFMAN
C
        SUBROUTINE POMIX (A,NCODE,REG,NMIX,COMP,EFFV,ISAIR,NCOMP)
C
C       DIMENSION FOR POMIX SUBROUTINE
        DIMENSION REG(200),COMP(40),EFFV(500),NCODE(20)
C
C       BEGIN EXECUTABLE PART OF SUBROUTINE POMIX
C
      1 PRINT 2
      2 FORMAT (1H1///15X,37HREGIONS CONTAINING MIXED COMPOSITIONS///)
        I=5
        J=1
        I1=1
        I2=NMIX
        I3=NCODE(1)
        DO 3 K=1,I3
        IF (A-REG(J)) 4,5,4
      5 IF (I-50*(I/50)) 6,7,6
      6 PRINT 8,K,REG(J),REG(J+1)
      8 FORMAT (16X,13HREGION NUMBERI4,2X,15HIDENTIFICATION 2A6//)
        I=I+1
        IF (I-50*(I/50)) 22,10,22
     22 I=I+1
        IF (I-50*(I/50)) 9,10,9
      9 PRINT 13
     13 FORMAT (20X,11HCOMPOSITION9X,14HMIXING DENSITY)
        I=I+1
        IF (I-50*(I/50)) 14,15,14
      7 PRINT 11
     11 FORMAT (1H1///15X,37HREGIONS CONTAINING MIXED COMPOSITIONS///)
        I=5
        GO TO 6
     10 PRINT 12
     12 FORMAT (1H1///15X,37HREGIONS CONTAINING MIXED COMPOSITIONS///)
        I=5
        GO TO 9
     15 PRINT 16
     16 FORMAT (1H1///15X,37HREGIONS CONTAINING MIXED COMPOSITIONS///)
        I=5
     14 L=1
        DO 17 M=I1,I2
        PRINT 18,COMP(L),COMP(L+1),EFFV(M)
     18 FORMAT (19X,2A6,9X,1PE14.7)
        L=L+2
        I=I+1
        IF (I-50*(I/50)) 17,20,17
     20 PRINT 21
     21 FORMAT (1H1///15X,37HREGIONS CONTAINING MIXED COMPOSITIONS///)
        I=5
     17 CONTINUE
        I1=I2+1
        I2=I2+NMIX
        PRINT 23
     23 FORMAT (1H )
```

```
      I=I+1
      IF (I-50*(I/50)) 4,24,4
   24 PRINT 25
   25 FORMAT (1H1///15X,37HREGIONS CONTAINING MIXED COMPOSITIONS///)
      I=5
    4 J=J+2
    3 CONTINUE
      RETURN
      END (0,0,0)
```

```
*       CHAIN(3,B1)                     BLOCK F1
*       657             CONTROL F-1
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,FPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION A(5,5)
C
        CALL RANDC(6H MIX   )
        CALL GCOE
        CALL HOMRC
        CALL CHAIN(4,B1)
        CALL EXIT
        END(0,0,0)
```

```
*       657             SUBROUTINE GCOE
C
        SUBROUTINE GCOF
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION A(5,5)
C
        SBETF(H1,H2)=H2/H1
        SGAMF(H1,H2)=H2**2/2.
        SDELF(H1,H2)=H1*H2/2.
        CBETF(R,H1,H2)=H2/H1*(1. ABSF((R-H1/2.)/(R+H1/2.)))/(1.+ABSF((R+H2
       1/2.)/(R-H2/2.)))
        CGAMF(R,H1,H2)=H2/2.*(R+H2/2.-(R-H2/2.)*ABSF((R-H2/2.)/(R+H2/2.)))
       1/(1. ABSF((R-H2/2.)/(R+H2/2.)))
        CDELF(R,H1,H2)=H2/2.*(R+H1/2.-(R-H1/2.)*ABSF((R-H1/2.)/(R+H1/2.)))
       1/(1. ABSF((R+H2/2.)/(R-H2/2.)))
        NRG=NCODE(1)
        IF DIVIDE CHECK 2,2
      2 CONTINUE
        END=0.0                                                           00
        DO5J=1,NRG                                                        00
        H(J)=(R(J+1)-R(J))/ABSF(EN(J))                                    00
        IF DIVIDE CHECK 305,306                                           00
    305 CONTINUE                                                          00
        CALL ERRORA
        CALL EXIT
    306 CONTINUE                                                          00
        END=END+ABSF(EN(J))                                               00
      5 CONTINUE                                                          00
        N=XFIXF(END)                                                      00
        AR(1)=R(1)                                                        00
        AR(2)=R(1)+.001*H(1)
        AR(3)=R(1)+H(1)
        J=1
        DO 25 I=3,N
        IF(AR(I)-R(J+1)+0.1*H(J))26,27,27
     27 CONTINUE
        AR(I)=R(J+1)
        J=J+1
     26 CONTINUE
        AR(I 1)=AR(I)+H(J)
     25 CONTINUE
        AR(N 2)=R(NRG+1)-.001*H(NRG)
        AR(N 3)=R(NRG+1)
        M=N+3
```

```
      N=N+2
      J=1
      HA=.001*H(1)
      HB=.999*H(1)
      IF(NCODE(3)-1)100,101,101
  100 CONTINUE
      BETA(2)=SBETF(HA,HB)
      BETA(3)=SBETF(HB,H(1))
      GAM(2)=SGAMF(HA,HB)
      GAM(3)=SGAMF(HB,H(1))
      DEL(2)=SDELF(HA,HB)
      DEL(3)=SDELF(HB,H(1))
      DO 103 I=4,N
      IF(AR(I)-R(J+1))414,413,413
  413 CONTINUE
      BETA(I)=SBETF(H(J),H(J+1))
      GAM(I)=SGAMF(H(J),H(J+1))
      DEL(I)=SDELF(H(J),H(J+1))
      J=J+1
      GO TO 15
  414 CONTINUE
      BETA(I)=SBETF(H(J),H(J))
      GAM(I)=SGAMF(H(J),H(J))
      DEL(I)=SDELF(H(J),H(J))
   15 CONTINUE
  103 CONTINUE
      HA=.999*H(NRG)
      HB=.001*H(NRG)
      BETA(N-1)=SBETF(H(NRG),HA)
      BETA(N)=SBETF(HA,HB)
      GAM(N-1)=SGAMF(H(NRG),HA)
      GAM(N)=SGAMF(HA,HB)
      DEL(N-1)=SDELF(H(NRG),HA)
      DEL(N)=SDELF(HA,HB)
      GO TO 9
  101 CONTINUE
      BETA(2)=CBETF(AR(2),HA,HB)
      BETA(3)=CBETF(AR(3),HB,H(1))
      GAM(2)=CGAMF(AR(2),HA,HB)
      GAM(3)=CGAMF(AR(3),HB,H(1))
      DEL(2)=CDELF(AR(2),HA,HB)
      DEL(3)=CDELF(AR(3),HB,H(1))
      DO 102 I=4,N
      IF(AR(I)-R(J+1))11,12,12
   12 CONTINUE
      BETA(I)=CBETF(AR(I),H(J),H(J+1))
      GAM(I)=CGAMF(AR(I),H(J),H(J+1))
      DEL(I)=CDELF(AR(I),H(J),H(J+1))
      J=J+1
      GO TO 16
   11 CONTINUE
      BETA(I)=CBETF(AR(I),H(J),H(J))
      GAM(I)=CGAMF(AR(I),H(J),H(J))
      DEL(I)=CDELF(AR(I),H(J),H(J))
   16 CONTINUE
```

```
102 CONTINUE
    HA=.999*H(NRG)
    HB=.001*H(NRG)
    BETA(N-1)=CBETF(AR(N-1),H(NRG),HA)
    BETA(N)=CBETF(AR(N),HA,HB)
    GAM(N-1)=CGAMF(AR(N-1),H(NRG),HA)
    GAM(N)=CGAMF(AR(N),HA,HB)
    DEL(N-1)=CDELF(AR(N-1),H(NRG),HA)
    DEL(N)=CDELF(AR(N),HA,HB)
  9 CONTINUE                                                          00
    IF DIVIDE CHECK 307,308                                           00
307 CONTINUE                                                          00
    CALL ERRORA
    CALL EXIT
308 CONTINUE                                                          00
    RETURN
    END(0,0,0)
```

```
C           MATRIX INVERSION SUBROUTINE      J B RABIN                    MA
      SUBROUTINE MATINV(A,NR,NC)                                         MA
C
      COMMON   A,NR,NC                                                   MA
C
      DIMENSION A(5,5),LABEL(5)
C
      DO 38 I=1,NR                                                       MA
   38 LABEL(I)=I                                                         MA
    1 DO 24 I=1,NR                                                       MA
    2 FRE=0.0                                                            MA
    3 DO 7 M=I,NR                                                        MA
    4 IF(ABSF(A(M,I))-FRE) 7,7,5                                         MA
    5 FRE=ABSF(A(M,I))                                                   MA
    6 IBIG=M                                                             MA
    7 CONTINUE                                                           MA
    9 IF(IBIG-I) 10,14,10                                                MA
   10 DO 13 M=1,NC                                                       MA
   11 FRE=A(I,M)                                                         MA
   12 A(I,M)=A(IBIG,M)                                                   MA
   13 A(IBIG,M)=FRE                                                      MA
      M=LABEL(I)                                                         MA
      LABEL(I)=LABEL(IBIG)                                               MA
      LABEL(IBIG)=M                                                      MA
   14 FRE=A(I,I)                                                         MA
   15 A(I,I)=1.0                                                         MA
   16 DO 17 M=1,NC                                                       MA
   17 A(I,M)=A(I,M)/FRE                                                  MA
   18 DO 24 J=1,NR                                                       MA
   19 IF(J I) 20,24,20                                                   MA
   20 FRE=A(J,I)                                                         MA
   21 A(J,I)=0.0                                                         MA
   22 DO 23 K=1,NC                                                       MA
   23 A(J,K)=A(J,K)-FRE*A(I,K)                                           MA
   24 CONTINUE                                                           MA
   25 M=NR 1                                                             MA
   26 DO 36 I=1,M                                                        MA
   27 DO 30 J=I,NR                                                       MA
   28 IF(LABEL(J)-I) 30,29,30                                            MA
   29 IF(I J) 31,36,31                                                   MA
   30 CONTINUE                                                           MA
   31 DO 34 K=1,NR                                                       MA
   32 FRE=A(K,I)                                                         MA
   33 A(K,I)=A(K,J)                                                      MA
   34 A(K,J)=FRE                                                         MA
   35 LABEL(J)=LABEL(I)                                                  MA
   36 CONTINUE                                                           MA
   37 RETURN                                                             MA
      END(0,0,0)                                                         MA
```

```
*       657             SUBROUTINE HOMRC
C
        SUBROUTINE HOMRC
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,FFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION RXST(5),DIF(5),TSCAT(5,5)
C
        DIMENSION A(5,5)
C
        DO16KH=1,20
        IF(NCODE(2)-1)4,5,5
      4 CONTINUE
        K=KH
        GO TO 6
      5 CONTINUE
        K=1+20-KH
      6 CONTINUE
        J=1
        CALL RPAR(RXS,DIFC,K,J,6H MIX   )
        ALFT(K)=1.+(AR(2)-AR(1))/(2.*DIFC)*(1.-ALFT(K))/(1.+ALFT(K))
        IF DIVIDE CHECK 7,8
      7 CONTINUE
        CALL ERRORA
        CALL EXIT
      8 CONTINUE
        KN=N*(K-1)+1
        V(KN)=ALFT(K)
        KM=KN+1
        DO9I=2,N
        V(KM)=BETA(I)*DIFC*(1.-1./V(KM-1)) DEL(I)*RXS
        IF(AR(I)-R(J+1))10,11,11
     11 CONTINUE
        J=J+1
        CALL RPAR(RXS,DIFC,K,J,6H MIX   )
     10 CONTINUE
        V(KM)=1.+(V(KM)+GAM(I)*RXS)/DIFC
        IF DIVIDE CHECK12,13
     12 CONTINUE
        CALL ERRORA
        CALL EXIT
     13 CONTINUE
        KM=KM+1
      9 CONTINUE
        ARGT(K)=1.0+(AR(M)-AR(N))/(2.*DIFC)*(1.-ARGT(K))/(1.+ARGT(K))
        IF DIVIDE CHECK14,15
```

```
   14 CONTINUE
      CALL ERRORA
      CALL EXIT
   15 CONTINUE
   16 CONTINUE
      J=1
      CALL TMIX(1,DIF,RXST,TSCAT,6H MIX   )
      DO50K=1,5
      KA=20+K
      ALFT(KA)=1.+(AR(2)-AR(1))/(2.*DIF(K))*(1.-ALFT(KA))/(1.+ALFT(KA))
      IF DIVIDE CHECK 17,18
   17 CONTINUE
      CALL ERRORA
      CALL EXIT
   18 CONTINUE
      DO2L=1,5
      IF(K L)3,19,3
   19 CONTINUE
      VM(K,L,1)=1./ALFT(KA)
      GO TO 2
    3 CONTINUE
      VM(K,L,1)=0.0
    2 CONTINUE
   50 CONTINUE
      DO26I=2,N
      DO27K=1,5
      DO28L=1,5
      IF(NCODE(2)-1)40,41,41
   40 CONTINUE
      VM(K,L,I)=-BETA(I)*DIF(K)*VM(K,L,I 1)-DEL(I)*TSCAT(L,K)
      GOTO42
   41 CONTINUE
      VM(K,L,I)=-BETA(I)*DIF(K)*VM(K,L,I 1)-DEL(I)*TSCAT(K,L)
   42 CONTINUE
      IF(K L)28,29,28
   29 CONTINUE
      VM(K,L,I)=VM(K,L,I)+BETA(I)*DIF(K) DEL(I)*RXST(K)
   28 CONTINUE
   27 CONTINUE
      IF (AR(I)-R(J+1)) 110,111,111
  111 CONTINUE
      J=J+1
      CALL TMIX(J,DIF,RXST,TSCAT,6H MIX   )
  110 CONTINUE
      DO32K=1,5
      DO33L=1,5
      IF(NCODE(2)-1)45,46,46
   45 CONTINUE
      VM(K,L,I)=(VM(K,L,I)-GAM(I)*TSCAT(L,K))/DIF(K)
      GOTO47
   46 CONTINUE
      VM(K,L,I)=(VM(K,L,I)-GAM(I)*TSCAT(K,L))/DIF(K)
   47 CONTINUE
      IF(K L)33,34,33
   34 CONTINUE
```

```
      VM(K,L,I)=VM(K,L,I)+1.+(GAM(I)*RXST(K))/DIF(K)
   33 CONTINUE
   32 CONTINUE
      CALL MATINV(VM(1,1,I),5,5)
   26 CONTINUE
      DO 60 K=1,5
      KA=20+K
      ARGT(KA)=1.+(AR(M)-AR(N))/(2.*DIF(K))*(1.-ARGT(KA))/(1.+ARGT(KA))
      DO 51 L=1,5
      A(K,L)=-VM(K,L,N)
      IF(K L)51,52,51
   52 CONTINUE
      A(K,L)=A(K,L)+ARGT(KA)
   51 CONTINUE
   60 CONTINUE
      CALL MATINV(A(1,1),5,5)
      RETURN
      END(0,0,0)
```

* 657 SUBROUTINE RANDC

```
      SUBROUTINE RANDC(A)
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
     2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
     3,A,M,N
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
     2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
     3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100)
C
      MIX=0
      NRG=NCODE(1)
      DO2J=1,NRG
      IF(REG(2*J-1)-A)4,5,4
    4 CONTINUE
      DO3I=1,20
      IF(REG(2*J-1)-COMP(2*I-1))3,6,3
    6 CONTINUE
      IF(REG(2*J)-COMP(2*I))3,7,3
    3 CONTINUE
      CALL ERRORA
      CALL EXIT
    7 CONTINUE
      NCOMP(J)=I
      GO TO 2
    5 CONTINUE
      MIX=MIX+1
      NCOMP(J)=MIX
    2 CONTINUE
      RETURN
      END(0,0,0)
```

```
*       657                 SUBROUTINE RPAR
C
        SUBROUTINE RPAR(RXS,DIFC,K,J,E)
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,FPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION A(5,5)
C
        IF(REG(2*J-1)-E)2,3,2
      3 CONTINUE
        NA=NMIX*(NCOMP(J)-1)+1
        RXS=0
        DIFC=0
        SUM=0
        MA=5*(K-1)+1
        DO4I=1,NMIX
        RXS=RXS+D(MA+2)*EFFV(NA)
        IF(NCODE(3)-1)5,6,6
      5 CONTINUE
        DIFC=EFFV(NA)/D(MA+1)+DIFC
        SUM=EFFV(NA)/D(MA)+SUM
        GO TO 7
      6 CONTINUE
        DIFC=EFFV(NA)/D(MA)+DIFC
        SUM=EFFV(NA)/D(MA+1)+SUM
      7 CONTINUE
        NA=NA+1
        MA=MA+440
      4 CONTINUE
        IF(NCODE(3)-1)8,9,9
      8 CONTINUE
        RXS=RXS+ 23.13/(HE(J)+4.2624/SUM) **2/SUM
        DIFC=1./DIFC
        GO TO 10
      9 CONTINUE
        RXS=RXS+ 9.87/(HE(J)+4.2624/SUM) **2/SUM
        DIFC=1./DIFC
     10 CONTINUE
        RETURN
      2 CONTINUE
        NA=440*(NCOMP(J)-1)+5*K-4
        IF(NCODE(3)-1)11,12,12
     11 CONTINUE
        RXS=D(NA+2)+23.13*D(NA)/(HE(J)+4.2624*D(NA))**2
        DIFC=D(NA+1)
        GO TO 10
```

```
12 CONTINUE
   RXS=D(NA+2)+9.87*D(NA+1)/(HE(J)+4.2624*D(NA+1))**2
   DIFC=D(NA)
   GO TO 10
   END(0,0,1)
```

```
      657          SUBROUTINE TMIX
C
      SUBROUTINE TMIX(J,A,B,C,E)
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
     2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
     2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
     3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100)
C
      DIMENSION A(5),B(5),C(5,5),SUM(5)
C
      DO16K=1,5
      A(K)=0.0
      B(K)=0.0
      SUM(K)=0.0
      DO17L=1,5
      C(K,L)=0.0
   17 CONTINUE
   16 CONTINUE
      IF(REG(2*J-1)-E)2,3,2
    2 CONTINUE
      KA=440*(NCOMP(J)-1)+101
      KD=KA+314
      KE=KA
      DO7K=1,5
      KB=KA+5*(K-1)
      B(K)=D(KB+2)
      A(K)=1./D(KE)
      SUM(K)=1./D(KE 1)
      KE=KE+5
      DO8L=1,5
      LA=KD+L
      C(K,L)=D(LA)
    8 CONTINUE
      KD=KD+5
    7 CONTINUE
      GO TO 9
    3 CONTINUE
      KA=101
      KD=415
      KC=NMIX*(NCOMP(J)-1)+1
      DO10I=1,NMIX
      KE=KA
      DO11K=1,5
      KB=KA+5*(K-1)
      B(K)=B(K)+EFFV(KC)*D(KB+2)
      A(K)=A(K)+EFFV(KC)/D(KE)
      SUM(K)=SUM(K)+EFFV(KC)/D(KE+1)
      DO12L=1,5
      LA=KD+L
```

```
      C(K,L)=C(K,L)+EFFV(KC)*D(LA)
   12 CONTINUE
      KD=KD+5
      KE=KE+5
   11 CONTINUE
      KA=KA+440
      KD=KA+314
      KC=KC+1
   10 CONTINUE
    9 CONTINUE
      DO18K=1,5
      IF(NCODE(3)-1)19,20,20
   19 CONTINUE
      B(K)=B(K)+23.13/(HF(J)+4.2624/A(K))**2/A(K)
      A(K)=1./SUM(K)
      GOTO18
   20 CONTINUE
      B(K)=B(K)+9.87/(HF(J)+4.2624/SUM(K))**2/SUM(K)
      A(K)=1./A(K)
   18 CONTINUE
      RETURN
      END(0,0,0)
```

```
*       CHAIN(4,B1)                    BLOCK F2
C
*       657             CONTROL F-2
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION DIF(5),RXST(5),TSCAT(5,5)
C
        DIMENSION A(5,5)
C
        L=0
      2 CONTINUE
        L=L+1
        CALL SORRC
        CALL POWER
        IF (NCODE(3)-1) 3, 4, 4
      3 CONTINUE
        REAC=STINT(FP,FM,1,M,0)
        GO TO 5
      4 CONTINUE
        REAC=CTINT(FP,FM,1,M,0)
      5 CONTINUE
        IF(REAC)7,6,7
      6 CONTINUE
        IF (L-1) 9, 9, 10
      9 CONTINUE
        DO8I=1,150
        FP(I)=1.0
        FM(I)=1.0
      8 CONTINUE
        GO TO 2
      7 CONTINUE
        RK(L)=REAC
        DO 15 I=1,150
        FP(I)=FP(I)/REAC
        FM(I)=FM(I)/REAC
     15 CONTINUE
        IF(L 1)2,2,11
     11 CONTINUE
        IF(L LMAX)12,10,10
     12 CONTINUE
        IF(ABSF(RK(L-1)/RK(L)-1.)-EPSK)10,10,2
     10 CONTINUE
        DO500K=1,20
        CALL RPAR(RXS,DIFC,K,1,6H MIX  )
        ALFT(K)=(ALFT(K)-1.)*DIFC/(AR(2)-AR(1))*2.
```

```
      ALFT(K)=(1.-ALFT(K))/(1. ALFT(K))
      J=NCODE(1)
      CALL RPAR(RXS,DIFC,K,J,6H MIX   )
      ARGT(K)=(ARGT(K)-1.)*DIFC/(AR(M)-AR(M-1))*2.
      ARGT(K)=(1.-ARGT(K))/(1. ARGT(K))
  500 CONTINUE
      J=1
      CALL TMIX(J,DIF,RXST,TSCAT,6H MIX   )
      DO501K=1,5
      KA=20+K
      ALFT(KA)=(ALFT(KA)-1.)*DIF(K)/(AR(2)-AR(1))*2.
      ALFT(KA)=(1.-ALFT(KA))/(1.+ALFT(KA))
  501 CONTINUE
      CALL TMIX(NCODE(1),DIF,RXST,TSCAT,6H MIX   )
      DO502K=1,5
      KA=20+K
      ARGT(KA)=(ARGT(KA)-1.)*DIF(K)/(AR(M)-AR(M-1))*2.
      ARGT(KA)=(1.-ARGT(KA))/(1.+ARGT(KA))
  502 CONTINUE
      CALL CHAIN(5,B1)
      CALL EXIT
      END(0,0,0)
```

```
*       657              SUBROUTINE SORRC
C
        SUBROUTINE SORRC
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION SCATI(20)
C
        DIMENSIONDIF(5),RXST(5),TSCAT(5,5)
C
        DIMENSIONTSCATI(5)
C
        DIMENSION A(5,5)
C
        DIMENSION SUMT(5)
C
C COMPUTES ITERATION DEPENDENT QUANTITIES
C
        IF(NCODE(2)-1)2,3,3
      2 CONTINUE
        DO35K=1,20
        J=1
        CALL RPAR(RXS,DIFC,K,J,6H MIX    )
        CALL SPAR(S,SCATI,K,J,6H MIX    )
        KM=N*(K-1)+1
        W(1)=0.0
        DO10I=2,N
        W(I)=BETA(I)*DIFC/V(KM)*W(I-1)+DEL(I)*S*FM(I)
        DO15L-1,20
        IF(L K)11,16,16
     11 CONTINUE
        LM=I M*(L-1)
        W(I)=W(I)+DEL(I)*SCATI(L)*PHI(LM)
     15 CONTINUE
     16 CONTINUE
        IF(AR(I)-R(J+1))17,18,18
     18 CONTINUE
        J=J+1
        CALL RPAR(RXS,DIFC,K,J,6H MIX    )
        CALL SPAR(S,SCATI,K,J,6H MIX    )
     17 CONTINUE
        DO19L=1,20
        IF(L K)20,21,21
     20 CONTINUE
        LM=I M*(L-1)
        W(I)=W(I)+GAM(I)*SCATI(L)*PHI(LM)
```

```
 19 CONTINUE
 21 CONTINUE
    W(I)=(W(I)+GAM(I)*S*FP(I))/DIFC
    KM=KM+1
 10 CONTINUE
    KN=M*K
    KP=KN-K
    PHI(KN)=W(N)/(ARGT(K)*V(KP)-1.)
    DO25I=1,N
    IA=M I
    PHI(KN-1)=(PHI(KN)+W(IA))/V(KP)
    KN=KN-1
    KP=KP-1
 25 CONTINUE
 35 CONTINUE
    DO50K=1,750
    W(K)=0
 50 CONTINUE
    J=1
    CALL TMIX(J,DIF,RXST,TSCAT,6H MIX    )
    DO51I=2,N
    IA=5*(I-1)+1
    LB=IA-5
    DO52K=1,5
    SUM=0
    DO53L=1,5
    SUM=SUM+VM(K,L,I-1)*W(LB)
    LB=LB+1
 53 CONTINUE
    LB=LB-5
    W(IA)=BETA(I)*DIF(K)*SUM
    IA=IA+1
 52 CONTINUE
    IA=IA-5
    DO55K=21,25
    CALL SPAR(S,SCATI,K,J,6H MIX    )
    DO54L=1,20
    LM=M*(L-1)+I
    W(IA)=W(IA)+DEL(I)*SCATI(L)*PHI(LM)
 54 CONTINUE
    IA=IA+1
 55 CONTINUE
    IA=IA-5
    IF(AR(I)-R(J+1))56,57,57
 57 CONTINUE
    J=J+1
    CALL TMIX(J,DIF,RXST,TSCAT,6H MIX    )
 56 CONTINUE
    KA=1
    DO59K=21,25
    CALL SPAR(S,SCATI,K,J,6H MIX    )
    DO60L=1,20
    LM=M*(L-1)+I
    W(IA)=W(IA)+GAM(I)*SCATI(L)*PHI(LM)
 60 CONTINUE
```

```
      W(IA)=W(IA)/DIF(KA)
      IA=IA+1
      KA=KA+1
   59 CONTINUE
   51 CONTINUE
      LB=5*N-4
      DO62K=1,5
      SUMT(K)=0
      DO63L=1,5
      SUMT(K)=SUMT(K)+VM(K,L,N)*W(LB)
      LB=LB+1
   63 CONTINUE
      LB=LB-5
   62 CONTINUE
      LC=25*M-4
      DO64K=1,5
      PHI(LC)=0
      DO65L=1,5
      PHI(LC)=PHI(LC)+A(K,L)*SUMT(L)
   65 CONTINUE
      LC=LC+1
   64 CONTINUE
      DO66I=1,N
      LC=25*M-5*I+1
      IA=M I
      LA=LC
      DO67K=1,5
      PHI(LC-5)=0
      LB=5*IA-4
      DO68L=1,5
      PHI(LC-5)=VM(K,L,IA)*(PHI(LA)+W(LB))+PHI(LC-5)
      LA=LA+1
      LB=LB+1
   68 CONTINUE
      LA=LA-5
      LC=LC+1
   67 CONTINUE
   66 CONTINUE
      RETURN
    3 CONTINUE
      DO100K=1,750
      W(K)=0
  100 CONTINUE
      J=1
      CALL TMIX(J,DIF,RXST,TSCAT,6H MIX   )
      DO101I=2,N
      IA=5*(I-1)+1
      LB=IA-5
      DO102K=1,5
      SUM=0
      DO103L=1,5
      SUM=SUM+VM(K,L,I-1)*W(LB)
      LB=LB+1
  103 CONTINUE
      LB=LB-5
```

```
      W(IA)=BETA(I)*DIF(K)*SUM
      IA=IA+1
  102 CONTINUE
      IA=IA-5
      DO105K=21,25
      CALL SPAR(S,SCATI,K,J,6H MIX   )
      W(IA)=W(IA)+DEL(I)*S*FM(I)
      IA=IA+1
  105 CONTINUE
      IA=IA-5
      IF(AR(I)-R(J+1))106,107,107
  107 CONTINUE
      J=J+1
      CALL TMIX(J,DIF,RXST,TSCAT,6H MIX   )
  106 CONTINUE
      KA=1
      DO109K=21,25
      CALL SPAR(S,SCATI,K,J,6H MIX   )
      W(IA)=(W(IA)+GAM(I)*S*FP(I))/DIF(KA)
      IA=IA+1
      KA=KA+1
  109 CONTINUE
  101 CONTINUE
      LB=5*N-4
      DO112K=1,5
      SUMT(K)=0
      DO113L=1,5
      SUMT(K)=SUMT(K)+VM(K,L,N)*W(LB)
      LB=LB+1
  113 CONTINUE
      LB=LB-5
  112 CONTINUE
      LC=25*M-4
      DO114K=1,5
      PHI(LC)=0
      DO115L=1,5
      PHI(LC)=PHI(LC)+A(K,L)*SUMT(L)
  115 CONTINUE
      LC=LC+1
  114 CONTINUE
      DO116I=1,N
      LC=25*M-5*I+1
      IA=M-I
      LA=LC
      DO117K=1,5
      PHI(LC-5)=0
      LB=5*IA-4
      DO118L=1,5
      PHI(LC-5)=VM(K,L,IA)*(PHI(LA)+W(LB))+PHI(LC-5)
      LA=LA+1
      LB=LB+1
  118 CONTINUE
      LA=LA-5
      LC=LC+1
  117 CONTINUE
```

```
  116 CONTINUE
      DO 185 KH=1,20
      K=21 KH
      J=1
      CALL RPAR(RXS,DIFC,K,J,6H MIX   )
      CALL SPAR(S,SCATI,K,J,6H MIX   )
      KM=N*(K-1)+1
      W(1)=0.0
      DO150I=2,N
      W(I)=BETA(I)*DIFC/V(KM)*W(I-1)+DEL(I)*S*FM(I)
      DO155L=1,20
      IF(L K)156,156,151
  151 CONTINUE
      LM=I M*(L-1)
      W(I)=W(I)+DEL(I)*SCATI(L)*PHI(LM)
  156 CONTINUE
  155 CONTINUE
      CALL TSPAR(J,K,TSCATI,6H MIX   )
      LB=20*M+5*I-4
      DO125L=1,5
      W(I)=W(I)+DEL(I)*TSCATI(L)*PHI(LB)
      LB=LB+1
  125 CONTINUE
      IF(AR(I)-R(J+1))157,158,158
  158 CONTINUE
      J=J+1
      CALL RPAR(RXS,DIFC,K,J,6H MIX   )
      CALL SPAR(S,SCATI,K,J,6H MIX   )
      CALL TSPAR(J,K,TSCATI,6H MIX   )
  157 CONTINUE
      DO159L=1,20
      IF(L K)161,161,160
  160 CONTINUE
      LM=M*(L-1)+I
      W(I)=W(I)+GAM(I)*SCATI(L)*PHI(LM)
  161 CONTINUE
  159 CONTINUE
      LB=20*M+5*I-4
      DO126L=1,5
      W(I)=W(I)+GAM(I)*TSCATI(L)*PHI(LB)
      LB=LB+1
  126 CONTINUE
      W(I)=(W(I)+GAM(I)*S*FP(I))/DIFC
      KM=KM+1
  150 CONTINUE
      KN=M*K
      KP=KN-K
      PHI(KN)=W(N)/(ARGT(K)*V(KP)-1.)
      DO 175 I=1,N
      IA=M I
      PHI(KN-1)=(PHI(KN)+W(IA))/V(KP)
      KN=KN-1
      KP=KP-1
  175 CONTINUE
  185 CONTINUE
```

```
RETURN
END(0,0,0)
```

```
      657             SUBROUTINE POWER
C
      SUBROUTINE POWER
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,FN,HE,EFFV,ALFT,ARGT,LMAX,FPSK,NCODE,SFXM,
     2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
     3,A,M,N
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),FN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SFXM(150),
     2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
     3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100)
C
      DIMENSION A(5,5)
C
      DIMENSION FPAR(25)
C
      J=1
      CALL PMIX(J,FPAR,6H MIX   )
      FP(1)=0
      FM(1)=0
      IA=1
      DO20K=1,25
      FP(1)=FP(1)+FPAR(K)*PHI(IA)
      IF(K 20)21,23,22
   21 CONTINUE
      IA=IA+M
      GO TO 20
   23 CONTINUE
      IA=IA+M
      GO TO 20
   22 CONTINUE
      IA=IA+1
   20 CONTINUE
      DO10I=2,N
      IA=I
      FM(I)=0
      DO 11K=1,25
      FM(I)=FM(I)+FPAR(K)*PHI(IA)
      IF(K 20)12,9,13
   12 CONTINUE
      IA=IA+M
      GO TO 11
    9 CONTINUE
      IA=IA+(M-I)+5*(I-1)+1
      GO TO 11
   13 CONTINUE
      IA=IA+1
   11 CONTINUE
      IF(AR(I)-R(J+1))14,15,15
   15 CONTINUE
      J=J+1
      CALL PMIX(J,FPAR,6H MIX   )
```

```
      IA=I
      FP(I)=0
      DO16K=1,25
      FP(I)=FP(I)+FPAR(K)*PHI(IA)
      IF(K 20)17,19,18
   17 CONTINUE
      IA=IA+M
      GO TO 16
   19 CONTINUE
      IA=IA+(M-I)+5*(I-1)+1
      GO TO 16
   18 CONTINUE
      IA=IA+1
   16 CONTINUE
      GO TO 10
   14 CONTINUE
      FP(I)=FM(I)
   10 CONTINUE
      FP(M)=0
      FM(M)=0
      IA=M
      DO25K=1,25
      FM(M)=FM(M)+FPAR(K)*PHI(IA)
      IF(K 20)26,27,28
   26 CONTINUE
      IA=IA+M
      GO TO 25
   27 CONTINUE
      IA=IA+5*N+1
      GO TO 25
   28 CONTINUE
      IA=IA+1
   25 CONTINUE
      RETURN
      END(0,0,0)
```

```
*      657              SUBROUTINE SPAR
C
      SUBROUTINE SPAR(SOR,SCATI,K,J,E)
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
     2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
     3,A,M,N
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
     2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
     3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100)
C
      DIMENSION A(5,5)
C
      DIMENSION SCATI(20)
C
      SOR=0
      DO25L=1,20
      SCATI(L)=0
   25 CONTINUE
      IF(REG(2*J-1)-E)2,3,2
    3 CONTINUE
      NA=NMIX*(NCOMP(J)-1)+1
      MA=5*K-4
      DO4I=1,NMIX
      IF(NCODE(2)-1)5,6,6
    5 CONTINUE
      IF(D(MA+4))7,8,7
    7 CONTINUE
      SOR=D(MA+4)
    8 CONTINUE
      LA=124+K+440*(I-1)
      IF(K 21)50,50,51
   50 CONTINUE
      KA=K
      GO TO 52
   51 CONTINUE
      KA=21
   52 CONTINUE
      DO9L=2,KA
      SCATI(L-1)=EFFV(NA)*D(LA)+SCATI(L-1)
      LA=LA+25-L
    9 CONTINUE
      GO TO 10
    6 CONTINUE
      SOR=SOR+EFFV(NA)*D(MA+3)
      LA=125+440*(I-1)
      DO11L=1,20
      IF(L K)12,13,13
   12 CONTINUE
      LA=LA+(25-L)
   11 CONTINUE
```

```
13 CONTINUE
   DO14L=K,19
   SCATI(L+1)=EFFV(NA)*D(LA)+SCATI(L+1)
   LA=LA+1
14 CONTINUE
10 CONTINUE
   NA=NA+1
   MA=MA+440
 4 CONTINUE
   RETURN
 2 CONTINUE
   NA=440*(NCOMP(J)-1)+5*K-4
   IF(NCODE(2)-1)15,16,16
15 CONTINUE
   SOR=D(NA+4)
   LA=440*(NCOMP(J)-1)+124+K
   IF  (K-21) 30, 30, 31
30 CONTINUE
   KA=K
   GO TO 32
31 CONTINUE
   KA=21
32 CONTINUE
   DO17L=2,KA
   SCATI(L-1)=D(LA)
   LA=LA+25-L
17 CONTINUE
   RETURN
16 CONTINUE
   SOR=D(NA+3)
   LA=440*(NCOMP(J)-1)+126
   DO18L=1,19
   IF(L K)19,20,20
19 CONTINUE
   LA=LA+(25-L)
   GO TO 18
20 CONTINUE
   SCATI(L+1)=D(LA)
   LA-LA+1
18 CONTINUE
   RETURN
   END(0,0,0)
```

```
*      657             SUBROUTINE TSPAR
C
       SUBROUTINE TSPAR(J,K,SCATI,E)
C
       COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
      1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
      2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
      3,A,M,N
C
       DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
      1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
      2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
      3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
      4NCOMP(100)
C
       DIMENSION A(5,5)
C
       DIMENSION SCATI(20)
C
       DO 15 L=1,5
       SCATI(L)=0
    15 CONTINUE
       IF(REG(2*J-1)-E)2,3,2
     3 CONTINUE
       NA=NMIX*(NCOMP(J)-1)+1
       DO 4 I=1,NMIX
       LA=145+440*(I-1)
       DO 5 L=2,21
       IF(K L)6,7,7
     7 CONTINUE
       LA=LA+(25-L)
     5 CONTINUE
     6 CONTINUE
       DO 8 L=1,5
       SCATI(L)=D(LA)*EFFV(NA)+SCATI(L)
       LA=LA+1
     8 CONTINUE
       NA=NA+1
     4 CONTINUE
       RETURN
     2 CONTINUE
       NA=145+440*(NCOMP(J)-1)
       DO 10 L=2,21
       IF(K L)11,12,12
    12 CONTINUE
       NA=NA+(25-L)
    10 CONTINUE
    11 CONTINUE
       DO 13 L=1,5
       SCATI(L)=D(NA)
       NA=NA+1
    13 CONTINUE
       RETURN
       END(0,0,0)
```

```
*       657               SUBROUTINE PMIX
C
        SUBROUTINE PMIX(J,FPAR,F)
C
        COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
       1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
       2SEXP,FM,FP,VM,W,PHI,RK,V,AR,H,BETA,GAM,DEL,NCOMP
       3,A,M,N
C
        DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
       1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
       2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
       3RK(100),V(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
       4NCOMP(100)
C
        DIMENSION A(5,5)
C
        DIMENSION FPAR(25)
C
        IF(REG(2*J-1)-F)2,3,2
      2 CONTINUE
        KB=440*(NCOMP(J)-1)+1
        DO 5K=1,25
        IF(NCODE(2)-1)6,7,7
      6 CONTINUE
        FPAR(K)=D(KB+3)
        KB=KB+5
        GO TO 5
      7 CONTINUE
        FPAR(K)=D(KB+4)
        KB=KB+5
      5 CONTINUE
        RETURN
      3 CONTINUE
        NA=NMIX*(NCOMP(J)-1)+1
        DO 4K=1,25
        FPAR(K)=0
        KB=5*(K-1)+1
        DO 8I-1,NMIX
        IF(NCODE(2)-1)9,10,10
      9 CONTINUE
        FPAR(K)=FPAR(K)+EFFV(NA)*D(KB+3)
        GO TO 11
     10 CONTINUE
        IF(D(KB+4))11,11,12
     12 CONTINUE
        FPAR(K)=D(KB+4)
     11 CONTINUE
        KB=KB+440
        NA=NA+1
      8 CONTINUE
        NA=NA-NMIX
      4 CONTINUE
        RETURN
        END(0,0,0)
```

```
*       657             SUBROUTINE CTINT
C
        FUNCTION CTINT(A,B,N1,N3,N)
C
        COMMON Q,AR
C
        DIMENSION Q(22187),AR(1050),A(2),B(2)
C
        CTINT=0.0
        N2=N3-1
        DO 5 I=N1,N2
        J=N+1
        CTINT=CTINT+(A(J)*AR(I)+B(J+1)*AR(I+1))*(AR(I+1)-AR(I))/2.
      5 CONTINUE
        RETURN
        END(0,0,0)
```

```
*        657               SUBROUTINE STINT

         FUNCTION STINT(A,B,N1,N3,N)
C
         COMMON Q,AR
C
         DIMENSION Q(22187),AR(1050),A(2),B(2)
C
         STINT=0.0
         N2=N3-1
         DO 5 I=N1,N2
         J=N+I
         STINT=STINT+(A(J)+B(J+1))*(AR(I+1) AR(I))/2.
       5 CONTINUE
      10 CONTINUE
         RETURN
         END
```

```
      CHAIN(5,B1)                     BLOCK F3
C
*     657            CONTROL F-3
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,FPSK,NCODE,SEXM,
     2SEXP,FM,FP,VM,W,PHI,RK,APHI,VOL,APOW,B,AR,H,BETA,GAM,DEL,NCOMP,
     3A,M,N
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
     2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
     3RK(100)          ,AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100),APHI(2500),VOL(100),APOW(100),B(300),A(5,5)
C
      CALL WOT(NWOT)
      CALL NEWSET(NPAGE+1)
      CALL HDING(Q(12))
      CALL PREP
      NRG=NCODE(1)
      NA=2
      NB=2
      DO2J=1,NRG
      NA=NA+XFIXF(ABSF(EN(J)))
      IF(J NRG)7,8,8
    8 CONTINUE
      NA=NA+1
    7 CONTINUE
      WRITE OUTPUT TAPE 3,1000,AR(NB-1),FP(NB-1),SEXP(NB-1),(
     1AR(I),FM(I),SEXM(I),I=NB,NA)
      NB=NA+1
    2 CONTINUE
      IF (NCODE(6)-1) 3, 4, 4
    3 CONTINUE
      DO5K=1,20,5
      KA=K
      KB=K 4
      WRITE OUTPUT TAPE 3,1001,(I,I=KA,KB)
      JN=M*(K-1)+1
      DO9I=1,M
      JM=I 4*M+JN-1
      WRITE OUTPUT TAPE 3,1002,AR(I),(PHI(JA),JA=JN,JM,M)
      JN=JN+1
    9 CONTINUE
    5 CONTINUE
      WRITE OUTPUT TAPE 3,1001,(I,I=21,25)
      DO10I=1,M
      JM=5*I-4+20*M
      JN=JM+4
      WRITE OUTPUT TAPE 3,1002,AR(I),(PHI(JA),JA=JM,JN)
   10 CONTINUE
    4 CONTINUE
      DO12L=1,100
      IF(RK(L))12,13,12
   12 CONTINUE
```

```
      LIT=100
      GO TO 14
   13 CONTINUE
      LIT=L-1
   14 CONTINUE
      WRITE OUTPUT TAPE 3,1003,(I,RK(I),I=1,LIT)
      DO 26 J=1,NRG
      WRITE OUTPUT TAPE 3, 1012, J,VOL(J),APOW(J)
      DO 25 K=1,25
      KA=25*(J-1)+K
      WRITE OUTPUT TAPE 3, 1007, K,APHI(KA)
   25 CONTINUE
   26 CONTINUE
      DO 27 I=1,100
      RK(I)=0.0
   27 CONTINUE
      IF (NCODE(5)-1) 30, 28, 30
   28 CONTINUE
      CALL GPHI
   30 CONTINUE
      CALL PAGES(NPAGE)
      IF (NCODE(2)-2) 45, 32, 45
   32 CONTINUE
      NCODE(2)=0
      M1=25*M
      WRITE TAPE KTAPE, (PHI(I),I=1,M1)
      IF (NCODE(5)-1) 40, 34, 40
   34 CONTINUE
      M1=1
      M2=M
      DO 36 I=1,20
      WRITE TAPE KTAPE, (GPHIP(J),J=M1,M2),(GPHIM(J),J=M1,M2)
      M1=M2+1
      M2=(I+1)*M
   36 CONTINUE
      DO 38 I=1,5
      M1=20*M+I
      M2=25*M
      WRITE TAPE KTAPE, (GPHIP(J),J=M1,M2,5),(GPHIM(J),J=M1,M2,5)
   38 CONTINUE
   40 CONTINUE
      END FILE KTAPE
      REWIND KTAPE
      CALL CHAIN(3,B1)
   45 CONTINUE
      IF (XABSF(MORE)-2) 55, 50, 55
   50 CONTINUE
      CALL CHAIN(2,B1)
   55 CONTINUE
      CALL EXIT
C
 1000 FORMAT
      SPACE
  RADIUS          FISSION          EXTERNAL
                  SOURCE            SOURCE
```

```
      -0PF3                   -1PE5           -1PE5
          REPEAT 1
          END OF FORMAT
C
 1001 FORMAT
          RESTORE
   RELATIVE FLUX DISTRIBUTIONS
          SPACE
   RADIUS       GROUP -I     GROUP -I     GROUP -I     GROUP -I     GROUP -I
          END OF FORMAT
C
 10C2 FORMAT
      -0PF3                   -1PE5        -1PE5        -1PE5        -1PE5        -1PE5
          END OF FORMAT
C
 1003 FORMAT
          RESTORE
   ITERATION  EIGENVALUE
        -I                    -1PE7
          REPEAT 1
          END OF FORMAT
C
 1007 FORMAT
     -I                      -E7
          END OF FORMAT
C
 1012 FORMAT
          RESTORE
  AVERAGES    REGION NO -I
          SPACE
  VOLUME FRACTION                 -F7
  (REGION/CORE) AVERAGE POWER                 -F7
          SPACE
  GROUP      AVERAGE FLUX
          END OF FORMAT
C
          END(0,0,0)
```

```
      SUBROUTINE PREP
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,EPSK,NCODE,SEXM,
     2SEXP,FM,FP,VM,W,PHI,RK,APHI,VOL,APOW,B,AR,H,BETA,GAM,DEL,NCOMP,
     3A,M,N
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),
     2SEXP(150),FM(150),FP(150),VM(5,5,150),W(750),PHI(3750),
     3RK(100)          ,AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100),APHI(2500),VOL(100),APOW(100),B(300),A(5,5)
C
C     THIS BLOCK NORMALIZES POWER DISTRIBUTION
C     AND CALCULATES REGIONAL AVERAGES
C
      NRG=NCODE(1)
      AP=0.0
      VCORE=0.0
      KN=2
      KP=1
      DO100J=1,NRG
      KN=KN+XFIXF(ABSF(EN(J)))
      IF(J NRG)101,102,102
  102 CONTINUE
      KN=KN+1
  101 CONTINUE
      IF(EN(J))103,104,104
  103 CONTINUE
      IF(NCODE(3)-1)2,3,3
    2 CONTINUE
      AP=AP+STINT(FP,FM,KP,KN,0)
      VCORE=VCORE-R(J)+R(J+1)
      GOTO104
    3 CONTINUE
      AP=AP+CTINT(FP,FM,KP,KN,0)
      VCORE=VCORE+R(J+1)**2/2. R(J)**2/2.
  104 CONTINUE
      KP=KN
  100 CONTINUE
      DO 20 I =1,N
      FP(I)=FP(I)*VCORE/AP
      FM(I 1)=FM(I+1)*VCORE/AP
   20 CONTINUE
      VTOT=0.0
      KN=2
      KP=1
      DO450J=1,NRG
      KN=KN+XFIXF(ABSF(EN(J)))
      IF(J NRG)451,452,452
  452 CONTINUE
      KN=KN+1
  451 CONTINUE
```

```
      IF(NCODE(3)-1)23,24,24
   23 CONTINUE
      VOL(J)=R(J+1)-R(J)
      APOW(J)=STINT(FP,FM,KP,KN,0)/VOL(J)
      GOTO454
   24 CONTINUE
      VOL(J)=R(J+1)**2/2.-R(J)**2/2.
      APOW(J)=CTINT(FP,FM,KP,KN,0)/VOL(J)
  454 CONTINUE
      VTOT=VTOT+VOL(J)
      KP=KN
  450 CONTINUE
      DO 200 K=1,20
      KP=1
      KN=2
      KM=M*(K-1)
      DO201J=1,NRG
      KN=KN+XFIXF(ABSF(FN(J)))
      IF(J NRG)202,203,203
  203 CONTINUE
      KN=KN+1
  202 CONTINUE
      KA=K 25*(J-1)
      IF(NCODE(3)-1)204,205,205
  204 CONTINUE
      APHI(KA)=STINT(PHI,PHI,KP,KN,KM)/VOL(J)
      GOTO206
  205 CONTINUE
      APHI(KA)=CTINT(PHI,PHI,KP,KN,KM)/VOL(J)
  206 CONTINUE
      KP=KN
  201 CONTINUE
  200 CONTINUE
      DO 56 K=1,5
      KM=20*M+K
      KA=20+K
      J=1
      SUM=0.0
      DO 55 I=1,N
      IF(NCODE(3)-1)51,52,52
   51 CONTINUE
      SUM=SUM+(PHI(KM)+PHI(KM+5))*(AR(I+1)-AR(I))/2.
      GO TO 50
   52 CONTINUE
      SUM=SUM+(AR(I)*PHI(KM)+AR(I+1)*PHI(KM+5))*(AR(I+1)-AR(I))/2.
   50 CONTINUE
      IF(AR(I+1)-R(J 1))53,54,54
   54 CONTINUE
      APHI(KA)=SUM/VOL(J)
      J=J+1
      SUM=0.0
      KA=KA+25
   53 CONTINUE
      KM=KM+5
   55 CONTINUE
```

```
   56 CONTINUE
      DO207J=1,NRG
      VOL(J)=VOL(J)/VTOT
  207 CONTINUE
      RETURN
      END(0,0,0)
```

```
*       657              SUBROUTINE GPHI
C
      SUBROUTINE GPHI
C
C     THIS SUBROUTINE COMPUTES FLUX GRADIENTS USING
C     A CENTRAL DIFFERENCE APPROXIMATION EXCEPT AT
C     REGION INTERFACES AND NEAR THE INNER AND
C     OUTER BOUNDARIES      REQUIRED STORAGE 7500
C     MAXIMUM IS OBTAINED BY OVERLAY ON VM AND V
C
      COMMON Q,CDT,NPAGE,NWOT,NDT,KDT,ITAPE,JTAPE,KTAPE,MORE,D,
     1COMP,REG,NMIX,R,EN,HE,EFFV,ALFT,ARGT,LMAX,FPSK,NCODE,SEXM,
     2SEXP,FM,FP,GPHIP,W,PHI,RK,GPHIM,AR,H,BETA,GAM,DEL,NCOMP,
     3A,M,N
C
      DIMENSION Q(12),CDT(303),D(8800),COMP(40),REG(200),R(101),EN(100),
     1HE(100),EFFV(500),ALFT(25),ARGT(25),NCODE(20),SEXM(150),SEXP(150),
     2FM(150),FP(150),GPHIP(3750),W(750),PHI(3750),RK(100),
     3GPHIM(3000),AR(153),H(100),BETA(150),GAM(150),DEL(150),
     4NCOMP(100),A(5,5)
C
      DIMENSION SCATI(20),TSCATI(5),TSCAT(5,5),DIF(5),
     1RXST(5),RTEMP(153)
C
      CALL WOT(NWOT)
      DO 100 I=1,153
      RTEMP(I)=AR(I)
  100 CONTINUE
      DO 2 K=1,20
      KM=1 M*(K-1)
      J=1
      CALL RPAR(RXS,DIFC,K,J,6H MIX   )
      GPHIM(KM)=0.0
      GPHIP(KM)=(1.-ALFT(K))/(1.+ALFT(K))/(2.*DIFC)*PHI(KM)
      CALL SPAR(S,SCATI,K,J,6H MIX   )
      GPHIM(KM+1)=S*FM(2)-RXS*PHI(KM+1)
      GPHIM(KM+2)=S*FM(3)-RXS*PHI(KM+2)
      IF(NCODE(2)-1)3,4,4
    3 CONTINUE
      DO 5L=1,20
      IF(L K)6,5,5
    6 CONTINUE
      LA=M*(L-1)+2
      GPHIM(KM+1)=GPHIM(KM+1)+SCATI(L)*PHI(LA)
      GPHIM(KM+2)=GPHIM(KM+2)+SCATI(L)*PHI(LA+1)
    5 CONTINUE
      GO TO 7
    4 CONTINUE
      DO 8L=1,20
      IF(L K)8,8,9
    9 CONTINUE
      LA=M*(L-1)+2
      GPHIM(KM+1)=GPHIM(KM+1)+SCATI(L)*PHI(LA)
      GPHIM(KM+2)=GPHIM(KM+2)+SCATI(L)*PHI(LA+1)
    8 CONTINUE
```

```
      CALL TSPAR(J,K,TSCATI,6H MIX   )
      LA=20*M+6
      DO10L=1,5
      GPHIM(KM+1)=GPHIM(KM+1)+TSCATI(L)*PHI(LA)
      GPHIM(KM+2)=GPHIM(KM+2)+TSCATI(L)*PHI(LA+5)
      LA=LA+1
   10 CONTINUE
    7 CONTINUE
      GPHIM(KM+1)=-GPHIM(KM+1)*(.001*H(1))/(2.*DIFC)+(PHI(KM 1)-
     1PHI(KM))/(.001*H(1))
      GPHIM(KM+2)=-(.997*H(1))/(2.*DIFC)*GPHIM(KM+2)+(PHI(KM 2)
     1-PHI(KM+1))/(.997*H(1))
      GPHIP(KM+1)=GPHIM(KM+1)
      GPHIP(KM+2)=GPHIM(KM+2)
      KM=KM+3
      MA=M 3
      DO11I=4,MA
      IF(AR(I)-R(J+1))12,13,13
   12 CONTINUE
      GPHIM(KM)=(PHI(KM+1)-PHI(KM-1))/(2.*H(J))
      GPHIP(KM)=GPHIM(KM)
      KM=KM+1
      GO TO 11
   13 CONTINUE
      GPHIM(KM)=S*FM(I)-RXS*PHI(KM)
      IF(NCODE(2)-1)14,15,15
   14 CONTINUE
      DO16L=1,20
      IF(L K)17,16,16
   17 CONTINUE
      LA=M*(L-1)+I
      GPHIM(KM)=GPHIM(KM)+SCATI(L)*PHI(LA)
   16 CONTINUE
      GO TO 18
   15 CONTINUE
      DO19L=1,20
      IF(L K)19,19,20
   20 CONTINUE
      LA=M*(L-1)+1
      GPHIM(KM)=GPHIM(KM)+SCATI(L)*PHI(LA)
   19 CONTINUE
      LA=20*M+5*I-4
      DO21L=1,5
      GPHIM(KM)=GPHIM(KM)+TSCATI(L)*PHI(LA)
      LA=LA+1
   21 CONTINUE
   18 CONTINUE
      GPHIM(KM)=(PHI(KM)-PHI(KM-1))/H(J) H(J)/(2.*DIFC)*GPHIM(KM)
      J=J+1
      CALL RPAR(RXS,DIFC,K,J,6H MIX   )
      CALL SPAR(S,SCATI,K,J,6H MIX   )
      CALL TSPAR(J,K,TSCATI,6H MIX   )
      GPHIP(KM)=S*FP(I)-RXS*PHI(KM)
      IF(NCODE(2)-1)22,26,26
   22 CONTINUE
```

```
      DO23L=1,20
      IF(L K)24,23,23
   24 CONTINUE
      LA=M*(L-1)+I
      GPHIP(KM)=GPHIP(KM)+SCATI(L)*PHI(LA)
   23 CONTINUE
      GO TO 25
   26 CONTINUE
      DO27L=1,20
      IF(L K)27,27,28
   28 CONTINUE
      LA=M*(L-1)+I
      GPHIP(KM)=GPHIP(KM)+SCATI(L)*PHI(LA)
   27 CONTINUE
      LA=20*M+5*I-4
      DO29L=1,5
      GPHIP(KM)=GPHIP(KM)+TSCATI(L)*PHI(LA)
      LA=LA+1
   29 CONTINUE
   25 CONTINUE
      GPHIP(KM)=(PHI(KM+1)-PHI(KM))/H(J) H(J)/(2.*DIFC)*GPHIP(KM)
      KM=KM+1
   11 CONTINUE
      GPHIP(KM)=S*FP(M-2)-RXS*PHI(KM)
      GPHIP(KM+1)=S*FP(M-1)-RXS*PHI(KM+1)
      IF(NCODE(2)-1)30,31,31
   30 CONTINUE
      DO32L=1,20
      IF(L K)33,32,32
   33 CONTINUE
      LA=M*L
      GPHIP(KM)=GPHIP(KM)+SCATI(L)*PHI(LA-2)
      GPHIP(KM+1)=GPHIP(KM+1)+SCATI(L)*PHI(LA-1)
   32 CONTINUE
      GO TO 35
   31 CONTINUE
      DO36L=1,20
      IF(L K)36,36,37
   37 CONTINUE
      LA=M*L
      GPHIP(KM)=GPHIP(KM)+TSCATI(L)*PHI(LA-2)
      GPHIP(KM+1)=GPHIP(KM+1)+TSCATI(L)*PHI(LA-1)
   36 CONTINUE
      LA=25*M
      DO38L=1,5
      GPHIP(KM)=GPHIP(KM)+TSCATI(L)*PHI(LA-14)
      GPHIP(KM+1)=GPHIP(KM+1)+TSCATI(L)*PHI(LA-9)
      LA=LA+1
   38 CONTINUE
   35 CONTINUE
      GPHIP(KM)=(PHI(KM+1)-PHI(KM))/(.997*H(J))+(.997*H(J))/
     1(2.*DIFC)*GPHIP(KM)
      GPHIM(KM)=GPHIP(KM)
      GPHIP(KM+1)=(PHI(KM+2)-PHI(KM+1))/(.001*H(J))+(.001*H(J))/
     1(2.*DIFC)*GPHIP(KM+1)
```

```
      GPHIM(KM+1)=GPHIP(KM+1)
      KM=KM+2
      GPHIM(KM)=-(1. ARGT(K))/(1.+ARGT(K))/(2.*DIFC)*PHI(KM)
      GPHIP(KM)=0.0
    2 CONTINUE
C
C     GRADIENTS AT THERMAL
      DO50K=1,5
      J=1
      CALL TMIX(J,DIF,RXST,TSCAT,6H MIX   )
      KM=20*M+K
      KA=20+K
      GPHIM(KM)=0.0
      GPHIP(KM)=(1.-ALFT(KA))/(1.+ALFT(KA))/(2.*DIF(K))*PHI(KM)
      CALL SPAR(S,SCATI,KA,J,6H MIX   )
      GPHIM(KM+5)=-RXST(K)*PHI(KM+5)
      GPHIM(KM+10)=-RXST(K)*PHI(KM+10)
      IF(NCODE(2)-1)53,54,54
   53 CONTINUE
      DO51L=1,20
      LA=M*(L-1)+2
      GPHIM(KM+5)=GPHIM(KM+5)+SCATI(L)*PHI(LA)
      GPHIM(KM+10)=GPHIM(KM+10)+SCATI(L)*PHI(LA+1)
   51 CONTINUE
      LA=KM
      DO52L=1,5
      GPHIM(KM+5)=GPHIM(KM+5)+TSCAT(L,K)*PHI(LA+5)
      GPHIM(KM+10)=GPHIM(KM+10)+TSCAT(L,K)*PHI(LA+10)
      LA=LA+1
   52 CONTINUE
      GO TO 55
   54 CONTINUE
      LA=KM
      DO56L=1,5
      GPHIM(KM+5)=GPHIM(KM+5)+TSCAT(K,L)*PHI(LA+5)
      GPHIM(KM+10)=GPHIM(KM+10)+TSCAT(K,L)*PHI(LA+10)
      LA=LA+1
   56 CONTINUE
      GPHIM(KM+5)=GPHIM(KM+5)+S*FM(I+1)
      GPHIM(KM+10)=GPHIM(KM+10)+S*FM(I+2)
   55 CONTINUE
      GPHIM(KM+5)=GPHIM(KM+5)*(.001*H(1))/(2.*DIF(K))-
     1(PHI(KM+10)-PHI(KM+5))/(.001*H(1))
      GPHIM(KM+10)=GPHIM(KM+10)*(.997*H(1))/(2.*DIF(K))-
     1(PHI(KM+15)-PHI(KM+10))/(.997*H(1))
      GPHIP(KM+5)=GPHIM(KM+5)
      GPHIP(KM+10)=GPHIM(KM+10)
      KM=KM+15
      DO60I=4,MA
      IF(AR(I)-R(J+1))61,62,62
   61 CONTINUE
      GPHIM(KM)=(PHI(KM+5)-PHI(KM-5))/(2.*H(J))
      GPHIP(KM)=GPHIM(KM)
      KM=KM+5
      GO TO 60
```

```
62 CONTINUE
   GPHIM(KM)=-RXST(K)*PHI(KM)
   IF(NCODE(2)-1)64,65,65
64 CONTINUE
   DO63L=1,5
   LA=20*M+5*I-5+L
   GPHIM(KM)=GPHIM(KM)+TSCAT(L,K)*PHI(LA)
63 CONTINUE
   DO66L=1,20
   LA=M*(L-1)+I
   GPHIM(KM)=GPHIM(KM)+SCATI(L)*PHI(LA)
66 CONTINUE
   GO TO 67
65 CONTINUE
   DO68L=1,5
   LA=20*M+5*I-5+L
   GPHIM(KM)=GPHIM(KM)+TSCAT(K,L)*PHI(LA)
68 CONTINUE
   GPHIM(KM)=GPHIM(KM)+S*FM(I)
67 CONTINUE
   GPHIM(KM)=(PHI(KM)-PHI(KM-1))/H(J) H(J)/(2.*DIF(K))*
  1GPHIM(KM)
   J=J+1
   CALL TMIX(J,DIF,RXST,TSCAT,6H MIX   )
   CALL SPAR(S,SCATI,KA,J,6H MIX   )
   GPHIP(KM)=-RXST(K)*PHI(KM)
   IF(NCODE(2)-1)69,70,70
69 CONTINUE
   DO71L=1,5
   LA=20*M+5*I-5+L
   GPHIP(KM)=GPHIP(KM)+TSCAT(L,K)*PHI(LA)
71 CONTINUE
   DO72L=1,20
   LA=M*(L-1)+I
   GPHIP(KM)=GPHIP(KM)+SCATI(L)*PHI(LA)
72 CONTINUE
   GO TO 73
70 CONTINUE
   DO74L=1,5
   LA=20*M+5*I-5+L
   GPHIP(KM)=GPHIP(KM)+TSCAT(K,L)*PHI(LA)
74 CONTINUE
   GPHIP(KM)=GPHIP(KM)+S*FP(I)
73 CONTINUE
   GPHIP(KM)=(PHI(KM+5)-PHI(KM))/H(J) H(J)/(2.*DIF(K))
  1*GPHIP(KM)
   KM=KM+5
60 CONTINUE
   GPHIP(KM)=-RXST(K)*PHI(KM)
   GPHIP(KM+5)=-RXST(K)*PHI(KM+5)
   IF(NCODE(2)-1)80,81,81
80 CONTINUE
   DO82L=1,5
   LA=KM-1+L
   GPHIP(KM)=GPHIP(KM)+TSCAT(L,K)*PHI(LA)
```

```
      GPHIP(KM+5)=GPHIP(KM+5)+TSCAT(L,K)*PHI(LA+5)
   82 CONTINUE
      DO83L=1,20
      LA=M*L-2
      GPHIP(KM)=GPHIP(KM)+SCATI(L)*PHI(LA)
      GPHIP(KM+5)=GPHIP(KM+5)+SCATI(L)*PHI(LA+1)
   83 CONTINUE
      GOTO85
   81 CONTINUF
      GPHIP(KM+5)=GPHIP(KM+1)+S*FP(M-1)
      GPHIP(KM)=GPHIP(KM)+S*FP(M-2)
      DO84L=1,5
      LA=KM-1+L
      GPHIP(KM)=GPHIP(KM)+TSCAT(K,L)*PHI(LA)
      GPHIP(KM+5)=GPHIP(KM+5)+TSCAT(L,K)*PHI(LA+5)
   84 CONTINUE
   85 CONTINUE
      GPHIP(KM)=(PHI(KM+5)-PHI(KM))/(.997*H(J))+(.997*H(J))
     1/(2.*DIF(K))*GPHIP(KM)
      GPHIM(KM)=GPHIP(KM)
      GPHIP(KM+5)=(PHI(KM+10)-PHI(KM+5))/(.001*H(J))+(.001*
     1H(J))/(2.*DIF(K))*GPHIP(KM+5)
      GPHIM(KM+5)=GPHIP(KM+5)
      KM=KM+10
      GPHIP(KM)=0.0
      GPHIM(KM)=-(1. ARGT(K+20))/(1.+ARGT(K+20))/(2.*DIF(K))*PHI(KM)
   50 CONTINUE
      IF (NCODE(6)-1) 110, 150, 150
  110 CONTINUE
      DO 125 I=1,20,2
      KA=I
      KB=I 1
      PRINT 1001, (NG,NG=KA,KB)
      PRINT 1005
      M2=(I+1)*M
      DO 120 J=1,M
      M1=(I-1)*M+J
      PRINT 1002, RTEMP(J),(GPHIM(L),GPHIP(L),L=M1,M2,M)
  120 CONTINUF
  125 CONTINUE
      DO 135 I=1,3,2
      KA=I 20
      KB=I 21
      PRINT 1001, (NG,NG=KA,KB)
      PRINT 1005
      DO 130 J=1,M
      M1=20*M+5*(J-1)+I
      M2=M1+1
      PRINT 1002, RTEMP(J),GPHIM(M1),GPHIP(M1),GPHIM(M2),GPHIP(M2)
  130 CONTINUE
  135 CONTINUE
      NG=25
      PRINT 1003, NG
      DO 140 J=1,M
      M1=20*M+5*J
```

```
      PRINT 1002, RTEMP(J),GPHIM(M1),GPHIP(M1)
  140 CONTINUE
  150 CONTINUE
      RETURN
C
 1001 FORMAT(1H1///31X,14HFLUX GRADIENTS//19X,6HGROUP I2,21X,6HGROUP I2)
C
 1002 FORMAT(0PF8.3,1PE15.5,1PE13.5,1PE15.5,1PE13.5)
C
 1003 FORMAT(1H1///31X,14HFLUX GRADIENTS//19X,6HGROUP I2//7H RADIUS8X,4H
     1LEFT9X,5HRIGHT)
C
 1005 FORMAT(7H0RADIUS8X,4HLEFT9X,5HRIGHT10X,4HLEFT9X,5HRIGHT)
C
      END
```

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GENERAL ELECTRIC