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ANCON User's Manual

by

John C. Vigil

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ABSTRACT

The ANCON code is a FORTRAN-IV program that solves the point reactor kinetic equations, including thermal feedback. Lump-type heat balance equations are used to represent the thermodynamics, and the heat capacity of each lump can vary with temperature. Thermal feedback can be either a linear or a nonlinear function of lump temperature, and the impressed reactivity can be either a polynomial or sinusoidal function.

This report includes a description of the equations solved by the code, a description of the computational algorithms, detailed input specifications, and other information required for effective use of the code. The code is structured in a form such that reactivity or heat balance options, other than those presently available, can be incorporated with a minimum of code modification.

I. INTRODUCTION

The ANCON (analytic continuation) code has been in use at the Los Alamos Scientific Laboratory for several years. This code solves the point reactor kinetic equations, including thermal feedback, by a method known as continuous analytic continuation.¹ Lump-type heat balance equations are used to represent the thermodynamics. Although the theory and computational algorithms have been described in other publications,^{2,3} there is a need for a report that describes the various options available, the detailed input specifications, and other information required by the user. The ANCON User's Manual was prepared to fill this need.

The equations solved by the code and the various options available are described in Sec. II. To make this report self-contained, the main features of the computational method are described in Sec. III. Generalized expressions for the higher-order derivatives of the dependent variables appearing in the kinetics equations are given in Appendix A. Detailed input specifications are given in Appendix B, and the code organization and storage requirements

are discussed in Appendix C. Input data for a sample problem and computer output from execution of this problem are given in Appendix D.

II. EQUATIONS SOLVED

The point reactor kinetic equations solved by the ANCON code are

$$dN(t)/dt = \Lambda^{-1} [\rho(t) - \beta] N(t) + \sum_{i=1}^{IMAX} \lambda_i \theta_i(t) + S \quad (1)$$

$$d\theta_i(t)/dt = \Lambda^{-1} \beta_i N(t) - \lambda_i \theta_i(t) \quad (i=1,2,\dots,IMAX), \quad (2)$$

where

$N(t)$ = neutron level,

$\theta_i(t)$ = delayed neutron precursor level for group i ,

S = external neutron source (neutrons/sec),

Λ = prompt neutron generation time (sec),

λ_i = decay constant of group i of delayed neutron precursors (1/sec),

β_i = fraction of delayed neutrons in group i ,
and

$$\beta = \sum_{i=1}^{IMAX} \beta_i .$$

At present, the external neutron source is restricted to a constant. However, a time-dependent source could be incorporated with a minimum of effort and would require modification of the main program only. The number of delayed neutron groups is presently restricted to the range $0 \leq IMAX \leq 6$, but a larger number can be accommodated by increasing the dimensions of a few subscripted variables.

A. Reactivity Options

In a general form, the reactivity is given by

$$\rho(t) = I(t) + F(t) , \quad (3)$$

where $I(t)$ and $F(t)$ are, respectively, functions representing the impressed reactivity and reactivity feedback. Three options are currently available for $\rho(t)$. Because the code is written in modular form (see Appendix C), other options can be incorporated by either expanding or rewriting subroutine REACT without requiring modifications to the main program and other subroutines in the process.

Reactivity Option 1 (NRHO = 1).* In this option, $\rho(t)$ contains constant and sinusoidal driving terms with or without linear thermal feedback. That is, the impressed reactivity function is given by

$$I(t) = a_0 + a_1 \sin(\omega t) , \quad (4)$$

where

- a_0 = constant reactivity ($\Delta k/k$),
- a_1 = amplitude ($\Delta k/k$), and
- ω = angular frequency (rad/sec).

The feedback function is given by

$$F(t) = \sum_{j=1}^{JMAX} \alpha_j [T_j(t) - T_j(t_0)] , \quad (5)$$

where

- α_j = temperature coefficient of reactivity ($\Delta k/k$ per $^{\circ}K$) for lump j ,
- $T_j(t)$ = temperature ($^{\circ}K$) of lump j ,
- $T_j(t_0)$ = initial temperature ($^{\circ}K$) of lump j , and
- $JMAX$ = total number of lumps.

* See input specifications, Appendix B.

At present, $JMAX$ must be in the range $0 \leq JMAX \leq 56$, which should be sufficient for most problems. The function $F(t)$ can be omitted by specifying $JMAX = 0$.

Reactivity Option 2 (NRHO = 2). In this option, $\rho(t)$ contains two terminating polynomials in time as the driving terms and nonlinear thermal feedback including Doppler feedback. That is, $I(t)$ is given by

$$I(t) = \sum_{n=0}^{NA} a_n t^n \quad \text{for } t_0 \leq t < t_1 , \quad (6a)$$

$$I(t) = \sum_{n=0}^{NA} a_n t_1^n + \sum_{m=0}^{NB} b_m (t - t_1)^m \quad \text{for } t_1 \leq t < t_2 , \quad (6b)$$

$$I(t) = \sum_{n=0}^{NA} a_n t_1^n + \sum_{m=0}^{NB} b_m (t_2 - t_1)^m \quad \text{for } t \geq t_2 . \quad (6c)$$

Equations (6) for $I(t)$ allow almost any impressed reactivity function to be approximated very closely. For example, the impressed reactivity due to withdrawal of a control rod followed by a scram can be simulated with Eqs. (6). Impressed reactivities containing more than three time zones can be simulated with Eqs. (6) by terminating the first run at the appropriate place and by utilizing the restart feature built into the code. In such a case, the new input for $I(t)$ should be such that $\rho(t)$ is continuous from one run to the next, unless, of course, a discontinuity is desired. In Eqs. (6), the polynomial in t can be omitted by specifying $NA = -1$ and the polynomial in $(t - t_1)$ can be omitted by specifying $NB = -1$. Otherwise, these parameters are restricted to the range $0 \leq NA \leq 9$ and $0 \leq NB \leq 9$.

The feedback function for this option is given by

$$F(t) = F_1(t) + F_2(t) , \quad (7)$$

where

$$F_1(t) = \sum_{j=1}^{JMAX} \sum_{n=1}^{NC_j} \gamma_{jn} [T_j(t) - T_j(t_0)]^n \quad (8)$$

and

$$F_2(t) = \sum_{j=1}^{JMAX} \left[\alpha_j^D / (1 - x_j) \right] \left[T_j^{1-x_j}(t) - T_j^{1-x_j}(t_0) \right] \quad (x_j \neq 1) \quad (9a)$$

$$F_2(t) = \sum_{j=1}^{JMAX} \alpha_j^D \ln[T_j(t)/T_j(t_0)] \quad (x_j = 1) \quad (9b)$$

Let us discuss first how the sum over n in Eq. (8) might arise. If the temperature coefficient, say α_j , for lump j is not a constant, but varies with temperature according to

$$\alpha_j(T_j) = \sum_{n=1}^{NC_j} a_{jn} [T_j(t) - T_j(t_0)]^{n-1},$$

then the feedback, defined by

$$\int_{T_j(t_0)}^{T_j(t)} \alpha_j(T_j) dT_j,$$

is given by

$$\sum_{n=1}^{NC_j} (a_{jn}/n) [T_j(t) - T_j(t_0)]^n,$$

which is equal to the sum over n in Eq. (8) if $Y_{jn} = a_{jn}/n$. The value of NC_j must be within the range $1 \leq NC_j \leq 5$ for each lump j .

Let us now discuss how the term $F_2(t)$ (Eqs. 9) might arise. Assume that the temperature coefficient from Doppler broadening is given by $\alpha_j^D/T_j^{x_j}$ for lump j . The reactivity feedback is then given by

$$c_j^D \int_{T_j(t_0)}^{T_j(t)} dT_j / T_j^{x_j},$$

which yields

$$\left[\alpha_j^D / (1 - x_j) \right] \left[T_j^{1-x_j}(t) - T_j^{1-x_j}(t_0) \right] \quad \text{for } x_j \neq 1$$

and

$$\alpha_j^D \ln[T_j(t)/T_j(t_0)] \quad \text{for } x_j = 1.$$

The term $F_2(t)$ in Eq. (7) can be omitted by specifying the input parameter $ND = 0$. Also, by specifying $JMAX = 0$, the entire function $F(t)$ can be omitted. For this option, $KMAX$, discussed in Sec. III, must be in the range $1 \leq KMAX \leq 4$. If the input value of $KMAX$ is greater than 4, the code resets $KMAX = 4$, and a comment to this effect is printed. The reason for this limitation is discussed in Appendix A.

Reactivity Option 3 (NRHO = 3). For this option, $I(t)$ is given by a nonterminating polynomial in time,

$$I(t) = \sum_{n=0}^{NA} a_n t^n, \quad (10)$$

and $F(t)$ is given by

$$F(t) = \sum_{j=1}^{JMAX} \alpha_j [T_j(t) - T_j(t_0)]^{x_j} \quad (0 < x_j < 1). \quad (11)$$

Equation (10) for $I(t)$ can be omitted from the calculation by specifying $NA = -1$; otherwise, NA must be within the range $0 \leq NA \leq 9$. As in option $NRHO = 2$, $KMAX$ is reset to 4 if the input value is greater than 4.

B. Heat Balance Options

As for the reactivity equations, three options are currently available for the heat balance equations that define the $T_j(t)$. Other options can be incorporated by either expanding or rewriting subroutine `TEMPER`; the main program and other subroutines need not be modified in the process.

Heat Balance Option 1 (NTYPE = 1).* In this option, the heat balance equations are for constant heat removal from each lump, and the heat capacity is expressed as a polynomial in the temperature. That is,

$$C_j(T_j) [dT_j(t)/dt] = Q_j H_N(t) - b_j \quad (j=1,2,\dots,JMAX), \quad (12)$$

* See input specifications, Appendix B.

where

$$C_j(T_j) = \sum_{n=1}^{NHC_j+1} \delta_{jn} [T_j(t) - T_j(t_0)]^{n-1} \quad (j=1,2,\dots,JMAX) \quad (13)$$

In Eqs. (12) and (13),

$T_j(t)$ = temperature ($^{\circ}K$) of lump j ,

$N(t)$ = neutron level,

H = conversion factor (MW) from neutron level to power level, that is, $P(t) = HN(t)$.

Q_j = fraction of the fission energy deposited directly in lump j ,

b_j = constant heat removal term (MW) for lump j ,

$C_j(T_j)$ = heat capacity (MW-sec/ $^{\circ}K$) of lump j ,

δ_{jn} = coefficients of heat capacity polynomial for lump j , and

NHC_j = order of heat capacity polynomial for lump j .

The conversion factor H is specified in the input and can be computed approximately from $H = 1/e\bar{\nu}\Lambda$, where e = MW-sec/fission and $\bar{\nu}$ = average number of neutrons per fission. If the heat capacity of lump j is a constant, then NHC_j should be set equal to zero. For this case, Eq. (13) yields $C_j = \delta_{j1}$. Presently, the value of NHC_j is restricted to the range $0 \leq NHC_j \leq 5$ for all j .

Heat Balance Option 2 (NTYPE = 2). This option is similar to NTYPE = 1, except that heat removal is proportional to the temperature. The heat balance equations are given by

$$C_j(T_j)[dT_j(t)/dt] = Q_j HN(t) - b_j T_j(t) \quad (j=1,2,\dots,JMAX) \quad (14)$$

where $C_j(T_j)$ is given by Eq. (13). The proportionality constant b_j is in units of MW/ $^{\circ}K$. All other quantities are the same as for NTYPE = 1.

Heat Balance Option 3 (NTYPE = 3). In this option, heat transfer is allowed among lumps by conduction (or convection) and/or by radiation, and the heat capacity of each lump can be temperature dependent. The heat balance equations are given by

$$C_j(T_j)[dT_j(t)/dt] = Q_j HN(t) - \sum_k h_c^{j+k} [T_j(t) - T_k(t)] - \sum_k h_r^{j+k} [T_j^4(t) - T_k^4(t)] \quad (j=1,2,\dots,JMAX) \quad (15)$$

where $C_j(T_j)$ is given by Eq. (13). In Eq. (15),

h_c^{j+k} = conductive or convective heat transfer coefficient (MW/ $^{\circ}K$) from lump j to lump k ,

h_r^{j+k} = radiative heat transfer coefficient (MW/ $^{\circ}K^4$) from lump j to lump k ,

and all other quantities have been previously defined. The user can specify the lumps k to which lump j loses heat by either conduction-convection or by radiation. To ensure that heat is conserved, that is, that a heat loss from lump j to lump k appears as an equal heat gain in lump k from lump j , the following equalities must hold.

$$h_c^{j+k} = h_c^{k+j} \quad ,$$

and

$$h_r^{j+k} = h_r^{k+j} \quad .$$

The conduction-convection term can be omitted from Eq. (15) by specifying NCON = 0 in the input. Similarly, the radiation term can be omitted by specifying NRAD = 0 in the input. This option can be specified only if JMAX $\geq$ 2.

III. COMPUTATIONAL METHOD

A. Basic Procedure

The system of coupled first-order differential equations is solved by continuous analytic continuation.¹⁻³ Basically, the method consists of expanding the dependent variables in Taylor series, with a truncation error criterion, over successive intervals on the time axis. The dependent variables must be analytic functions within each interval to assure that the series will converge to the value of the function and to assure that the functions are infinitely differentiable.

The average neutron and delayed neutron precursor levels, when large, and temperatures are analytic functions of time because there are no physical processes in a reactor that can result in discontinuous changes in these variables or their derivatives. Therefore, values of these dependent variables, denoted in general by $y_i(t)$, are determined approximately at time t_{j+1} from

$$y_i(t_{j+1}) = \sum_{k=0}^K \frac{y_i^{(k)}(t_j)(t_{j+1} - t_j)^k}{k!}, \quad (16)$$

where $y_i^{(k)}(t_j)$ denotes the k th derivative of $y_i(t)$ evaluated at $t = t_j$. The order K of the Taylor expansion is specified by input parameter KMAX. Because Eq. (16) requires information only at t_j to obtain a solution at t_{j+1} , the method is self-starting and requires only that the initial values $y_i(0^+)$ be specified. The higher-order derivatives in Eq. (16) are obtained by successive differentiation of Eqs. (1) through (3) and any associated heat balance equations. Expressions for these derivatives are given in Appendix A.

Although $\rho(t)$ is analytic for most problems, it is possible to introduce discontinuities in $\rho(t)$ or some of its derivatives at certain points in the transient through the function $I(t)$. Discontinuities in $\rho(t)$ at $t = 0$, such as a step input of reactivity, are not a problem because the initial conditions are defined at $t = 0^+$. At times other than $t = 0$, discontinuities in $\rho(t)$ (whether deliberate or inadvertent) can be introduced when the restart feature is utilized and the input for $I(t)$ is modified from that used in the previous run. Also, for reactivity option NRHO = 2 [Eqs. (6)], it is possible that some of the derivatives of $\rho(t)$ may be discontinuous at $t = t_1$ and $t = t_2$. For these reasons, the value of $\rho(t_{j+1})$ is obtained explicitly from its defining equation [Eq. (3)] after the values of all the other dependent variables at t_{j+1} have been obtained from their Taylor expansions. This approach requires only that $\rho(t)$ be a piecewise analytic function.

The time steps $t_{j+1} - t_j$ in Eq. (16) are obtained by requiring that the absolute value of the fractional truncation error for each expansion be, at most, equal to an input truncation error

criterion ϵ ,

$$\left| \frac{R_1(t_{j+1})}{y_1(t_{j+1})} \right| \leq \epsilon, \quad (17)$$

for all time steps j and variables y_i for which the expansion is made. $R_1(t_{j+1})$ is the remainder after $K + 1$ terms in the expansion of y_i for the $j+1$ th time step. This remainder is given by

$$R_1(t_{j+1}) = \frac{y_1^{(K+1)}(t_j)(t_{j+1} - t_j)^{K+1}}{(K+1)!}, \quad (18)$$

where

$$y_1^{(K+1)}(t_j) = \frac{y_1^{(K)}(t_{j+1}) - y_1^{(K)}(t_j)}{t_{j+1} - t_j}. \quad (19)$$

By substitution of Eq. (18) into Eq. (17), it is seen that the largest time step that satisfies Eq. (17) for variable y_1 is given by

$$(t_{j+1} - t_j)_1 = \left[\frac{(K+1)! \epsilon |y_1(t_{j+1})|}{|y_1^{(K+1)}(t_j)|} \right]^{\frac{1}{K+1}}. \quad (20)$$

Equation (20) is an analytic criterion for determining the time step. Note that the time step is determined by the truncation error criterion ϵ , the order K of the Taylor expansion, and the behavior of the function $y_1(t)$ in the interval $t_j \leq t \leq t_{j+1}$. For a fixed ϵ , the time step can be increased in most problems by increasing K . However, the running time for any particular problem is usually minimized for K in the range $2 \leq K \leq 4$. This is true because the additional computation required to obtain the higher derivatives eventually offsets the increase in time-step size (Ref. 3). For a fixed K , the time step can be increased by increasing ϵ . For fixed ϵ and K , the time step is largest where the ratio

$$\left| \frac{y_1(t_{j+1})}{y_1^{(K+1)}(t_j)} \right|$$

is a maximum and smallest where this ratio is a minimum. Thus, the time step automatically expands or contracts, depending on the behavior of the function, in order to maintain a constant fractional truncation error.

Because the method requires a common time step for all the dependent variables that are expanded in Taylor series and because the time step computed from Eq. (20) is different for each variable, a common time step must be computed from the variable, say $y_m(t)$, which yields the smallest time step. The use of $y_m(t)$ in Eq. (20) to compute a common time step will guarantee that all the dependent variables will satisfy Eq. (17). Periodic tests are made in the code to determine which of the dependent variables is to be used to compute the common time step. Experience has shown that the neutron level $N(t)$ usually places the greatest restriction on the time step.

Because $y_m(t_{j+1})$ and $y_m^{(K+1)}(t_j)$ cannot be calculated until $t_{j+1} - t_j$ is known, an iterative procedure is used to calculate the time step. First, a tentative time step is computed from

$$(t_{j+1} - t_j)_t = \left[\frac{(K+1)!\epsilon |y_m(t_j)|}{|y_m^{(K+1)}(t_j)|} \right]^{\frac{1}{K+1}}. \quad (21)$$

This tentative value is then modified, if necessary, by the following iterative process:

1. Using the tentative value for $t_{j+1} - t_j$, tentative values for $y_m(t_{j+1})$ and its derivatives are computed. Because the equations are coupled, this requires a pass through all the equations in the system for each derivative.
2. $y_m^{(K+1)}(t_j)$ is calculated from Eq. (19), and an improved time step is then computed from Eq. (20).
3. If the improved time step is larger than its tentative value (for this case, the tentative time step yields a smaller truncation error than required) or smaller by a factor not exceeding a preset value, the calculation proceeds to the next time step. If the improved time step does not satisfy these conditions, it becomes the tentative time step and Steps 1 through 3 are repeated until the conditions are satisfied.

Iterations on $t_{j+1} - t_j$, where j is fixed, are referred to as inner iterations, and iterations in which j changes are referred to as outer iterations or time steps. For most problems, inner iterations

are required only in limited portions of the transient, if ϵ is in the range $10^{-6} \leq \epsilon \leq 10^{-5}$. Where they are required, usually one inner iteration is sufficient. Up to 10 inner iterations per outer iteration are allowed in the code. If this number is exceeded, the calculation is terminated, and a comment is printed suggesting that a smaller value of ϵ be used.

A problem that can arise in connection with computing the time step is that $y_m^{(K+1)}(t_j)$ in Eq. (21) may be zero either at the beginning of the transient or at some other point. If this problem occurs at $t = 0$, a tentative time step equal to 10Δ is assigned by the code. If this problem occurs at $t \neq 0$, the time step is tentatively set equal to the previous time step. These tentative time steps are then modified, if necessary, by the inner iteration scheme discussed previously.

The value of ϵ to be used in a calculation depends on the accuracy desired, which, in turn, depends on ϵ and the number of time steps n . In particular, it is shown in Ref. 2 that, to a first-order approximation, the absolute value of the accumulated fractional error $|E_n|$ is given by

$$|E_n| \leq n\epsilon. \quad (22)$$

That is, the accumulated fractional error increases, at most, linearly with the number of time steps. For $K > 1$, accuracy can be increased by decreasing ϵ without causing a proportionate increase in computing time. This situation becomes more favorable with increasing values of K (Ref. 3).

B. Variations of the Basic Procedure

For some types of problems, a straightforward application of the basic procedure is not the most efficient way, from the viewpoint of computing time, to utilize analytic continuation. In these cases, modification of the basic procedure can result in considerable savings in computer time. Two of the variations of the basic procedure discussed in Refs. 2 and 3 were incorporated into the ANCON code.

The first variation, referred to as the prompt-jump approximation, is applicable to slow transients in fast reactors. In particular, this variation is used when the criterion

$$\Lambda[\lambda\rho(t) + d\rho(t)/dt] \ll [\beta - \rho(t)]^2 \quad (23)$$

is satisfied. If more than one delayed neutron group is involved, then λ in Eq. (23) is the effective one-group decay constant. In this variation of the basic procedure, the time steps are limited by the $\theta_i(t)$ or $T_k(t)$ rather than by $N(t)$, thereby allowing much larger time steps than would be allowed by the basic procedure.

The $\theta_i(t)$ or $T_k(t)$ that yields the smallest time step is used in Eq. (20) to compute the time step. Values of $\theta_i(t_{j+1})$ and $T_k(t_{j+1})$ are then obtained as in the basic procedure from Taylor expansions about t_j using this time step. Because this time step is too large to calculate $N(t_{j+1})$ from its Taylor expansion and still retain the desired accuracy, $N(t_{j+1})$ is computed in terms of the $\theta_i(t_{j+1})$ and $\rho(t_{j+1})$. Specifically, if Eq. (23) is satisfied, the derivative in Eq. (1) can be neglected, and $N(t_{j+1})$ is computed from

$$N(t_{j+1}) = \frac{\Lambda \sum_{i=1}^I \lambda_i \theta_i(t_{j+1}) + \Lambda S}{\beta - \rho(t_{j+1})} \quad (24)$$

The second variation of the basic method included in the code is for the case of constant reactivity with $\rho < \beta$. In this variation, the $\theta_i(t)$ that yields the smallest time step is used in Eq. (20) to compute Δt . Values for $\theta_i(t_{j+1})$ are obtained from Taylor expansions as in the basic procedure and $N(t_{j+1})$ is then computed from

$$N(t_{j+1}) = N(t_j) \exp(\omega \Delta t) + \sum_{i=1}^{IMAX} \lambda_i \sum_{k=0}^K \frac{\theta_i^{(k)}(t_j)}{\omega^{k-1}} \cdot \left\{ \exp(\omega \Delta t) - \left[\frac{(\omega \Delta t)^k}{k!} + \frac{(\omega \Delta t)^{k-1}}{(k-1)!} + \dots + 1 \right] \right\} + \frac{S}{\omega} [\exp(\omega \Delta t) - 1] \quad (25)$$

where $\Delta t = t_{j+1} - t_j$ and $\omega = (\rho - \beta)/\Lambda$. Equation (25), which is developed in Ref. 2, is exact within the accuracy of the Taylor expansions for $\theta_i(t_{j+1})$ and is used for any constant value of $\rho < \beta$ and any value of $\Lambda \neq 0$. Because in this case there is no feedback (ρ is constant), solutions for the $T_k(t)$ are not developed, even if heat balance equations are included in the problem.

For problems in which the two variations of the basic procedure described above are applicable, the time steps can be two or more orders of magnitude larger than those obtained with the basic procedure, with little, if any, sacrifice in accuracy. At the beginning of a problem, the code automatically determines which procedure is to be used. If either the basic procedure or the prompt-jump approximation procedure is selected by the code, automatic switching from one procedure to the other may occur during the course of the transient, depending on the results of periodic tests on Eq. (23).

Because of the occurrence of Λ^{-1} in Eqs. (1) and (2), the higher derivatives of $N(t)$ and $\theta_i(t)$ with respect to t can become very large when Λ is small (Λ can vary from 10^{-3} to 10^{-9} sec). This is a problem only in that the largest floating-point number permissible on some computers is restricted. For example, the largest number permissible on the IBM 7094 computer is only $\approx 10^{38}$. (On the CDC 6600, the largest number permitted is $\approx 10^{322}$.) Therefore, to allow use of the ANCON code on a low-capacity computer, all the equations are solved by the code in terms of the dimensionless independent variable

$$\tau = \Lambda^{-1} t \quad (26)$$

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APPENDIX A

EXPRESSIONS FOR HIGHER-ORDER DERIVATIVES

Analytic continuation requires the computation of derivatives, to order $KMAX + 1$, of the dependent variables at each time point t_j . The establishment of general expressions for these derivatives, where possible, is convenient for solution on a digital computer. In terms of the dimensionless independent variable $\tau = t/\Lambda$, Eqs. (1) through (3) are given by

$$N^{(1)}(\tau) = [\rho(\tau) - \beta] N(\tau) + \Lambda \sum_{i=1}^{IMAX} \lambda_i \theta_i(\tau) + \Lambda S(\tau), \quad (A-1)$$

$$\psi_i^{(1)}(\tau) = \beta_i N(\tau) - \Lambda \lambda_i \theta_i(\tau) \quad (i=1,2,\dots,IMAX), \quad (A-2)$$

$$\rho(\tau) = I(\tau) + F(\tau). \quad (A-3)$$

The Taylor expansion for $y_i(\tau_{j+1})$ and the expression for the time step $\tau_{j+1} - \tau_j$ are identical, respectively, to Eqs. (16) and (20), except that τ_{j+1} is replaced by τ_{j+1} and t_j is replaced by τ_j .

The derivatives of N and θ_i are computed in the main program. By successive differentiation of Eq. (A-1) and the use of mathematical induction, the k th derivative of N is found to be given by

$$N^{(k+1)} = [\rho - \beta] N^{(k)} + \frac{k}{1!} \rho^{(1)} N^{(k-1)} + \frac{k(k-1)}{2!} \rho^{(2)} N^{(k-2)} + \dots + \rho^{(k)} N + \Lambda \sum_{i=1}^{IMAX} \lambda_i \theta_i^{(k)} + \Lambda S^{(k)} \quad (A-4)$$

for $k \geq 0$. In terms of the binomial coefficients defined by

$$B_n^k = \frac{k(k-1)\dots(k-n+1)}{n!} = \frac{k!}{n!(k-n)!}, \quad (A-5)$$

Eq. (A-4) can be expressed in the compact form

$$N^{(k+1)} = [\rho - \beta] N^{(k)} + \sum_{n=1}^k B_n^k \rho^{(n)} N^{(k-n)} + \Lambda \sum_{i=1}^{IMAX} \lambda_i \theta_i^{(k)} + \Lambda S^{(k)}. \quad (A-6)$$

The code presently provides only for a constant source so that $S^{(k)} = 0$ for $k \geq 1$. A source that is an analytic function of time (sinusoidal, exponential, or polynomial) could be easily incorporated by making the proper modifications to the main program. Modifications of the other routines would not be required in the process.

Because Eq. (A-2) is linear, the k th derivative of θ_i can be established by inspection. The result is

$$\theta_i^{(k+1)} = \beta_i N^{(k)} - \Lambda \lambda_i \theta_i^{(k)} \quad (i=1,2,\dots,IMAX) \quad (A-7)$$

for $k \geq 0$.

The derivatives of ρ are computed in subroutine REACT. From Eq. (A-3), the k th derivative of ρ is given formally by

$$\rho^{(k)} = I^{(k)} + F^{(k)}. \quad (A-8)$$

To proceed further, particular forms for the functions I and F must be considered. The forms considered are those included as options in the code. Other options can be incorporated by either expanding or rewriting subroutine REACT.

Reactivity Option 1 (NRHO = 1). For this option, the equations for $I(t)$ and $F(t)$ are given by Eqs. (4) and (5). The derivatives of I with respect to τ are given by

$$I^{(2k)} = (-1)^k (\Lambda\omega)^{2k} a_1 \sin(\omega\tau) \quad (\text{even derivatives})$$

$$I^{(2k-1)} = (-1)^{k+1} (\Lambda\omega)^{2k-1} a_1 \cos(\omega\tau) \quad (\text{odd derivatives}) \quad (A-9)$$

and those for F are given by

$$F^{(k)} = \sum_{j=1}^{JMAX} \alpha_j T_j^{(k)} \quad (A-10)$$

for $k \geq 1$. In Eq. (A-10), $T_j^{(k)}$ is the kth derivative of T_j with respect to τ . The derivatives of T_j are obtained from the heat balance equations as described below.

Reactivity Option 2 (NRHO = 2). For this option, the function I is given by Eqs. (6). The derivatives of I with respect to τ are, for $t_0 \leq \tau < t_1$,

$$I^{(k)} = A^k \sum_{n=k}^{NA} \frac{n!}{(n-k)!} a_n \tau^{n-k} \quad (k \leq NA)$$

$$I^{(k)} = 0 \quad (k > NA) \quad (A-11)$$

For $t_1 \leq \tau < t_2$, the derivatives are

$$I^{(k)} = A^k \sum_{m=k}^{NB} \frac{m!}{(m-k)!} b_m (\tau - t_1)^{m-k} \quad (k \leq NB)$$

$$I^{(k)} = 0 \quad (k > NB) \quad (A-12)$$

and for $\tau \geq t_2$, the derivatives are

$$I^{(k)} = 0 \quad (k \geq 1) \quad (A-13)$$

The feedback function for this option is given by Eqs. (7) through (9). Because it is not possible to establish a general expression for the kth derivative of F in this case, the order of the Taylor expansion is restricted to $1 \leq KMAX \leq 4$. If a value larger than 4 is specified in the input, the code sets $KMAX = 4$, and a comment to this effect is printed. The limitation to $KMAX \leq 4$ is not a serious restriction because the running time is usually minimized for $KMAX \leq 4$.

For purposes of illustrating how the derivatives of F are obtained, it is sufficient to consider a single lump. Therefore, the subscript j is omitted in the following development.

The first five derivatives of F are expressed in the form

$$F^{(1)} = T^{(1)} \frac{\partial F}{\partial T}$$

$$F^{(2)} = T^{(2)} \frac{\partial F}{\partial T} + [T^{(1)}]^2 \frac{\partial^2 F}{\partial T^2}$$

$$F^{(3)} = T^{(3)} \frac{\partial F}{\partial T} + 3T^{(1)}T^{(2)} \frac{\partial^2 F}{\partial T^2} + [T^{(1)}]^3 \frac{\partial^3 F}{\partial T^3}$$

$$F^{(4)} = T^{(4)} \frac{\partial F}{\partial T} + \{4T^{(1)}T^{(3)} + 3[T^{(2)}]^2\} \frac{\partial^2 F}{\partial T^2} + 6[T^{(1)}]^2 T^{(2)} \frac{\partial^3 F}{\partial T^3} + [T^{(1)}]^4 \frac{\partial^4 F}{\partial T^4}$$

$$F^{(5)} = T^{(5)} \frac{\partial F}{\partial T} + [5T^{(1)}T^{(4)} + 10T^{(2)}T^{(3)}] \frac{\partial^2 F}{\partial T^2} + \{10[T^{(1)}]^2 T^{(3)} + 15T^{(1)}[T^{(2)}]^2\} \frac{\partial^3 F}{\partial T^3} + 10[T^{(1)}]^3 T^{(2)} \frac{\partial^4 F}{\partial T^4} + [T^{(1)}]^5 \frac{\partial^5 F}{\partial T^5} \quad (A-14)$$

where $F^{(k)} = d^k F / d\tau^k$ and $T^{(k)} = d^k T / d\tau^k$. The coefficients of the partial derivatives in Eqs. (A-14) are computed in subroutine SUPONE. However, the individual $T^{(k)}$ are computed from the heat balance equations as described below. Referring to Eq. (7), we see that

$$\frac{\partial F}{\partial T^k} = \frac{\partial F_1}{\partial T^k} + \frac{\partial F_2}{\partial T^k} \quad (A-15)$$

From Eq. (8), we find

$$\frac{\partial F_1}{\partial T^k} = \sum_{n=k}^{NC} \frac{n!}{(n-k)!} \gamma_n [T - T_0]^{n-k} \quad (k \leq NC)$$

$$\frac{\partial F_1}{\partial T^k} = 0 \quad (k > NC) \quad (A-16)$$

where T_0 is the initial temperature. The partial derivatives of F_2 are obtained from Eqs. (9). For $x \neq 1$ (Eq. 9a), we find

$$\frac{\partial F_2}{\partial T} = \alpha^D T^{-x}$$

$$\frac{\partial F_2}{\partial T^k} = (-1)^{k+1} x(x+1)\dots(x+k-2) \alpha^D T^{-(x+k-1)} \quad (k \geq 2) \quad (A-17)$$

and for $x = 1$ (Eq. 9b), we find

$$\frac{\partial^k F}{\partial T^k} = (-1)^{k+1} (k-1)! \alpha^D T^{-k} \quad (k \geq 1) \quad (A-18)$$

Reactivity Option 3 (NRHO = 3). For this option, the derivatives with respect to τ of the function I (Eq. 10) are given by

$$I^{(k)} = \Lambda^k \sum_{n=k}^{NA} \frac{n!}{(n-k)!} a_n \tau^{n-k} \quad (k \leq NA)$$

$$I^{(k)} = 0 \quad (k > NA). \quad (A-19)$$

As was the case for NRHO = 2, the value of KMAX is reset to 4 if the input value is greater and the derivatives of F are expressed by Eqs. (A-14). The partial derivatives of F with respect to T are obtained from Eq. (11). The results are

$$\frac{\partial^k F}{\partial T^k} = x(x-1)\dots(x-k+1) \alpha [T - T_0]^{x-k} \quad (k \geq 1), \quad (A-20)$$

where T_0 is the initial temperature.

Derivatives of the temperature are computed from the heat balance equations in subroutine TEMPER. The three types of heat balance equations considered below are presently included as options in the code. Other options can be incorporated by either expanding or rewriting subroutine TEMPER. In the following equations, the lump index has been omitted, except where it is required to avoid ambiguity.

Heat Balance Option 1 (NTYPE = 1). The heat balance equation [Eq. (12)] for this option is given by

$$CT^{(1)} = Q_{HN} - b, \quad (A-21)$$

where C is given by Eq. (13). The first derivative of T is computed directly from Eq. (A-21), and the higher derivatives are established by successive differentiation of this equation. The results for

the higher derivatives are

$$T^{(k)} = \frac{1}{C} \left[Q_{HN}^{(k-1)} - \sum_{n=1}^k B_n^k C^{(n)} T^{(k-n)} \right] \quad (k \geq 2), \quad (A-22)$$

where B_n^k is defined by Eq. (A-5) and $C^{(n)} = d^n C / dt^n$. The derivatives $C^{(n)}$ are expressed by equations identical to Eqs. (A-14), with F replaced by C. From Eq. (13), the partial derivatives of C with respect to T are

$$\frac{\partial^k C}{\partial T^k} = \sum_{n=k+1}^{NHC+1} \frac{(n-1)!}{(n-k-1)!} \delta_n (T - T_0)^{n-k-1} \quad (k \leq NHC)$$

$$\frac{\partial^k C}{\partial T^k} = 0 \quad (k > NHC), \quad (A-23)$$

where T_0 is the initial temperature.

Heat Balance Option 2 (NTYPE = 2). The heat balance equation [Eq. (14)] for this case is

$$CT^{(1)} = Q_{HN} - bT, \quad (A-24)$$

where C is given by Eq. (13). The first derivative of T is obtained by solving for $T^{(1)}$ in Eq. (A-24). Higher derivatives of T, obtained by successive differentiation of Eq. (A-24), are given by

$$T^{(k)} = \frac{1}{C} \left[Q_{HN}^{(k-1)} - bT^{(k-1)} - \sum_{n=1}^k B_n^k C^{(n)} T^{(k-n)} \right] \quad (k \geq 2), \quad (A-25)$$

where the $C^{(n)}$ are obtained in the same manner as for NTYPE = 1, and the B_n^k are given by Eq. (A-5).

Heat Balance Option 3 (NTYPE = 3). If we let $Y = T^4$, the heat balance equation [Eq. (15)] for this case is given by

$$C_j T_j^{(1)} = Q_{jHN} - \sum_i h_c^{j \rightarrow i} (T_j - T_i) - \sum_i h_r^{j \rightarrow i} (Y_j - Y_i), \quad (A-26)$$

The first derivative of T_j is obtained by solving for $T_j^{(1)}$ in Eq. (A-26). Higher derivatives of T_j are established by successive differentiation of Eq. (A-26). The results are

$$T_j^{(k)} = \frac{1}{C_j} \left\{ Q_j H^{(k-1)} - \sum_{n=1}^k B_n^k C_j^{(n)} T_j^{(k-n)} \right. \\ \left. - \sum_i h_c^{j+i} [T_j^{(k-1)} - T_i^{(k-1)}] \right. \\ \left. - \sum_i h_r^{j+i} [Y_j^{(k-1)} - Y_i^{(k-1)}] \right\} \\ (k \geq 2) , \quad (A-27)$$

where the $C_j^{(n)}$ are obtained in the same manner as for $NTYPE = 1$ and the B_n^k are given by Eq. (A-5). If we let $X = T^2$ so that $Y = X^2$, the derivatives of Y can be obtained from

$$Y^{(k)} = XX^{(k)} + \sum_{n=1}^k B_n^k X^{(n)} X^{(k-n)} \quad (k \geq 1) , \quad (A-28)$$

where

$$X^{(k)} = TT^{(k)} + \sum_{n=1}^k B_n^k T^{(n)} T^{(k-n)} \quad (k \geq 1) . \quad (A-29)$$

APPENDIX B

INPUT SPECIFICATIONS

Input specifications for the ANCON code are described in the following pages. The input is divided into four blocks of data and should be input in the order:

- Block 1: Control Data
- Block 2: Reactivity Equation Data
- Block 3: Heat Balance Equation Data
- Block 4: Restart Dump Data.

Blocks 1 and 2 are always required, Block 3 is required if thermal feedback is desired, and Block 4 is required if the problem is a continuation of a previous run. Block 4 data in the proper format is always punched by the code at the end of every successful run.

The input data are edited by the code to ensure that various parameters are within the ranges allowed.

CONTROL DATA (Required)

<u>Word</u>	<u>Variable</u>	<u>Format</u>	<u>Comments</u>
<u>Card 1 (required)</u>			
All	AL(I)	12A6	Problem identification card that may contain any alphanumeric characters desired.
<u>Card 2 (required)</u>			
1	KMAX	I6	Order of Taylor expansion ($1 \leq KMAX \leq 10$). For most problems, $KMAX = 3$ or $KMAX = 4$ will minimize the running time.
2	IMAX	I6	Number of delayed neutron groups ($0 \leq IMAX \leq 6$).
3	NEW	I6	0/1 = new problem/continuation of a previous run. If $NEW = 1$, a restart dump must be included in the input.
4	NRHO	I6	Reactivity equation option (1, 2, or 3). See Sec. II.
5	NMAX	I6	Maximum number of time points for which values of variables will be printed.
6	NSAVE	I6	1/0 = save printed output on TAPE1/no. If $NSAVE = 1$, the values of the variables printed out at the various time points are also written onto logical unit TAPE1.

<u>Word</u>	<u>Variable</u>	<u>Format</u>	<u>Comments</u>
7	NEQUI	I6	1/0 = read initial values for delayed neutron precursors/compute initial values from equilibrium condition. The equilibrium condition is $\theta_1 = \beta_1 N / \Lambda \lambda_1$.
8	NPREC	I6	1/0 = precursor level output desired/no.
9	NTEMP	I6	1/0 = temperature output desired/no.
<u>Card 3 (required)</u>			
1	E	E12.5	Epsilon truncation error criterion. Recommended value: $0.000001 \leq E \leq 0.0001$.
2	DEL1	E12.5	Percent change in neutron level $N(t)$ before current values of variables are printed. Recommended value: $5 \leq \text{DEL1} \leq 20$.
3	TIMEST	E12.5	Time (sec) in the transient at which the calculation is terminated.
4	ANMAX	E12.5	Maximum number of outer iterations or time steps. ANMAX = 100,000 is sufficient for most problems.
5	G	E12.5	Prompt neutron generation time Λ (sec).
6	S	E12.5	External source strength (neutrons/sec).
<u>Card 4 (required)</u>			
1	PWRCON	E12.5	Conversion factor (MW) from neutron level $N(t)$ to power level $P(t)$. $\text{PWRCON} = 1/e\bar{\nu}\Lambda$ where e = MW-sec/fission, $\bar{\nu}$ = average number of neutrons per fission.
2	FO	E12.5	Initial value of neutron level $N(t_0)$.
3	TBEG	E12.5	Starting time t_0 (sec). Usually TBEG = 0.
4	POWINT	E12.5	Energy (W-sec) at $t = t_0$. Usually POWINT = 0.
<u>Card 5 (required if IMAX > 0)</u>			
1	B(1)	E12.5	Delayed neutron fraction β_1 for $i = 1$.
2	DC(1)	E12.5	Decay constant λ_1 (1/sec) for $i = 1$.
.	.	.	.
.	.	.	.
2*IMAX-1	B(IMAX)	E12.5	β_1 for $i = \text{IMAX}$.
2*IMAX	DC(IMAX)	E12.5	λ_1 for $i = \text{IMAX}$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 6 (required if IMAX > 0 and NEQUI = 1)</u>			
1	CO(1)	E12.5	Initial precursor level $\theta_1(t_0)$ for $i = 1$.
.	.	.	.
.	.	.	.
.	.	.	.
IMAX	CO(IMAX)	E12.5	$\theta_1(t_0)$ for $i = \text{IMAX}$.

REACTIVITY EQUATION DATA

(One Option Required)

Word	Variable	Format	Comments
<u>Reactivity Option 1 (required if NRHO = 1)</u>			
<u>Card 1 (required)</u>			
1	JMAX	I6	Total number of heat balance equations or lumps ($0 \leq JMAX \leq 56$).
2	NTYPE	I6	Type of heat balance equations (1, 2, or 3). See Sec. II.
<u>Card 2 (required)</u>			
1	A0	E12.5	Constant a_0 ($\Delta k/k$) in impressed reactivity term.
2	A1	E12.5	Amplitude a_1 ($\Delta k/k$) of sinusoidal term.
3	W	E12.5	Angular frequency ω (rad/sec) of sinusoidal term.
<u>Card 3 (required if JMAX > 0)</u>			
1	TC(1)	E12.5	Temperature coefficient of reactivity α_j ($\Delta k/k$ per $^{\circ}K$) for lump $j = 1$.
.	.	.	
.	.	.	
JMAX	TC(JMAX)	E12.5	α_j for lump $j = JMAX$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Reactivity Option 2 (required if NRHO = 2)</u>			
<u>Card 1 (required)</u>			
1	JMAX	I6	See Card 1 for Reactivity Option 1 (NRHO = 1).
2	NTYPE	I6	See Card 1 for Reactivity Option 1 (NRHO = 1).
3	NA	I6	Order of polynomial in t . Set NA = -1 to omit this polynomial, otherwise $0 \leq NA \leq 9$.
4	NB	I6	Order of polynomial in $(t - t_1)$. Set NB = -1 to omit this polynomial, otherwise $0 \leq NB \leq 9$.
5	ND	I6	1/0 = Doppler feedback terms to be included/no.
<u>Card 2 (required)</u>			
1	T1	E12.5	Time t_1 (sec) at which polynomial in t is terminated, and polynomial in $(t - t_1)$ begins. $t_1 > t_0$ but is not used if both NA = -1 and NB = -1.
2	T2	E12.5	Time t_2 (sec) at which polynomial in $(t - t_1)$ is terminated. $t_2 > t_1$ but is not used if NB = -1.
<u>Card 3 (required if NA $\geq$ 0)</u>			
1	AN(1)	E12.5	Coefficient a_n of polynomial in t for $n = 0$.
.	.	.	
.	.	.	
NA+1	AN(NA+1)	E12.5	a_n for $n = NA$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 4 (required if NB $\geq$ 0)</u>			
1	BN(1)	E12.5	Coefficient b_m of polynomial in $(t - t_1)$ for $m = 0$.
.	.	.	
.	.	.	
NB+1	BN(NB+1)	E12.5	b_m for $m = NB$.
NOTE: Use as many cards as needed (6 words per card).			

<u>Word</u>	<u>Variable</u>	<u>Format</u>	<u>Comments</u>
<u>Reactivity Option 2 (cont)</u>			
<u>Card 5 (required if JMAX > 0)</u>			
1	NC(1)	I6	Number of terms NC_j in feedback polynomial for lump $j = 1$. $1 \leq NC_j \leq 5$ for all j .
.	.	.	
JMAX	NC(JMAX)	I6	NC_j for lump $j = JMAX$.
NOTE: Use as many cards as needed (12 words per card).			
<u>Card 6 (required if JMAX > 0)</u>			
1	GAMMA(J,1)	E12.5	Coefficient γ_{jn} of feedback polynomial for lump $j = J$ and $n = 1$.
.	.	.	
NC(J)	GAMMA(J,NC(J))	E12.5	γ_{jn} for lump $j = J$ and $n = NC(J)$.
NOTE: This data is input first for $J = 1$, then $J = 2$, and so on up to $J = JMAX$. The data for each J must begin on a new card.			
<u>Card 7 (required if ND = 1)</u>			
1	DOPCO(1)	E12.5	Doppler coefficient α_j^D ($\Delta k/k$) for lump $j = 1$.
2	X(1)	E12.5	Exponent x_j of T_j in Doppler feedback for lump $j = 1$.
.	.	.	
2*JMAX-1	DOPCO(JMAX)	E12.5	α_j^D for lump $j = JMAX$.
2*JMAX	X(JMAX)	E12.5	x_j for lump $j = JMAX$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Reactivity Option 3 (required if NRHO = 3)</u>			
<u>Card 1 (required)</u>			
1	JMAX	I6	See Card 1 for Reactivity Option 1 (NRHO = 1).
2	NTYPE	I6	See Card 1 for Reactivity Option 1 (NRHO = 1).
3	NA	I6	Order of polynomial term in t . Set $NA = -1$ if this polynomial is to be omitted, otherwise $0 \leq NA \leq 9$.
<u>Card 2 (required if NA $\geq$ 0)</u>			
1	AN(1)	E12.5	Coefficient a_n for $n = 0$.
.	.	.	
NA+1	AN(NA+1)	E12.5	a_n for $n = NA$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 3 (required if JMAX > 0)</u>			
1	X(1)	E12.5	Exponent x_j of feedback term for lump $j = 1$. $0 < X(J) < 1$ for all J .
.	.	.	
JMAX	X(JMAX)	E12.5	x_j for lump $j = JMAX$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 4 (required if JMAX > 0)</u>			
1	TC(1)	E12.5	Temperature coefficient α_j ($\Delta k/k$ per $^{\circ}K$) for lump $j = 1$.
.	.	.	
JMAX	TC(JMAX)	E12.5	α_j for lump $j = JMAX$.
NOTE: Use as many cards as needed (6 words per card).			

HEAT BALANCE EQUATION DATA
(One Option Required if JMAX > 0)

Word	Variable	Format	Comments
------	----------	--------	----------

Heat Balance Option 1 (required if NTYP = 1)

Card 1 (required)

1	TO(1)	E12.5	Initial temperature $T_j(t_0)$ ($^{\circ}$ K) for lump $j = 1$.
2	Q(1)	E12.5	Fraction Q_j of fission energy deposited in lump $j = 1$.
3	B(1)	E12.5	Heat removal constant b_j (MW) for lump $j = 1$.
:	:	:	
:	:	:	
3*JMAX-2	TO(JMAX)	E12.5	$T_j(t_0)$ for lump $j = JMAX$.
3*JMAX-1	Q(JMAX)	E12.5	Q_j for lump $j = JMAX$.
3*JMAX	B(JMAX)	E12.5	b_j for lump $j = JMAX$.

NOTE: Use as many cards as needed (6 words per card).

Card 2 (required)

1	NHC(1)	I6	Order of heat capacity polynomial for lump 1. $0 \leq NHC(J) \leq 5$ for all J.
:	:	:	
:	:	:	
JMAX	NHC(JMAX)	I6	Order of heat capacity polynomial for lump JMAX.

NOTE: Use as many cards as needed (12 words per card).

Card 3 (required)

1	DELTA(J,1)	E12.5	Coefficients δ_{jn} of heat capacity polynomial for lump $j = J$ and $n = 1$. Heat capacity is in units of MW-sec/ $^{\circ}$ K.
:	:	:	
:	:	:	
:	:	:	
NHC(J)+1	DELTA(J,NHC(J)+1)	E12.5	δ_{jn} for lump J and $n = NHC(J)+1$.

NOTE: This data is input first for $J = 1$, then $J = 2$, and so on up to $J = JMAX$. The data for each J must begin on a new card.

Heat Balance Option 2 (required if NTYP = 2)

Card 1 (required)

1	TO(1)	E12.5	See Card 1 for Heat Balance Option 1.
2	Q(1)	E12.5	See Card 1 for Heat Balance Option 1.
3	B(1)	E12.5	Proportionality constant b_j (MW/ $^{\circ}$ K) for lump $j = 1$.
:	:	:	
:	:	:	
3*JMAX-2	TO(JMAX)	E12.5	See Card 1 for Heat Balance Option 1.
3*JMAX-1	Q(JMAX)	E12.5	See Card 1 for Heat Balance Option 1.
3*JMAX	B(JMAX)	E12.5	b_j for lump $j = JMAX$.

NOTE: Use as many cards as needed (6 words per card).

Card 2 (required)

1	NHC(1)	I6	See Card 2 for Heat Balance Option 1.
:	:	:	
:	:	:	
:	:	:	
JMAX	NHC(JMAX)		See Card 2 for Heat Balance Option 1.

NOTE: Use as many cards as needed (12 words per card).

<u>Word</u>	<u>Variable</u>	<u>Format</u>	<u>Comments</u>
<u>Heat Balance Option 2 (cont)</u>			
<u>Card 3 (required)</u>			
1	DELTA(J,1)	E12.5	See Card 3 for Heat Balance Option 1.
.	.	.	
.	.	.	
.	.	.	
NHC(J)+1	DELTA (J,NHC(J)+1)	E12.5	See Card 3 for Heat Balance Option 1.
NOTE: This data is input first for J = 1, then J = 2, and so on up to J = JMAX. The data for each J must begin on a new card.			
<u>Heat Balance Option 3 (required if NTYPE = 3)</u>			
NOTE: This option can be specified only if JMAX $\geq$ 2.			
<u>Card 1 (required)</u>			
1	NCON	I6	1/0 = conduction-convection terms included/no.
2	NRAD	I6	1/0 = radiation terms included/no.
<u>Card 2 (required)</u>			
1	TO(1)	E12.5	See Card 1 for Heat Balance Option 1.
2	Q(1)	E12.5	See Card 1 for Heat Balance Option 1.
.	.	.	
.	.	.	
2*JMAX-1	TO(JMAX)	E12.5	See Card 1 for Heat Balance Option 1.
2*JMAX	Q(JMAX)	E12.5	See Card 1 for Heat Balance Option 1.
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 3 (required if NCON = 1)</u>			
1	NLPSC(1)	I6	Total number of lumps to which lump 1 is coupled by conduction-convection.
.	.	.	
.	.	.	
.	.	.	
JMAX	NLPSC(JMAX)	I6	Total number of lumps to which lump JMAX is coupled by conduction-convection. $0 \leq \text{NLPSC}(J) \leq \text{JMAX}-1$ for all J.
NOTE: Use as many cards as needed (12 words per card).			
NOTE: Input Cards 4 and 5 first for J = 1, then for J = 2, and so on up to J = JMAX.			
<u>Card 4 (required if NCON = 1 and NLPSC(J) > 0)</u>			
1	NIDC(J,1)	I6	Identification number of first lump to which lump J is coupled by conduction-convection.
.	.	.	
.	.	.	
.	.	.	
NLPSC(J)	NIDC (J,NLPSC(J))	I6	Identification number of NLPSC(J)th lump to which lump J is coupled by conduction-convection.
NOTE: Use as many cards as needed (12 words per card).			
<u>Card 5 (required if NCON = 1 and NLPSC(J) > 0)</u>			
1	HC(J,1)	E12.5	Conductive-convective heat transfer coefficient h_c^{j+k} (MW/°K) from lump j = J to lump k = NIDC(J,1).
.	.	.	
.	.	.	
.	.	.	
NLPSC(J)	HC (J,NLPSC(J))	E12.5	h_c^{j+k} from lump j = J to lump k = NIDC(J,NLPSC(J)).
NOTE: Use as many cards as needed (6 words per card).			

Word	Variable	Format	Comments
<u>Heat Balance Option 3 (cont)</u>			
<u>Card 6 (required if NRAD = 1)</u>			
1	NLPSR(1)	I6	Total number of lumps to which lump 1 is coupled by radiation.
.	.	.	
.	.	.	
JMAX	NLPSR(JMAX)	I6	Total number of lumps to which lump JMAX is coupled by radiation. $0 \leq \text{NLPSR}(J) \leq \text{JMAX}-1$ for all J.
NOTE: Use as many cards as needed (12 words per card).			
NOTE: Input Cards 7 and 8 first for J = 1, then for J = 2, and so on up to J = JMAX.			
<u>Card 7 (required if NRAD = 1 and NLPSR(J) > 0)</u>			
1	NIDR(J,1)	I6	Identification number of first lump to which lump J is coupled by radiation.
.	.	.	
.	.	.	
NLPSR(J)	NIDR(J,NLPSR(J))	I6	Identification number of NLPSR(J)th lump to which lump J is coupled by radiation.
NOTE: Use as many cards as needed (12 words per card).			
<u>Card 8 (required if NRAD = 1 and NLPSR(J) > 0)</u>			
1	HR(J,1)	E12.5	Radiative heat transfer coefficient $h_r^{j \rightarrow k}$ (MW/°K ⁴) from lump j = J to lump k = NIDR(J,1).
.	.	.	
.	.	.	
NLPSR(J)	HR(J,NLPSR(J))	E12.5	$h_r^{j \rightarrow k}$ from lump j = J to lump k = NIDR(J,NLPSR(J)).
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 9 (required)</u>			
1	NHC(1)	I6	See Card 2 for Heat Balance Option 1.
.	.	.	
.	.	.	
JMAX	NHC(JMAX)	I6	See Card 2 for Heat Balance Option 1.
NOTE: Use as many cards as needed (12 words per card).			
<u>Card 10 (required)</u>			
1	DELTA(J,1)	E12.5	See Card 3 for Heat Balance Option 1.
.	.	.	
.	.	.	
NHC(J)+1	DELTA(J,NHC(J)+1)	E12.5	See Card 3 for Heat Balance Option 1.
NOTE: This data is input first for J = 1, then for J = 2, and so on up to J = JMAX. The data for each J must begin on a new card.			

RESTART DUMP DATA
(Required if NEW = 1)

<u>Word</u>	<u>Variable</u>	<u>Format</u>	<u>Comments</u>
<u>Card 1 (required)</u>			
1	TIME	E12.5	Time (sec) at which the previous run was terminated.
2	DELTAT	E12.5	Time step Δt (sec) at $t = \text{TIME}$.
3	POWINT	E12.5	Energy release (W-sec) up to $t = \text{TIME}$.
4	AJ	E12.5	Number of outer iterations (time steps) up to $t = \text{TIME}$.
5	BJ	E12.5	Number of inner iterations required at $t = \text{TIME}$.
<u>Card 2 (required)</u>			
1	F(1)	E12.5	Neutron level $N(t)$ at $t = \text{TIME}$.
2	F(2)	E12.5	First derivative of $N(t)$ at $t = \text{TIME}$.
.	.	.	.
.	.	.	.
KMAX+2	F(KMAX+2)	E12.5	KMAX+1th derivative of $N(t)$ at $t = \text{TIME}$.
KMAX+3	RHO(1)	E12.5	Total reactivity $\rho(t)$ ($\Delta k/k$) at $t = \text{TIME}$.
KMAX+4	RHO(2)	E12.5	First derivative of $\rho(t)$ at $t = \text{TIME}$.
.	.	.	.
.	.	.	.
2*(KMAX+2)	RHO(KMAX+2)	E12.5	KMAX+1th derivative of $\rho(t)$ at $t = \text{TIME}$.
NOTE: Use as many cards as needed (6 words per card).			
<u>Card 3 (required if IMAX > 0)</u>			
1	C(1,1)	E12.5	Delayed neutron precursor level $\theta_1(t)$ for $t = \text{TIME}$ and $i = 1$.
.	.	.	.
.	.	.	.
IMAX	C(1,IMAX)	E12.5	$\theta_1(t)$ for $t = \text{TIME}$ and $i = \text{IMAX}$.
IMAX+1	C(2,1)	E12.5	First derivative of $\theta_1(t)$ for $t = \text{TIME}$ and $i = 1$.
.	.	.	.
.	.	.	.
2*IMAX	C(2,IMAX)	E12.5	First derivative of $\theta_1(t)$ for $t = \text{TIME}$ and $i = \text{IMAX}$.
.	.	.	.
.	.	.	.
(KMAX+1)*IMAX+1	C(KMAX+2,1)	E12.5	KMAX+1th derivative of $\theta_1(t)$ for $t = \text{TIME}$ and $i = 1$.
.	.	.	.
.	.	.	.
(KMAX+2)*IMAX	C(KMAX+2,IMAX)	E12.5	KMAX+1th derivative of $\theta_1(t)$ for $t = \text{TIME}$ and $i = \text{IMAX}$.
NOTE: Use as many cards as needed (6 words per card).			

Word	Variable	Format	Comments
Card 4 (required if JMAX > 0)			
1	T(1,1)	E12.5	Temperature $T_j(t)$ ($^{\circ}$ K) for lump $j = 1$ and $t = \text{TIME}$.
.	.	.	.
JMAX	T(1,JMAX)	E12.5	$T_j(t)$ for lump $j = \text{JMAX}$ and $t = \text{TIME}$.
JMAX+1	T(2,1)	E12.5	First derivative of $T_j(t)$ for lump $j = 1$ and $t = \text{TIME}$.
.	.	.	.
2*JMAX	T(2,JMAX)	E12.5	First derivative of $T_j(t)$ for lump $j = \text{JMAX}$ and $t = \text{TIME}$.
.	.	.	.
(KMAX+1)*JMAX+1	T(KMAX+2,1)	E12.5	KMAX+1th derivative of $T_j(t)$ for lump $j = 1$ and $t = \text{TIME}$.
.	.	.	.
(KMAX+2)*JMAX	T(KMAX+2,JMAX)	E12.5	KMAX+1th derivative of $T_j(t)$ for lump $j = \text{JMAX}$ and $t = \text{TIME}$.
NOTE: Use as many cards as needed (6 words per card).			

APPENDIX C

CODE ORGANIZATION AND STORAGE REQUIREMENTS

As shown in Fig. C-1, the ANCON code consists of a main program and three subroutines (system subroutines are not shown). In addition to controlling the overall flow of the problem, the main program includes the outer and inner iteration loops for the basic method and its two variations. The derivatives of N and θ_i , the time step, and the Taylor expansions are computed in the main program. The main program also reads, edits, and prints the control data, reads and punches the restart dump data, and prints the solution to the problem. Subroutine REACT is called several times during each time step by the main program.

Subroutine REACT reads, edits, and prints the reactivity equation data, computes ρ and its derivatives when they are required by the main program, and calls on subroutine TEMPER. Subroutine TEMPER reads, edits, and prints the heat balance equation data, and computes the derivatives of the T_j when they are required by subroutine REACT. Both REACT and TEMPER call on subroutine SUBONE, which computes the coefficients of the partial derivatives in Eqs. (A-14).

Fig. C-1. Code organization.

At present, the code allows only a constant external neutron source. However, by writing a SOURCE subroutine, which would have a structure similar to the REACT subroutine, various source options could be incorporated. The function of the SOURCE subroutine would be to read the source equation data and to compute S and its derivatives when required by the main program. A few modifications would be required in the main program, including calls to SOURCE at the appropriate places.

In its present form, ANCON requires at least 32,000₁₀ words of central memory. Peripheral storage devices are not used if NSAVE = 0. If NSAVE = 1, the code requires one logical unit which may be either a tape unit or a disk file. The usual I/O

devices (card reader, printer, and card punch) are required. Standard system library functions, including a CLOCK routine, are also required. However, the CLOCK routine is not essential, and calls to CLOCK may be deleted from the program.

APPENDIX D

EXECUTED SAMPLE PROBLEM

Input data and computer output for a sample problem are given in the following pages. The sample problem contains four lumps and six delayed neutron groups. Reactivity equation option NRHO = 2 and heat balance equations option NTYPE = 3 are used in the problem. The impressed reactivity is a third-order terminating polynomial (final reactivity insertion is 60¢) and the thermal feedback is a linear function of temperature. The heat balance equations include heat transfer by conduction-convection and radiation between lumps 1 and 2 and from lump 3 to lump 4. Lump 4 is an infinite heat sink, that is, a constant temperature lump. The heat capacities of lumps 1 through 3 are fifth-order polynomials in the temperature.

The first section of output is a listing of the input data. This is followed by a listing of the starting values of the various dependent variables and their derivatives (up to order KMAX+1). The main section of output, which contains the solution to the problem, then follows. This section lists the following information at each time point.

<u>Variable</u>	<u>Description</u>
t	Time (sec),
N(t)/N(t ₀)	Normalized neutron level,
P(t)	Power (W),
E(t)	Energy release (W-sec),
ρ(t)	Total reactivity (Δk/k),
α(t)	Inverse reactor period (sec ⁻¹),
Δt	Current time step (sec),

<u>Variable</u>	<u>Description</u>
AJ	Current number of outer iterations (time steps),
BJ	Number of inner iterations for the current outer iteration,
$\theta_i(t)/\theta_i(t_0)$ (i=1,...,IMAX)	Normalized delayed neutron precursor levels (This output is optional and was omitted in the sample problem.), and
$T_j(t)$ (j=1,...,JMAX)	Temperatures (°K) of the various lumps. (This output is also optional and was called for in the sample problem.)

The frequency at which the above variables are printed is controlled mainly with input parameter DEL1. Regardless of the value of DEL1, however, the variables are printed if the elapsed time from the last time point printed is greater than (TIMEST-TBEG)/200. If NSAVE = 1, all the information printed in the main output section is also written on TAPE1. If a magnetic tape is not assigned to TAPE1, then TAPE1 is a disk file. From TAPE1, the user can make plots by using his own plotting code.

Following the main output section, ANCON prints and punches the restart dump. The restart dump contains all the necessary information to allow continuation of the problem in a subsequent run. Finally, the running time (min) for the problem and the number of time points at which the solution was printed are given. The running time depends on the number of equations in the system, the type of reactivity feedback and heat balance equations, ρ(t), λ, and the time (TIMEST) at which the transient is terminated. Most problems that have been run with ANCON required less than five minutes of running time on the CDC 6600 computer.

SAMPLE PROBLEM INPUT AND OUTPUT DATA

I N P U T D A T A

SAMPLE PROBLEM. 60 CENT TRANSIENT. 6 DELAYED GROUPS. 4 LUMPS										CONTROL1
4	6	0	2	10000	0	0	0	1		CONTROL2
1.0	-06	1.0	+01	1.00	+03	1.0	+05	6.486	-04 0.0	+00CONTROL3
3.658	-14	2.73373	+07	0.0	+00	0.0	+00			CONTROL4
2.22581	-04	1.244	-02	1.44207	-03	3.051	-02	1.33413	-03 1.1144	-01CONTROL5
2.67844	-03	3.0137	-01	7.83107	-04	1.13631	+00	2.85691	-04 3.0137	+00CONTROL5
4	3	3	-1	0						REACT EQ
6.84	+01	0.0								REACT EQ
0.0	+00	1.70062	-04	-2.52534	-06	1.32948	-08			REACT EQ
1	1	1	1							REACT EQ
-1.54	-05									REACT EQ
-1.80	-04									REACT EQ
-1.23	-08									REACT EQ
0.0	+00									REACT EQ
1	1									HEAT BAL
3.0	+02	9.25	-01	1.0	+02	7.5	-02	3.0	+02 1.271	+00HEAT BAL
3.0	+02	0.0	+00							HEAT BAL
1	1	1	0							HEAT BAL
2										HEAT BAL
2.0186	-03									HEAT BAL
1										HEAT BAL
2.0186	-03									HEAT BAL
4										HEAT BAL
1.249	-03									HEAT BAL
1	1	1	0							HEAT BAL
2										HEAT BAL
6.368	-13									HEAT BAL
1										HEAT BAL
6.368	-13									HEAT BAL
4										HEAT BAL
6.368	-13									HEAT BAL
5	5	5	0							HEAT BAL
7.76836	-02	3.31022	-04	-1.54824	-07	2.04923	-10	-6.26841	-14 7.36248	-15HEAT BAL
2.50667	+00	1.06985	-02	-1.15115	-05	6.82406	-09	-2.03902	-12 2.39435	-16HEAT BAL
7.76836	-02	3.31022	-04	-1.54824	-07	2.04923	-10	-6.26841	-14 7.36248	-18HEAT BAL
1.0	+00									HEAT BAL

O U T P U T D A T A

PROBLEM)

NEW PROBLEM

SAMPLE PROBLEM. 60 CENT TRANSIENT. 6 DELAYED GROUPS. 4 LUMPS

KMAX	TMAX	NFW	NH0	NMAX	NSAVE	NEQUI	NPREC	NTEMP
4	6	0	2	10000	0	0	0	1

EPSILON	DFL1	TIMEST(SEC)	MAX ITERS	GEN TME(SEC)	S(N/SEC)	PWRCON(MW)	N(0)	TSTART(SEC)	PINT(W-SEC)
.10000E-05	1.00000E+01	1.00000E+03	1.00000E+05	8.88600E-04	0.	3.65800E-14	2.73373E+07	0.	0.

I	C0(I)	B(I)	DC(I)SEC-1
1	5.50449E+08	2.22581E-04	1.24400E-02
2	1.49443E+09	1.48207E-03	3.05100E-02
3	3.68304E+08	1.33413E-03	1.11440E-01
4	2.73421E+08	2.67844E-03	3.01370E-01
5	2.12018E+07	7.83107E-04	1.13631E+00
6	2.91639E+06	2.85691E-04	3.01370E+00

$\text{RHO}(T) = \text{SUM } N=0, \text{NA} (\text{AN}(N) * T ** N) + \text{SUM } J=1, \text{JMAX} (\text{ALPHA}(J)) \text{ FOR } T=0, T1$
 $\text{RHO}(T) = \text{SUM } N=0, \text{NA} (\text{AN}(N) * T1 ** N) + \text{SUM } M=0, \text{NH} (\text{HN}(M) * (T-T1) ** M) + \text{SUM } J=1, \text{JMAX} (\text{ALPHA}(J)) \text{ FOR } T=T1, T2$
 $\text{RHO}(T) = \text{SUM } N=0, \text{NA} (\text{AN}(N) * T ** N) + \text{SUM } M=0, \text{NH} (\text{HN}(M) * (T2-T1) ** M) + \text{SUM } J=1, \text{JMAX} (\text{ALPHA}(J)) \text{ FOR } T \text{ GT } T2$
 WHERE $\text{ALPHA}(J) = \text{SUM } N=1, \text{NC}(J) (\text{GAMMA}(J, N) * (\text{TEMPJ}(T) - \text{TEMPJ}(0)) ** N) + \text{DOPCO}(J) * \text{INTEGRAL}(\text{DTFEMP}(J) / \text{TEMP}(J) ** X(J))$

JMAX = 4 NTYPE = 3 NA = 3 NH = -1 T1 = 6.84000E+01 T2 = 0.

AN(N)	N=0,NA
0.	1.7006E-04-2.5254E-06 1.3295E-08

SECOND POLY WILL BE OMITTED

GAMMA(J,N)					
J	N=1	N=2	N=3	N=4	N=5
1	-1.54000E-05				
2	-1.80000E-04				
3	-1.23000E-08				
4	0.				

NO DOPPLER FEEDBACK

```

HCAP(J)*(D/DT)TEMPJ(T) = U(J)*PWHCON*N(T)
- SUM N(HC(J-N)*(TEMPJ(T)-TEMPN(T)))
- SUM N(HR(J-N)*(TEMPJ(T)**4-TEMPN(T)**4))
WHEREF HCAP(J) = SUM N=0,NHC(J) (DELTA(J,N)*(TEMPJ(T)-TEMPJ(0)))

```

```

J T0(J) U(J)
1 3.00000E+02 9.25000E-01
2 3.00000E+02 7.50000E-02
3 3.00000E+02 1.27100E+00
4 3.00000E+02 0.

```

CONDUCTIVE-CONVECTIVE HEAT TRANSFER COEFFICIENTS HC(J,N)

```

J= 1 N= 2 N=
2.01860E-03
J= 2 N= 1 N=
2.01860E-03
J= 3 N= 4 N=
1.24900E-03

```

RADIATIVE HEAT TRANSFER COEFFICIENTS HR(J,N)

```

J= 1 N= 2 N=
6.36800E-13
J= 2 N= 1 N=
6.36800E-13
J= 3 N= 4 N=
6.36800E-13

```

DELTA(J,N)

J	N=0	N=1	N=2	N=3	N=4	N=5
1	7.76836E-02	3.31022E-04	-3.54824E-07	2.09923E-10	-6.26841E-14	7.36248E-18
2	2.50667E+00	1.06985E-02	-1.15115E-05	6.82406E-09	-2.03902E-12	2.39435E-16
3	7.76836E-02	3.31022E-04	-3.54824E-07	2.09923E-10	-6.26841E-14	7.36248E-18
4	1.00000E+00					

```

K N(K-1) RHO(K-1)
1 2.73373E+07 0.
2 9.02219E-10 1.51117E-07
3 4.13113E+00 3.98813E-12
4 -2.81429E-02 5.59441E-17
5 2.02965E-04 1.73231E-22
6 -1.47594E-06 1.24918E-24

```

C(K-1,T)

5.50449E+08	1.49443E+04	3.68304E+08	2.73421E+08	2.12018E+07	2.91639E+06	2.91038E-11	2.32831E-10	2.32831E-10
9.31323E-10	1.16415E-10	2.91038E-11	2.00495E-13	1.33084E-12	1.18062E-12	2.16713E-12	5.88986E-13	1.79816E-13
9.19511E-04	6.12262E-03	5.51146E-03	1.10650E-02	3.23512E-03	1.18023E-03	-6.27425E-06	-4.18758E-05	-3.80921E-05
-7.83424E-05	-2.53055E-05	-1.12008E-05	4.52456E-08	3.01944E-07	2.74554E-07	5.64610E-07	1.84495E-07	8.79808E-08

T(K-1,J)

3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02	1.05808E-08	2.65870E-11	1.45386E-08	0.	-2.52113E-13
7.80971E-15	-2.19361E-13	0.	1.60510E-15	3.82700E-18	2.20030E-15	0.	-1.09306E-17	-2.61954E-20
-1.49999E-17	0.	7.88156E-20	1.89392E-22	1.08166E-19	0.			

FOLLOWING OUTPUT IS IN THE ORDER...TIME(SEC), N(I)/N(0), POWER(WATTS), ENERGY(WATT-SEC), TOTAL REACTIVITY, INVERSE PERIOD(SEC-1), TIME STEP(SEC), OUTER ITERATIONS, INNER ITERATIONS, AND TEMPERATURES(DEG KELVIN) FOR J=1,JMAX

NOTE...WHEN INVPSE PERIOD=0, THIS INDICATES THAT PROMPT JUMP APPROX WAS USED AND PERIOD WAS NOT COMPUTED.

0.	1.00000E+00	9.99998E-01	0.	0.	3.71407E-14	6.57779E-02	0.
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
3.31962E+00	1.11464E+00	1.11464E+00	3.48421E+00	5.37198E-04	4.18690E-02	3.66069E-01	1.50000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
5.57366E+00	1.23815E+00	1.23815E+00	6.12876E+00	8.71716E-04	5.12384E-02	3.82992E-01	2.10000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
7.53486E+00	1.37954E+00	1.37954E+00	8.68993E+00	1.14370E-03	5.89882E-02	3.98516E-01	2.60000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
9.16123E+00	1.52631E+00	1.52631E+00	1.10489E+01	1.35625E-03	6.53230E-02	4.11495E-01	3.00000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.08406E+01	1.71268E+00	1.71268E+00	1.37632E+01	1.56373E-03	7.18737E-02	4.24923E-01	3.40000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.21360E+01	1.88602E+00	1.88601E+00	1.60910E+01	1.71569E-03	7.69739E-02	4.35266E-01	3.70000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.34629E+01	2.09616E+00	2.09616E+00	1.87289E+01	1.86424E-03	8.22652E-02	4.45820E-01	4.00000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.48218E+01	2.35287E+00	2.35286E+00	2.17465E+01	2.00912E-03	8.77712E-02	4.56561E-01	4.30000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.62133E+01	2.66913E+00	2.66912E+00	2.52335E+01	2.15007E-03	9.35104E-02	4.67462E-01	4.60000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.76377E+01	3.06242E+00	3.06241E+00	2.93063E+01	2.28683E-03	9.94963E-02	4.78490E-01	4.90000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.86058E+01	3.37882E+00	3.37881E+00	3.24205E+01	2.37554E-03	1.03628E-01	4.85895E-01	5.10000E+01
0.	3.00000E+02	3.00000E+02	3.00000E+02	3.00000E+02			
1.95887E+01	3.74893E+00	3.74892E+00	3.59192E+01	2.46219E-03	1.07872E-01	4.93328E-01	5.30000E+01
0.	3.00000E+02	3.00000E+02	3.00001E+02	3.00000E+02			
2.05865E+01	4.18406E+00	4.18405E+00	3.98717E+01	2.54670E-03	1.12228E-01	5.00776E-01	5.50000E+01
0.	3.00000E+02	3.00000E+02	3.00001E+02	3.00000E+02			
2.15993E+01	4.64829E+00	4.64828E+00	4.43626E+01	2.62901E-03	1.16693E-01	5.08224E-01	5.70000E+01
0.	3.00000E+02	3.00000E+02	3.00001E+02	3.00000E+02			
2.26269E+01	5.10930E+00	5.10929E+00	4.94961E+01	2.70904E-03	1.21261E-01	5.15658E-01	5.90000E+01
0.	3.00000E+02	3.00000E+02	3.00001E+02	3.00000E+02			

2.36693E+01 0.	6.03937E+00 3.00001E+02	6.03936E+00 3.00000E+02	5.54006E+01 3.00001E+02	2.78672E-03 3.00000E+02	1.25927E-01	5.23061E-01	6.10000E+01
2.47264E+01 0.	6.91670E+00 3.00001E+02	6.91669E+00 3.00000E+02	6.22356E+01 3.00001E+02	2.86199E-03 3.00000E+02	1.30680E-01	5.30415E-01	6.30000E+01
2.57982E+01 0.	7.97721E+00 3.00001E+02	7.97720E+00 3.00000E+02	7.02000E+01 3.00001E+02	2.93479E-03 3.00000E+02	1.35510E-01	5.37701E-01	6.50000E+01
2.68844E+01 0.	9.26687E+00 3.00001E+02	9.26685E+00 3.00000E+02	7.95438E+01 3.00001E+02	3.00507E-03 3.00000E+02	1.40405E-01	5.44899E-01	6.70000E+01
2.79840E+01 0.	1.08447E+01 3.00001E+02	1.08447E+01 3.00000E+02	9.05819E+01 3.00001E+02	3.07276E-03 3.00000E+02	1.45349E-01	5.51989E-01	6.90000E+01
2.90993E+01 0.	1.27872E+01 3.00001E+02	1.27872E+01 3.00000E+02	1.03714E+02 3.00001E+02	3.13784E-03 3.00000E+02	1.50326E-01	5.58947E-01	7.10000E+01
3.02274E+01 0.	1.51933E+01 3.00001E+02	1.51933E+01 3.00000E+02	1.19450E+02 3.00002E+02	3.20027E-03 3.00000E+02	1.55318E-01	5.65751E-01	7.30000E+01
3.13689E+01 0.	1.81923E+01 3.00001E+02	1.81923E+01 3.00000E+02	1.38444E+02 3.00002E+02	3.26001E-03 3.00000E+02	1.60305E-01	5.72377E-01	7.50000E+01
3.25233E+01 0.	2.19537E+01 3.00002E+02	2.19537E+01 3.00000E+02	1.61538E+02 3.00002E+02	3.31706E-03 3.00000E+02	1.65266E-01	5.78802E-01	7.70000E+01
3.31052E+01 0.	2.41873E+01 3.00002E+02	2.41873E+01 3.00000E+02	1.74951E+02 3.00003E+02	3.34457E-03 3.00000E+02	1.67731E-01	5.81932E-01	7.80000E+01
3.36902E+01 0.	2.67003E+01 3.00002E+02	2.67002E+01 3.00000E+02	1.89822E+02 3.00003E+02	3.37140E-03 3.00000E+02	1.70182E-01	5.85004E-01	7.90000E+01
3.42783E+01 0.	2.95316E+01 3.00002E+02	2.95315E+01 3.00000E+02	2.06339E+02 3.00003E+02	3.39755E-03 3.00000E+02	1.72616E-01	5.88015E-01	8.00000E+01
3.48692E+01 0.	3.27266E+01 3.00002E+02	3.27266E+01 3.00000E+02	2.24716E+02 3.00003E+02	3.42303E-03 3.00000E+02	1.75031E-01	5.90963E-01	8.10000E+01
3.54631E+01 0.	3.63373E+01 3.00002E+02	3.63373E+01 3.00000E+02	2.45202E+02 3.00004E+02	3.44783E-03 3.00000E+02	1.77424E-01	5.93846E-01	8.20000E+01
3.60597E+01 0.	4.04238E+01 3.00003E+02	4.04237E+01 3.00000E+02	2.68078E+02 3.00004E+02	3.47196E-03 3.00000E+02	1.79793E-01	5.96662E-01	8.30000E+01
3.66591E+01 0.	4.50554E+01 3.00003E+02	4.50554E+01 3.00000E+02	2.93668E+02 3.00004E+02	3.49542E-03 3.00000E+02	1.82135E-01	5.99409E-01	8.40000E+01
3.72612E+01 0.	5.03126E+01 3.00003E+02	5.03125E+01 3.00000E+02	3.22346E+02 3.00005E+02	3.51821E-03 3.00000E+02	1.84447E-01	6.02086E-01	8.50000E+01
3.78659E+01 0.	5.62881E+01 3.00004E+02	5.62880E+01 3.00000E+02	3.54538E+02 3.00005E+02	3.54035E-03 3.00000E+02	1.86729E-01	6.04692E-01	8.60000E+01

3.84731E+01 0.	6.30896E+01 3.00004E+02	6.30895E+01 3.00000E+02	3.90740E+02 3.00006E+02	3.56183E-03 3.00000E+02	1.88977E-01	6.07226E-01	8.70000E+01
3.90828E+01 0.	7.08420E+01 3.00004E+02	7.08418E+01 3.00000E+02	4.31517E+02 3.00006E+02	3.58266E-03 3.00000E+02	1.91189E-01	6.09688E-01	8.80000E+01
3.96949E+01 0.	7.96900E+01 3.00005E+02	7.96899E+01 3.00000E+02	4.77528E+02 3.00007E+02	3.60285E-03 3.00000E+02	1.93364E-01	6.12077E-01	8.90000E+01
4.03093E+01 0.	8.98019E+01 3.00005E+02	8.98018E+01 3.00000E+02	5.29527E+02 3.00008E+02	3.62241E-03 3.00000E+02	1.95500E-01	6.14394E-01	9.00000E+01
4.09259E+01 0.	1.01373E+02 3.00006E+02	1.01373E+02 3.00000E+02	5.88392E+02 3.00009E+02	3.64134E-03 3.00000E+02	1.97595E-01	6.16639E-01	9.10000E+01
4.15448E+01 0.	1.14632E+02 3.00007E+02	1.14632E+02 3.00000E+02	6.55134E+02 3.00010E+02	3.65965E-03 3.00000E+02	1.99649E-01	6.18815E-01	9.20000E+01
4.21657E+01 0.	1.29842E+02 3.00007E+02	1.29842E+02 3.00000E+02	7.30928E+02 3.00011E+02	3.67736E-03 3.00000E+02	2.01659E-01	6.20921E-01	9.30000E+01
4.27886E+01 0.	1.47313E+02 3.00008E+02	1.47313E+02 3.00000E+02	8.17133E+02 3.00012E+02	3.69446E-03 3.00000E+02	2.03625E-01	6.22960E-01	9.40000E+01
4.34136E+01 0.	1.67406E+02 3.00009E+02	1.67405E+02 3.00000E+02	9.15329E+02 3.00014E+02	3.71098E-03 3.00000E+02	2.05545E-01	6.24936E-01	9.50000E+01
4.40404E+01 0.	1.90539E+02 3.00011E+02	1.90539E+02 3.00000E+02	1.02735E+03 3.00015E+02	3.72693E-03 3.00000E+02	2.07420E-01	6.26850E-01	9.60000E+01
4.46691E+01 0.	2.17206E+02 3.00012E+02	2.17205E+02 3.00000E+02	1.15533E+03 3.00017E+02	3.74231E-03 3.00000E+02	2.09248E-01	6.28707E-01	9.70000E+01
4.52996E+01 0.	2.47979E+02 3.00013E+02	2.47979E+02 3.00000E+02	1.30176E+03 3.00019E+02	3.75715E-03 3.00000E+02	2.11030E-01	6.30513E-01	9.80000E+01
4.59319E+01 0.	2.83533E+02 3.00015E+02	2.83532E+02 3.00000E+02	1.46952E+03 3.00022E+02	3.77145E-03 3.00000E+02	2.12765E-01	6.32273E-01	9.90000E+01
4.65659E+01 0.	3.24654E+02 3.00017E+02	3.24654E+02 3.00000E+02	1.66200E+03 3.00025E+02	3.78522E-03 3.00000E+02	2.14454E-01	6.33996E-01	1.00000E+02
4.72016E+01 0.	3.72268E+02 3.00019E+02	3.72267E+02 3.00000E+02	1.88315E+03 3.00028E+02	3.79849E-03 3.00000E+02	2.16096E-01	6.35692E-01	1.01000E+02
4.78390E+01 0.	4.27460E+02 3.00022E+02	4.27459E+02 3.00000E+02	2.13159E+03 3.00032E+02	3.81127E-03 3.00000E+02	2.17692E-01	6.37374E-01	1.02000E+02
4.84780E+01 0.	4.91508E+02 3.00025E+02	4.91508E+02 3.00000E+02	2.43072E+03 3.00036E+02	3.82357E-03 3.00000E+02	2.19242E-01	6.39059E-01	1.03000E+02
4.91188E+01 0.	5.65919E+02 3.00029E+02	5.65918E+02 3.00000E+02	2.76892E+03 3.00041E+02	3.83541E-03 3.00000E+02	2.20748E-01	6.40770E-01	1.04000E+02

4.97613E+01 0.	6.52469E+02 3.00033E+02	6.52468E+02 3.00000E+02	3.15966E+03 3.00047E+02	3.84681E-03 3.00000E+02	2.22211E-01	6.42537E-01	1.05000E+02
5.04057E+01 0.	7.53266E+02 3.00038E+02	7.53265E+02 3.00000E+02	3.61177E+03 3.00054E+02	3.85778E-03 3.00000E+02	2.23631E-01	6.44399E-01	1.06000E+02
5.10522E+01 0.	8.70812E+02 3.00043E+02	8.70811E+02 3.00000E+02	4.13573E+03 3.00062E+02	3.86834E-03 3.00000E+02	2.25009E-01	6.46411E-01	1.07000E+02
5.17008E+01 0.	1.00809E+03 3.00050E+02	1.00809E+03 3.00000E+02	4.74397E+03 3.00071E+02	3.87851E-03 3.00000E+02	2.26349E-01	6.48647E-01	1.08000E+02
5.23520E+01 0.	1.16870E+03 3.00057E+02	1.16870E+03 3.00000E+02	5.45141E+03 3.00082E+02	3.88832E-03 3.00000E+02	2.27651E-01	6.51211E-01	1.09000E+02
5.30063E+01 0.	1.35696E+03 3.00066E+02	1.35696E+03 3.00000E+02	6.27602E+03 3.00094E+02	3.89778E-03 3.00000E+02	2.28917E-01	6.54249E-01	1.10000E+02
5.36642E+01 0.	1.57819E+03 3.00076E+02	1.57819E+03 3.00001E+02	7.23974E+03 3.00109E+02	3.90691E-03 3.00000E+02	2.30149E-01	6.57968E-01	1.11000E+02
5.43269E+01 0.	1.83896E+03 3.00088E+02	1.83895E+03 3.00001E+02	8.36969E+03 3.00126E+02	3.91574E-03 3.00000E+02	2.31351E-01	6.62676E-01	1.12000E+02
5.49957E+01 0.	2.14756E+03 3.00102E+02	2.14755E+03 3.00001E+02	9.70009E+03 3.00146E+02	3.92431E-03 3.00000E+02	2.32526E-01	6.68831E-01	1.13000E+02
5.56729E+01 0.	2.51477E+03 3.00119E+02	2.51476E+03 3.00001E+02	1.12753E+04 3.00170E+02	3.93263E-03 3.00000E+02	2.33677E-01	6.77151E-01	1.14000E+02
5.63617E+01 0.	2.95510E+03 3.00138E+02	2.95510E+03 3.00001E+02	1.31549E+04 3.00198E+02	3.94077E-03 3.00000E+02	2.34811E-01	6.88802E-01	1.15000E+02
5.70675E+01 0.	3.48915E+03 3.00162E+02	3.48915E+03 3.00001E+02	1.54236E+04 3.00232E+02	3.94877E-03 3.00000E+02	2.35935E-01	7.05780E-01	1.16000E+02
5.77992E+01 0.	4.14833E+03 3.00192E+02	4.14832E+03 3.00001E+02	1.82106E+04 3.00273E+02	3.95673E-03 3.00000E+02	2.37062E-01	7.31682E-01	1.17000E+02
5.84716E+01 1.00000E+00	4.86696E+03 3.00223E+02	4.86695E+03 3.00001E+02	2.12354E+04 3.00318E+02	3.96376E-03 3.00000E+02	2.38065E-01	6.72496E-01	1.18000E+02
5.91667E+01 0.	5.74480E+03 3.00262E+02	5.74479E+03 3.00002E+02	2.49147E+04 3.00373E+02	3.97075E-03 3.00000E+02	2.39070E-01	6.95085E-01	1.19000E+02
5.97071E+01 0.	6.53840E+03 3.00297E+02	6.53839E+03 3.00002E+02	2.82289E+04 3.00422E+02	3.97599E-03 3.00000E+02	2.39825E-01	5.40403E-01	1.20000E+02
6.02089E+01 0.	7.37573E+03 3.00333E+02	7.37572E+03 3.00002E+02	3.17154E+04 3.00474E+02	3.98070E-03 3.00000E+02	2.40505E-01	5.01758E-01	1.21000E+02
6.06945E+01 0.	8.29071E+03 3.00373E+02	8.29069E+03 3.00002E+02	3.55147E+04 3.00530E+02	3.98514E-03 3.00000E+02	2.41145E-01	4.85589E-01	1.22000E+02

6.11664E+01 0.	9.29119E+03 3.00416E+02	9.29118E+03 3.00003E+02	3.96584E+04 3.00592E+02	3.98932E-03 3.00000E+02	2.41749E-01	4.71878E-01	1.23000E+02
6.16248E+01 0.	1.03815E+04 3.00663E+02	1.03815E+04 3.00003E+02	4.41633E+04 3.00658E+02	3.99327E-03 3.00000E+02	2.42318E-01	4.58469E-01	1.24000E+02
6.20700E+01 0.	1.15655E+04 3.00514E+02	1.15655E+04 3.00003E+02	4.50439E+04 3.00730E+02	3.99699E-03 3.00000E+02	2.42852E-01	4.45208E-01	1.25000E+02
6.25022E+01 0.	1.28466E+04 3.00569E+02	1.28466E+04 3.00004E+02	5.43138E+04 3.00807E+02	4.00049E-03 3.00000E+02	2.43354E-01	4.32147E-01	1.26000E+02
6.29215E+01 0.	1.42282E+04 3.00628E+02	1.42282E+04 3.00004E+02	5.99856E+04 3.00890E+02	4.00378E-03 3.00000E+02	2.43822E-01	4.19344E-01	1.27000E+02
6.33284E+01 0.	1.57133E+04 3.00691E+02	1.57133E+04 3.00004E+02	6.00713E+04 3.00979E+02	4.00687E-03 3.00000E+02	2.44258E-01	4.06843E-01	1.28000E+02
6.37230E+01 0.	1.73049E+04 3.00759E+02	1.73049E+04 3.00005E+02	7.25819E+04 3.01074E+02	4.00976E-03 3.00000E+02	2.44662E-01	3.94677E-01	1.29000E+02
6.44773E+01 0.	2.08177E+04 3.00907E+02	2.08176E+04 3.00006E+02	8.69183E+04 3.01281E+02	4.01500E-03 3.00000E+02	2.45377E-01	3.71428E-01	1.31000E+02
6.51874E+01 0.	2.47848E+04 3.01073E+02	2.47848E+04 3.00007E+02	1.03066E+05 3.01514E+02	4.01953E-03 3.00000E+02	2.45971E-01	3.49663E-01	1.33000E+02
6.58560E+01 0.	2.92202E+04 3.01257E+02	2.92201E+04 3.00008E+02	1.21081E+05 3.01771E+02	4.02340E-03 3.00000E+02	2.46447E-01	3.29343E-01	1.35000E+02
6.64861E+01 0.	3.41324E+04 3.01460E+02	3.41323E+04 3.00009E+02	1.40999E+05 3.02054E+02	4.02664E-03 3.00000E+02	2.46808E-01	3.10375E-01	1.37000E+02
6.70801E+01 0.	3.95244E+04 3.01681E+02	3.95243E+04 3.00011E+02	1.62835E+05 3.02362E+02	4.02930E-03 3.00000E+02	2.47058E-01	2.92642E-01	1.39000E+02
6.76403E+01 0.	4.53931E+04 3.01920E+02	4.53930E+04 3.00012E+02	1.86584E+05 3.02695E+02	4.03139E-03 3.00000E+02	2.47200E-01	2.76029E-01	1.41000E+02
6.81689E+01 0.	5.17289E+04 3.02178E+02	5.17288E+04 3.00014E+02	2.12214E+05 3.03051E+02	4.03294E-03 3.00000E+02	2.47237E-01	2.60438E-01	1.43000E+02
6.86060E+01 0.	5.76302E+04 3.02418E+02	5.76302E+04 3.00016E+02	2.36089E+05 3.03384E+02	4.03153E-03 3.00000E+02	2.44571E-01	2.50060E-01	1.45000E+02
6.90671E+01 0.	6.44843E+04 3.02698E+02	6.44842E+04 3.00017E+02	2.64218E+05 3.03772E+02	4.02688E-03 3.00000E+02	2.42931E-01	2.3053E-01	1.47000E+02
6.94979E+01 0.	7.15764E+04 3.02989E+02	7.15763E+04 3.00019E+02	2.93499E+05 3.04173E+02	4.02206E-03 3.00000E+02	2.41586E-01	2.09165E-01	1.49000E+02
7.00638E+01 0.	8.20202E+04 3.03420E+02	8.20200E+04 3.00022E+02	3.36844E+05 3.04767E+02	4.01492E-03 3.00000E+02	2.39775E-01	1.79482E-01	1.52000E+02

7.05572E+01 0.	9.22798E+04 3.03846E+02	9.22796E+04 3.00025E+02	3.79847E+05 3.05354E+02	4.00785E-03 3.00000E+02	2.38065E-01	1.57608E-01	1.55000E+02
7.09954E+01 0.	1.02389E+05 3.04268E+02	1.02389E+05 3.00028E+02	4.22466E+05 3.05336E+02	4.00085E-03 3.00000E+02	2.36408E-01	1.40765E-01	1.58000E+02
7.15137E+01 0.	1.15672E+05 3.04826E+02	1.15672E+05 3.00031E+02	4.78417E+05 3.06705E+02	3.99159E-03 3.00000E+02	2.34252E-01	1.23489E-01	1.62000E+02
7.19735E+01 0.	1.28762E+05 3.05379E+02	1.28762E+05 3.00035E+02	5.35057E+05 3.07467E+02	3.98240E-03 3.00000E+02	2.32138E-01	1.10211E-01	1.66000E+02
7.23873E+01 0.	1.41682E+05 3.05930E+02	1.41682E+05 3.00038E+02	5.90970E+05 3.08224E+02	3.97327E-03 3.00000E+02	2.30059E-01	9.96715E-02	1.70000E+02
7.28532E+01 0.	1.57618E+05 3.06614E+02	1.57617E+05 3.00043E+02	6.60635E+05 3.09165E+02	3.96191E-03 3.00000E+02	2.27500E-01	8.91929E-02	1.75000E+02
7.33528E+01 0.	1.76456E+05 3.07430E+02	1.76456E+05 3.00048E+02	7.44005E+05 3.10286E+02	3.94836E-03 3.00000E+02	2.24480E-01	7.93751E-02	1.81000E+02
7.38011E+01 0.	1.95010E+05 3.08241E+02	1.95010E+05 3.00054E+02	8.27221E+05 3.11400E+02	3.93488E-03 3.00000E+02	2.21509E-01	7.16479E-02	1.87000E+02
7.42730E+01 0.	2.16324E+05 3.09184E+02	2.16323E+05 3.00060E+02	9.24201E+05 3.12692E+02	3.91922E-03 3.00000E+02	2.18099E-01	6.44778E-02	1.94000E+02
7.47587E+01 0.	2.40271E+05 3.10255E+02	2.40271E+05 3.00067E+02	1.03499E+06 3.14159E+02	3.90140E-03 3.00000E+02	2.14269E-01	5.79988E-02	2.02000E+02
7.52509E+01 0.	2.66719E+05 3.11455E+02	2.66718E+05 3.00075E+02	1.15967E+06 3.15800E+02	3.88144E-03 3.00000E+02	2.10042E-01	5.22443E-02	2.11000E+02
7.57446E+01 0.	2.95524E+05 3.12782E+02	2.95524E+05 3.00085E+02	1.29836E+06 3.17613E+02	3.85935E-03 3.00000E+02	2.05440E-01	4.71884E-02	2.21000E+02
7.62362E+01 0.	3.26537E+05 3.14234E+02	3.26537E+05 3.00095E+02	1.45118E+06 3.19594E+02	3.83514E-03 3.00000E+02	2.00485E-01	4.27742E-02	2.32000E+02
7.67237E+01 0.	3.59599E+05 3.15812E+02	3.59599E+05 3.00106E+02	1.61833E+06 3.21744E+02	3.80882E-03 3.00000E+02	1.95203E-01	3.89333E-02	2.44000E+02
7.72411E+01 0.	3.97196E+05 3.17645E+02	3.97195E+05 3.00119E+02	1.81398E+06 3.24237E+02	3.77822E-03 3.00000E+02	1.89196E-01	3.53666E-02	2.58000E+02
7.77785E+01 0.	4.38925E+05 3.19731E+02	4.38925E+05 3.00134E+02	2.03856E+06 3.27067E+02	3.74336E-03 3.00000E+02	1.82525E-01	3.21460E-02	2.74000E+02
7.83290E+01 0.	4.84353E+05 3.22066E+02	4.84352E+05 3.00151E+02	2.29257E+06 3.30231E+02	3.70428E-03 3.00000E+02	1.75257E-01	2.92921E-02	2.92000E+02
7.88877E+01 0.	5.33012E+05 3.24649E+02	5.33011E+05 3.00170E+02	2.57662E+06 3.33724E+02	3.66098E-03 3.00000E+02	1.67461E-01	2.67945E-02	3.12000E+02

7.94758E+01 0.	5.86695E+05 3.27606E+02	5.86695E+05 3.00193E+02	2.90574E+06 3.37713E+02	3.61134E-03 3.00000E+02	1.58842E-01	2.45398E-02	3.35000E+02
8.01084E+01 0.	6.46733E+05 3.31060E+02	6.46732E+05 3.00220E+02	3.29580E+06 3.42364E+02	3.55322E-03 3.00000E+02	1.49173E-01	2.24838E-02	3.62000E+02
8.07751E+01 0.	7.11856E+05 3.35006E+02	7.11855E+05 3.00252E+02	3.74862E+06 3.47664E+02	3.48666E-03 3.00000E+02	1.38634E-01	2.06700E-02	3.93000E+02
8.15073E+01 0.	7.84497E+05 3.39691E+02	7.84496E+05 3.00291E+02	4.29640E+06 3.53942E+02	3.40740E-03 3.00000E+02	1.26796E-01	1.90312E-02	4.30000E+02
8.23106E+01 0.	8.64031E+05 3.45233E+02	8.64030E+05 3.00339E+02	4.95856E+06 3.61349E+02	3.31331E-03 3.00000E+02	1.13690E-01	1.75887E-02	4.74000E+02
8.32072E+01 0.	9.50509E+05 3.51871E+02	9.50508E+05 3.00399E+02	5.77226E+06 3.70200E+02	3.20009E-03 3.00000E+02	9.91934E-02	1.63407E-02	5.27000E+02
8.42629E+01 0.	1.04619E+06 3.60212E+02	1.04619E+06 3.00480E+02	6.82703E+06 3.81296E+02	3.05696E-03 3.00000E+02	8.26889E-02	1.52674E-02	5.94000E+02
8.55790E+01 0.	1.15159E+06 3.71221E+02	1.15159E+06 3.00595E+02	8.27516E+06 3.95913E+02	2.86650E-03 3.00000E+02	6.35390E-02	1.44022E-02	6.83000E+02
8.74359E+01 0.	1.26692E+06 3.87426E+02	1.26692E+06 3.00785E+02	1.05271E+07 4.17411E+02	2.58246E-03 3.00000E+02	4.00597E-02	1.38532E-02	8.15000E+02
9.24375E+01 0.	1.37747E+06 4.30300E+02	1.37747E+06 3.01444E+02	1.72519E+07 4.74590E+02	1.80300E-03 3.00000E+02	-1.71480E-03	1.49245E-02	1.16900E+03
9.74532E+01 0.	1.29208E+06 4.06357E+02	1.29208E+06 3.02274E+02	2.39984E+07 5.23740E+02	1.09769E-03 3.00000E+02	-2.10586E-02	1.85836E-02	1.47300E+03
1.01680E+02 0.	1.16214E+06 4.89755E+02	1.16214E+06 3.03065E+02	2.91930E+07 5.56793E+02	5.94557E-04 3.00000E+02	-2.80706E-02	2.35354E-02	1.67600E+03
1.05272E+02 0.	1.04523E+06 5.04977E+02	1.04523E+06 3.03781E+02	3.31566E+07 5.79248E+02	2.30909E-04 3.00000E+02	-3.05278E-02	2.93521E-02	1.81300E+03
1.08676E+02 0.	9.40619E+05 5.16000E+02	9.40617E+05 3.04485E+02	3.65340E+07 5.96383E+02	-6.57879E-05 3.00000E+02	-3.11883E-02	3.66371E-02	1.91700E+03
1.12087E+02 0.	8.45851E+05 5.24248E+02	8.45850E+05 3.05206E+02	3.95781E+07 6.10112E+02	-3.22769E-04 3.00000E+02	-3.09101E-02	4.62866E-02	2.00000E+03
1.15543E+02 0.	7.61099E+05 5.30220E+02	7.61098E+05 3.05945E+02	4.23517E+07 6.21059E+02	-5.47856E-04 3.00000E+02	-3.00882E-02	5.94777E-02	2.06600E+03
1.19165E+02 0.	6.83881E+05 5.34349E+02	6.83880E+05 3.06722E+02	4.49648E+07 6.29859E+02	-7.51353E-04 3.00000E+02	-2.89219E-02	7.89294E-02	2.11900E+03
1.22966E+02 0.	6.14238E+05 5.36760E+02	6.14237E+05 3.07533E+02	4.74245E+07 6.36656E+02	-9.34592E-04 3.00000E+02	-2.75440E-02	1.09740E-01	2.16000E+03

1.26929E+02 0.	5.52311E+05 5.37554E+02	5.52310E+05 3.08368E+02	4.97366E+07 6.41558E+02	-1.09724E-03 3.00000E+02	-2.60456E-02	1.50496E-01	2.19000E+03
1.31277E+02 0.	4.95444E+05 5.36774E+02	4.95443E+05 3.09260E+02	5.14847E+07 6.44900E+02	-1.24567E-03 3.00000E+02	-2.44700E-02	1.44310E-01	2.21900E+03
1.35799E+02 0.	4.44563E+05 5.74390E+02	4.44562E+05 3.10189E+02	5.41307E+07 6.46545E+02	-1.37620E-03 3.00000E+02	-2.28805E-02	1.33490E-01	2.25200E+03
1.40562E+02 0.	4.00034E+05 5.30561E+02	4.00034E+05 3.11131E+02	5.61388E+07 6.46443E+02	-1.48679E-03 3.00000E+02	-2.13747E-02	1.24834E-01	2.28900E+03
1.45661E+02 0.	3.59965E+05 5.25314E+02	3.59964E+05 3.12105E+02	5.80732E+07 6.44607E+02	-1.58141E-03 3.00000E+02	-1.99564E-02	1.18588E-01	2.33100E+03
1.50666E+02 0.	3.26657E+05 5.19324E+02	3.26656E+05 3.13025E+02	5.97892E+07 6.41369E+02	-1.65471E-03 3.00000E+02	-1.87564E-02	1.14594E-01	2.37400E+03
1.55758E+02 0.	2.97611E+05 5.12637E+02	2.97611E+05 3.13922E+02	6.13769E+07 6.36889E+02	-1.71308E-03 3.00000E+02	-1.77138E-02	1.12022E-01	2.41900E+03
1.60762E+02 0.	2.72886E+05 5.05685E+02	2.72886E+05 3.14763E+02	6.28027E+07 6.31545E+02	-1.75739E-03 3.00000E+02	-1.68430E-02	1.10534E-01	2.46400E+03
1.65826E+02 0.	2.50974E+05 4.98421E+02	2.50973E+05 3.15574E+02	6.41281E+07 6.25375E+02	-1.79148E-03 3.00000E+02	-1.60937E-02	1.09796E-01	2.51000E+03
1.70871E+02 0.	2.31700E+05 4.91079E+02	2.31700E+05 3.16343E+02	6.53447E+07 6.18622E+02	-1.81659E-03 3.00000E+02	-1.54583E-02	1.09642E-01	2.55600E+03
1.75920E+02 0.	2.14530E+05 4.83719E+02	2.14530E+05 3.17072E+02	6.64704E+07 6.11389E+02	-1.83448E-03 3.00000E+02	-1.49146E-02	1.09940E-01	2.60200E+03
1.80992E+02 0.	1.99075E+05 4.76389E+02	1.99075E+05 3.17766E+02	6.75185E+07 6.03752E+02	-1.84647E-03 3.00000E+02	-1.44452E-02	1.10602E-01	2.64800E+03
1.86101E+02 0.	1.85045E+05 4.69125E+02	1.85045E+05 3.18428E+02	6.84992E+07 5.95774E+02	-1.85359E-03 3.00000E+02	-1.40365E-02	1.11570E-01	2.69400E+03
1.91149E+02 0.	1.72488E+05 4.62110E+02	1.72488E+05 3.19046E+02	6.94010E+07 5.87688E+02	-1.85665E-03 3.00000E+02	-1.36850E-02	1.12772E-01	2.73900E+03
1.96255E+02 0.	1.60924E+05 4.55210E+02	1.60924E+05 3.19636E+02	7.02519E+07 5.79365E+02	-1.85650E-03 3.00000E+02	-1.33732E-02	1.14201E-01	2.78400E+03
2.01316E+02 0.	1.50455E+05 4.48592E+02	1.50454E+05 3.20187E+02	7.10393E+07 5.71029E+02	-1.85376E-03 3.00000E+02	-1.31006E-02	1.15798E-01	2.82800E+03
2.06333E+02 0.	1.40929E+05 4.42262E+02	1.40929E+05 3.20703E+02	7.17699E+07 5.62722E+02	-1.84903E-03 3.00000E+02	-1.28601E-02	1.17540E-01	2.87100E+03
2.11428E+02 0.	1.32027E+05 4.36082E+02	1.32027E+05 3.21197E+02	7.24650E+07 5.54279E+02	-1.84263E-03 3.00000E+02	-1.26417E-02	1.19453E-01	2.91400E+03

2.16488E+02	1.23875E+05	1.23875E+05	3.21659E+02	1.31122E+07	-1.83505E-03	-1.24667E-02	1.21484E-01	2.95600E+03
2.21514E+02	1.16387E+05	1.16387E+05	3.22091E+02	7.37157E+07	-1.82664E-03	-1.22716E-02	1.23618E-01	2.99700E+03
2.26429E+02	1.09325E+05	1.09325E+05	3.22504E+02	7.62928E+07	-1.81745E-03	-1.21097E-02	1.25904E-01	3.03800E+03
2.31714E+02	1.02612E+05	1.02612E+05	3.22891E+02	7.64319E+07	-1.80790E-03	-1.19632E-02	1.26281E-01	3.07800E+03
2.36765E+02	9.67946E+04	9.67946E+04	3.23252E+02	7.53359E+07	-1.79820E-03	-1.18299E-02	1.30742E-01	3.11700E+03
2.41783E+02	9.12263E+04	9.12263E+04	3.23590E+02	7.58074E+07	-1.78849E-03	-1.17084E-02	1.33278E-01	3.15500E+03
2.46899E+02	8.59308E+04	8.59308E+04	3.23914E+02	7.62604E+07	-1.77866E-03	-1.15943E-02	1.35957E-01	3.19300E+03
2.51981E+02	8.10208E+04	8.10207E+04	3.24216E+02	7.66845E+07	-1.76905E-03	-1.14897E-02	1.38705E-01	3.23000E+03
2.57026E+02	7.64637E+04	7.64636E+04	3.24498E+02	7.70816E+07	-1.75974E-03	-1.13936E-02	1.41517E-01	3.26600E+03
2.62031E+02	7.22307E+04	7.22305E+04	3.24761E+02	7.74536E+07	-1.75081E-03	-1.13050E-02	1.44385E-01	3.30100E+03
2.67138E+02	6.81828E+04	6.81827E+04	3.25014E+02	7.78120E+07	-1.74203E-03	-1.12210E-02	1.47391E-01	3.33600E+03
2.72202E+02	6.44198E+04	6.44197E+04	3.25249E+02	7.81477E+07	-1.73372E-03	-1.11433E-02	1.50448E-01	3.37000E+03
2.77219E+02	6.09201E+04	6.09200E+04	3.25488E+02	7.84620E+07	-1.72587E-03	-1.10714E-02	1.53546E-01	3.40300E+03
2.82341E+02	5.75647E+04	5.75646E+04	3.25679E+02	7.87654E+07	-1.71828E-03	-1.10027E-02	1.56779E-01	3.43600E+03
2.87411E+02	5.44435E+04	5.44434E+04	3.25875E+02	7.90492E+07	-1.71120E-03	-1.09389E-02	1.60045E-01	3.46800E+03
2.92425E+02	5.15400E+04	5.15399E+04	3.26057E+02	7.93149E+07	-1.70461E-03	-1.08796E-02	1.63333E-01	3.49900E+03
2.97543E+02	4.87506E+04	4.87506E+04	3.26232E+02	7.95714E+07	-1.69831E-03	-1.08225E-02	1.66750E-01	3.53000E+03
3.02598E+02	4.61564E+04	4.61564E+04	3.26394E+02	7.98112E+07	-1.69249E-03	-1.07694E-02	1.70177E-01	3.56000E+03

3.07758E+02 0.	4.16633E+04 3.63512E+02	4.16632E+04 3.26550E+02	4.00429E+07 4.18376E+02	-1.66696E-03 3.00000E+02	-1.07182E-02	1.73723E-01	3.59000E+03
3.12849E+02 0.	4.13459E+04 3.61496E+02	4.13459E+04 3.26645E+02	4.02572E+07 4.12442E+02	-1.66189E-03 3.00000E+02	-1.06703E-02	1.7264E-01	3.61900E+03
3.17663E+02 0.	3.91930E+04 3.54631E+02	3.91929E+04 3.26829E+02	4.04611E+07 4.07876E+02	-1.67727E-03 3.00000E+02	-1.06256E-02	1.80787E-01	3.64700E+03
3.22977E+02 0.	3.71210E+04 3.57845E+02	3.71209E+04 3.26958E+02	4.06562E+07 4.02848E+02	-1.67290E-03 3.00000E+02	-1.05823E-02	1.84411E-01	3.67500E+03
3.28006E+02 0.	3.51980E+04 3.56197E+02	3.51979E+04 3.27077E+02	4.08340E+07 3.98089E+02	-1.66894E-03 3.00000E+02	-1.05417E-02	1.87997E-01	3.70200E+03
3.33134E+02 0.	3.33699E+04 3.54619E+02	3.3368E+04 3.27192E+02	4.10137E+07 3.93423E+02	-1.66522E-03 3.00000E+02	-1.05023E-02	1.91670E-01	3.72900E+03
3.38166E+02 0.	3.16310E+04 3.53165E+02	3.16310E+04 3.27298E+02	4.11771E+07 3.89022E+02	-1.66186E-03 3.00000E+02	-1.04654E-02	1.95283E-01	3.75500E+03
3.43293E+02 0.	2.99793E+04 3.51775E+02	2.99792E+04 3.27400E+02	4.13350E+07 3.84718E+02	-1.65872E-03 3.00000E+02	-1.04295E-02	1.98965E-01	3.78100E+03
3.48313E+02 0.	2.84504E+04 3.50497E+02	2.84503E+04 3.27494E+02	4.14817E+07 3.80675E+02	-1.65590E-03 3.00000E+02	-1.03959E-02	2.02563E-01	3.80600E+03
3.53425E+02 0.	2.69786E+04 3.49275E+02	2.69785E+04 3.27584E+02	4.16233E+07 3.76729E+02	-1.65328E-03 3.00000E+02	-1.03631E-02	2.06210E-01	3.83100E+03
3.58628E+02 0.	2.55629E+04 3.48109E+02	2.55629E+04 3.27670E+02	4.17599E+07 3.72885E+02	-1.65084E-03 3.00000E+02	-1.03312E-02	2.09896E-01	3.85600E+03
3.63710E+02 0.	2.42558E+04 3.47039E+02	2.42558E+04 3.27750E+02	4.18865E+07 3.69293E+02	-1.64867E-03 3.00000E+02	-1.03013E-02	2.13463E-01	3.88000E+03
3.68878E+02 0.	2.29987E+04 3.46018E+02	2.29987E+04 3.27827E+02	4.20086E+07 3.65802E+02	-1.64666E-03 3.00000E+02	-1.02721E-02	2.17046E-01	3.90400E+03
3.73911E+02 0.	2.18401E+04 3.45084E+02	2.18401E+04 3.27897E+02	4.21214E+07 3.62553E+02	-1.64489E-03 3.00000E+02	-1.02448E-02	2.20483E-01	3.92700E+03
3.79023E+02 0.	2.07260E+04 3.44192E+02	2.07260E+04 3.27964E+02	4.22302E+07 3.59402E+02	-1.64325E-03 3.00000E+02	-1.02181E-02	2.23914E-01	3.95000E+03
3.84214E+02 0.	1.96556E+04 3.43342E+02	1.96556E+04 3.28029E+02	4.23349E+07 3.56350E+02	-1.64174E-03 3.00000E+02	-1.01921E-02	2.27324E-01	3.97300E+03
3.89253E+02 0.	1.86719E+04 3.42566E+02	1.86719E+04 3.28088E+02	4.24315E+07 3.53525E+02	-1.64042E-03 3.00000E+02	-1.01678E-02	2.30557E-01	3.99500E+03
3.94362E+02 0.	1.77269E+04 3.41826E+02	1.77269E+04 3.28145E+02	4.25244E+07 3.50794E+02	-1.63920E-03 3.00000E+02	-1.01441E-02	2.33747E-01	4.01700E+03

3.99540E+02 0.	1.66149E+04 3.41121E+02	1.66149E+04 3.41149E+02	8.26139E+07 3.46158E+02	-1.63809E-03 3.00000E+02	-1.01210E-02	2.36884E-01	4.03900E+03
4.04547E+02 0.	1.59889E+04 3.40479E+02	1.59889E+04 3.40749E+02	8.26960E+07 3.45731E+02	-1.63712E-03 3.00000E+02	-1.00995E-02	2.39817E-01	4.06000E+03
4.09615E+02 0.	1.51913E+04 3.39868E+02	1.51913E+04 3.40296E+02	8.27750E+07 3.43393E+02	-1.63624E-03 3.00000E+02	-1.00785E-02	2.42680E-01	4.08100E+03
4.14742E+02 0.	1.44253E+04 3.39285E+02	1.44263E+04 3.40342E+02	8.28509E+07 3.41142E+02	-1.63544E-03 3.00000E+02	-1.00580E-02	2.45462E-01	4.10200E+03
4.19927E+02 0.	1.36934E+04 3.38731E+02	1.36934E+04 3.40385E+02	8.29238E+07 3.38979E+02	-1.63471E-03 3.00000E+02	-1.00380E-02	2.48153E-01	4.12300E+03
4.25167E+02 0.	1.29919E+04 3.38204E+02	1.29919E+04 3.40427E+02	8.29937E+07 3.36904E+02	-1.63405E-03 3.00000E+02	-1.00186E-02	2.50745E-01	4.14400E+03
4.30206E+02 0.	1.23522E+04 3.37727E+02	1.23522E+04 3.40465E+02	8.30575E+07 3.35008E+02	-1.63348E-03 3.00000E+02	-1.00006E-02	2.53115E-01	4.16400E+03
4.35293E+02 0.	1.17396E+04 3.37272E+02	1.17396E+04 3.40501E+02	8.31188E+07 3.33190E+02	-1.63297E-03 3.00000E+02	-9.98313E-03	2.55381E-01	4.18400E+03
4.40423E+02 0.	1.11535E+04 3.36840E+02	1.11535E+04 3.40536E+02	8.31775E+07 3.31449E+02	-1.63252E-03 3.00000E+02	-9.96610E-03	2.57539E-01	4.20400E+03
4.45596E+02 0.	1.05931E+04 3.36429E+02	1.05931E+04 3.40569E+02	8.32337E+07 3.29785E+02	-1.63211E-03 3.00000E+02	-9.94956E-03	2.59586E-01	4.22400E+03
4.50808E+02 0.	1.00578E+04 3.36039E+02	1.00578E+04 3.40600E+02	8.32875E+07 3.28194E+02	-1.63174E-03 3.00000E+02	-9.93350E-03	2.61518E-01	4.24400E+03
4.56058E+02 0.	9.54675E+03 3.35669E+02	9.54674E+03 3.40630E+02	8.33390E+07 3.26677E+02	-1.63141E-03 3.00000E+02	-9.91792E-03	2.63335E-01	4.26400E+03
4.61077E+02 0.	9.08308E+03 3.35335E+02	9.08306E+03 3.40657E+02	8.33857E+07 3.25301E+02	-1.63114E-03 3.00000E+02	-9.90355E-03	2.64953E-01	4.28300E+03
4.66127E+02 0.	8.64000E+03 3.35017E+02	8.63998E+03 3.40683E+02	8.34304E+07 3.23989E+02	-1.63089E-03 3.00000E+02	-9.88962E-03	2.66468E-01	4.30200E+03
4.71204E+02 0.	8.21684E+03 3.34715E+02	8.21683E+03 3.40708E+02	8.34732E+07 3.22736E+02	-1.63068E-03 3.00000E+02	-9.87610E-03	2.67881E-01	4.32100E+03
4.76307E+02 0.	7.81295E+03 3.34429E+02	7.81294E+03 3.40731E+02	8.35141E+07 3.21544E+02	-1.63049E-03 3.00000E+02	-9.86301E-03	2.69194E-01	4.34000E+03
4.81434E+02 0.	7.42765E+03 3.34156E+02	7.42763E+03 3.40754E+02	8.35532E+07 3.20404E+02	-1.63032E-03 3.00000E+02	-9.85032E-03	2.70411E-01	4.35900E+03
4.86583E+02 0.	7.05025E+03 3.33898E+02	7.05024E+03 3.40775E+02	8.35905E+07 3.19324E+02	-1.63014E-03 3.00000E+02	-9.83805E-03	2.71535E-01	4.37800E+03

4.91753E+02 0.	6.71010E+03 3.33653E+02	6.71009E+03 3.24745E+02	8.36261E+07 3.18301E+02	-1.63005E-03 3.00000E+02	-9.82617E-03	2.72570E-01	4.39700E+03
4.96941E+02 0.	6.37652E+03 3.33420E+02	6.37651E+03 3.24415E+02	8.36600E+07 3.17325E+02	-1.62995E-03 3.00000E+02	-9.81469E-03	2.73521E-01	4.41600E+03
5.02147E+02 0.	6.05445E+03 3.33200E+02	6.05444E+03 3.24433E+02	8.36424E+07 3.16399E+02	-1.62985E-03 3.00000E+02	-9.80359E-03	2.74392E-01	4.43500E+03
5.07364E+02 0.	5.75645E+03 3.32991E+02	5.75644E+03 3.24451E+02	8.37232E+07 3.15520E+02	-1.62974E-03 3.00000E+02	-9.79287E-03	2.75189E-01	4.45400E+03
5.12604E+02 0.	5.46866E+03 3.32792E+02	5.46866E+03 3.24467E+02	8.37526E+07 3.14686E+02	-1.62971E-03 3.00000E+02	-9.78252E-03	2.75915E-01	4.47300E+03
5.17853E+02 0.	5.19488E+03 3.32605E+02	5.19487E+03 3.24483E+02	8.37806E+07 3.13896E+02	-1.62966E-03 3.00000E+02	-9.77254E-03	2.76577E-01	4.49200E+03
5.23115E+02 0.	4.93447E+03 3.32427E+02	4.93447E+03 3.24498E+02	8.38072E+07 3.13147E+02	-1.62962E-03 3.00000E+02	-9.76290E-03	2.77178E-01	4.51100E+03
5.28386E+02 0.	4.68686E+03 3.32258E+02	4.68686E+03 3.244913E+02	8.38326E+07 3.12434E+02	-1.62958E-03 3.00000E+02	-9.75361E-03	2.77723E-01	4.53000E+03
5.33390E+02 0.	4.46356E+03 3.32106E+02	4.46355E+03 3.244926E+02	8.38554E+07 3.11801E+02	-1.62956E-03 3.00000E+02	-9.74511E-03	2.78193E-01	4.54800E+03
5.38402E+02 0.	4.25073E+03 3.31962E+02	4.25073E+03 3.244938E+02	8.38773E+07 3.11196E+02	-1.62954E-03 3.00000E+02	-9.73691E-03	2.78620E-01	4.56600E+03
5.43420E+02 0.	4.04794E+03 3.31825E+02	4.04793E+03 3.244949E+02	8.38981E+07 3.10622E+02	-1.62953E-03 3.00000E+02	-9.72899E-03	2.79008E-01	4.58400E+03
5.48446E+02 0.	3.85471E+03 3.31695E+02	3.85471E+03 3.244961E+02	8.39179E+07 3.10077E+02	-1.62952E-03 3.00000E+02	-9.72135E-03	2.79361E-01	4.60200E+03
5.53478E+02 0.	3.67064E+03 3.31572E+02	3.67063E+03 3.244971E+02	8.39369E+07 3.09560E+02	-1.62952E-03 3.00000E+02	-9.71398E-03	2.79681E-01	4.62000E+03
5.58515E+02 0.	3.49529E+03 3.31454E+02	3.49529E+03 3.244981E+02	8.39549E+07 3.09069E+02	-1.62952E-03 3.00000E+02	-9.70686E-03	2.79971E-01	4.63800E+03
5.63557E+02 0.	3.32828E+03 3.31343E+02	3.32828E+03 3.244991E+02	8.39721E+07 3.08604E+02	-1.62952E-03 3.00000E+02	-9.70000E-03	2.80233E-01	4.65600E+03
5.68603E+02 0.	3.16922E+03 3.31237E+02	3.16922E+03 3.249000E+02	8.39885E+07 3.08163E+02	-1.62953E-03 3.00000E+02	-9.69338E-03	2.80471E-01	4.67400E+03
5.73654E+02 0.	3.01774E+03 3.31136E+02	3.01774E+03 3.249009E+02	8.40041E+07 3.07745E+02	-1.62954E-03 3.00000E+02	-9.68700E-03	2.80687E-01	4.69200E+03
5.78704E+02 0.	2.87349E+03 3.31040E+02	2.87349E+03 3.249017E+02	8.40190E+07 3.07344E+02	-1.62955E-03 3.00000E+02	-9.68085E-03	2.80881E-01	4.71000E+03

5.83766E+02 0.	2.73614E+03 3.30949E+02	2.73613E+03 3.29025E+02	8.40332E+07 3.06472E+02	-1.62956E-03 3.00000E+02	-9.67492E-03	2.81057E-01	4.72800E+03
5.88826E+02 0.	2.60534E+03 3.30663E+02	2.60534E+03 3.29032E+02	8.40467E+07 3.06616E+02	-1.62958E-03 3.00000E+02	-9.66921E-03	2.81217E-01	4.74600E+03
5.93889E+02 0.	2.48081E+03 3.30781E+02	2.48080E+03 3.29039E+02	8.40596E+07 3.06278E+02	-1.62959E-03 3.00000E+02	-9.66371E-03	2.81361E-01	4.76400E+03
5.98955E+02 0.	2.36223E+03 3.30703E+02	2.36223E+03 3.29046E+02	8.40719E+07 3.05957E+02	-1.62961E-03 3.00000E+02	-9.65840E-03	2.81491E-01	4.78200E+03
6.04023E+02 0.	2.24934E+03 3.30629E+02	2.24934E+03 3.29053E+02	8.40835E+07 3.05654E+02	-1.62963E-03 3.00000E+02	-9.65329E-03	2.81608E-01	4.80000E+03
6.09093E+02 0.	2.14185E+03 3.30558E+02	2.14185E+03 3.29059E+02	8.40947E+07 3.05365E+02	-1.62965E-03 3.00000E+02	-9.64837E-03	2.81714E-01	4.81800E+03
6.14165E+02 0.	2.03952E+03 3.30491E+02	2.03951E+03 3.29065E+02	8.41053E+07 3.05092E+02	-1.62967E-03 3.00000E+02	-9.64363E-03	2.81810E-01	4.83600E+03
6.19238E+02 0.	1.94209E+03 3.30428E+02	1.94208E+03 3.29070E+02	8.41154E+07 3.04834E+02	-1.62969E-03 3.00000E+02	-9.63906E-03	2.81897E-01	4.85400E+03
6.24313E+02 0.	1.84932E+03 3.30367E+02	1.84932E+03 3.29076E+02	8.41250E+07 3.04584E+02	-1.62971E-03 3.00000E+02	-9.63466E-03	2.81975E-01	4.87200E+03
6.29389E+02 0.	1.76101E+03 3.30310E+02	1.76101E+03 3.29081E+02	8.41341E+07 3.04355E+02	-1.62973E-03 3.00000E+02	-9.63043E-03	2.82046E-01	4.89000E+03
6.34467E+02 0.	1.67693E+03 3.30255E+02	1.67693E+03 3.29085E+02	8.41429E+07 3.04135E+02	-1.62975E-03 3.00000E+02	-9.62635E-03	2.82109E-01	4.90800E+03
6.39545E+02 0.	1.59688E+03 3.30203E+02	1.59688E+03 3.29090E+02	8.41512E+07 3.03926E+02	-1.62977E-03 3.00000E+02	-9.62242E-03	2.82167E-01	4.92600E+03
6.44625E+02 0.	1.52066E+03 3.30153E+02	1.52066E+03 3.29094E+02	8.41591E+07 3.03727E+02	-1.62979E-03 3.00000E+02	-9.61864E-03	2.82219E-01	4.94400E+03
6.49705E+02 0.	1.44810E+03 3.30106E+02	1.44810E+03 3.29099E+02	8.41666E+07 3.03539E+02	-1.62981E-03 3.00000E+02	-9.61500E-03	2.82266E-01	4.96200E+03
6.54786E+02 0.	1.37902E+03 3.30062E+02	1.37901E+03 3.29102E+02	8.41738E+07 3.03361E+02	-1.62983E-03 3.00000E+02	-9.61150E-03	2.82308E-01	4.98000E+03
6.59868E+02 0.	1.31324E+03 3.30019E+02	1.31324E+03 3.29106E+02	8.41807E+07 3.03192E+02	-1.62984E-03 3.00000E+02	-9.60813E-03	2.82346E-01	4.99800E+03
6.64951E+02 0.	1.25062E+03 3.29974E+02	1.25062E+03 3.29110E+02	8.41872E+07 3.03031E+02	-1.62986E-03 3.00000E+02	-9.60488E-03	2.82381E-01	5.01600E+03
6.70034E+02 0.	1.19094E+03 3.29940E+02	1.19094E+03 3.29113E+02	8.41934E+07 3.02879E+02	-1.62988E-03 3.00000E+02	-9.60176E-03	2.82412E-01	5.03400E+03

6.75118E+02 0.	1.13422E+03 3.29904E+02	1.13422E+03 3.29116E+02	8.41993E+07 3.02735E+02	-1.62990E-03 3.00000E+02	-9.59875E-03	2.82440E-01	5.05200E+03
6.80202E+02 0.	1.08017E+03 3.29864E+02	1.08016E+03 3.29120E+02	8.42049E+07 3.02594E+02	-1.62992E-03 3.00000E+02	-9.59586E-03	2.82466E-01	5.07000E+03
6.85287E+02 0.	1.02870E+03 3.29836E+02	1.02870E+03 3.29122E+02	8.42103E+07 3.02464E+02	-1.62993E-03 3.00000E+02	-9.59307E-03	2.82489E-01	5.08800E+03
6.90372E+02 0.	9.79644E+02 3.29804E+02	9.79643E+02 3.29125E+02	8.42154E+07 3.02345E+02	-1.62995E-03 3.00000E+02	-9.59039E-03	2.82509E-01	5.10600E+03
6.95457E+02 0.	9.33033E+02 3.29774E+02	9.33032E+02 3.29128E+02	8.42202E+07 3.02228E+02	-1.62997E-03 3.00000E+02	-9.58781E-03	2.82528E-01	5.12400E+03
7.00543E+02 0.	8.88603E+02 3.29746E+02	8.88602E+02 3.29130E+02	8.42249E+07 3.02117E+02	-1.62998E-03 3.00000E+02	-9.58533E-03	2.82545E-01	5.14200E+03
7.05629E+02 0.	8.46297E+02 3.29719E+02	8.46296E+02 3.29133E+02	8.42293E+07 3.02011E+02	-1.63000E-03 3.00000E+02	-9.58295E-03	2.82560E-01	5.16000E+03
7.10715E+02 0.	8.06013E+02 3.29693E+02	8.06011E+02 3.29135E+02	8.42335E+07 3.01911E+02	-1.63001E-03 3.00000E+02	-9.58065E-03	2.82574E-01	5.17800E+03
7.15801E+02 0.	7.67653E+02 3.29668E+02	7.67652E+02 3.29137E+02	8.42375E+07 3.01816E+02	-1.63003E-03 3.00000E+02	-9.57844E-03	2.82586E-01	5.19600E+03
7.20888E+02 0.	7.31125E+02 3.29645E+02	7.31124E+02 3.29139E+02	8.42413E+07 3.01726E+02	-1.63004E-03 3.00000E+02	-9.57631E-03	2.82598E-01	5.21400E+03
7.25975E+02 0.	6.96342E+02 3.29623E+02	6.96341E+02 3.29141E+02	8.42449E+07 3.01641E+02	-1.63005E-03 3.00000E+02	-9.57427E-03	2.82608E-01	5.23200E+03
7.31062E+02 0.	6.63219E+02 3.29602E+02	6.63218E+02 3.29143E+02	8.42484E+07 3.01560E+02	-1.63007E-03 3.00000E+02	-9.57230E-03	2.82617E-01	5.25000E+03
7.36149E+02 0.	6.31677E+02 3.29582E+02	6.31676E+02 3.29145E+02	8.42517E+07 3.01483E+02	-1.63008E-03 3.00000E+02	-9.57040E-03	2.82625E-01	5.26800E+03
7.41236E+02 0.	6.01640E+02 3.29562E+02	6.01639E+02 3.29147E+02	8.42548E+07 3.01409E+02	-1.63009E-03 3.00000E+02	-9.56858E-03	2.82633E-01	5.28600E+03
7.46324E+02 0.	5.73036E+02 3.29544E+02	5.73035E+02 3.29148E+02	8.42578E+07 3.01340E+02	-1.63010E-03 3.00000E+02	-9.56683E-03	2.82639E-01	5.30400E+03
7.51411E+02 0.	5.45795E+02 3.29527E+02	5.45795E+02 3.29150E+02	8.42606E+07 3.01274E+02	-1.63011E-03 3.00000E+02	-9.56514E-03	2.82645E-01	5.32200E+03
7.56499E+02 0.	5.19854E+02 3.29510E+02	5.19853E+02 3.29151E+02	8.42634E+07 3.01211E+02	-1.63012E-03 3.00000E+02	-9.56352E-03	2.82651E-01	5.34000E+03
7.61587E+02 0.	4.95149E+02 3.29495E+02	4.95149E+02 3.29153E+02	8.42659E+07 3.01152E+02	-1.63013E-03 3.00000E+02	-9.56196E-03	2.82656E-01	5.35800E+03

7.66675E+02 0.	4.71622F+02 3.29480F+02	4.71621F+02 3.29154E+02	8.42684F+07 3.01045F+02	-1.63014E-03 3.00000E+02	-9.56046E-03	2.82660E-01	5.37600E+03
7.71762E+02 0.	4.49215F+02 3.29465F+02	4.49215E+02 3.29156E+02	8.42707E+07 3.01041E+02	-1.63015E-03 3.00000E+02	-9.55902E-03	2.82664E-01	5.39400E+03
7.76850E+02 0.	4.27876F+02 3.29452F+02	4.27875E+02 3.29157E+02	8.42730E+07 3.00990E+02	-1.63016E-03 3.00000E+02	-9.55763E-03	2.82668E-01	5.41200E+03
7.81939E+02 0.	4.07553F+02 3.29439F+02	4.07553E+02 3.29158E+02	8.42751E+07 3.00942E+02	-1.63017E-03 3.00000E+02	-9.55629E-03	2.82671E-01	5.43000E+03
7.87027E+02 0.	3.88198E+02 3.29427F+02	3.88197E+02 3.29159E+02	8.42771E+07 3.00896E+02	-1.63018E-03 3.00000E+02	-9.55501E-03	2.82674E-01	5.44800E+03
7.92115E+02 0.	3.69764F+02 3.29415F+02	3.69763E+02 3.29160E+02	8.42790E+07 3.00852F+02	-1.63019E-03 3.00000E+02	-9.55377E-03	2.82677E-01	5.46600E+03
7.97203E+02 0.	3.52208F+02 3.29404F+02	3.52207E+02 3.29161E+02	8.42809E+07 3.00810E+02	-1.63020E-03 3.00000E+02	-9.55259E-03	2.82679E-01	5.48400E+03
8.02291E+02 0.	3.35486F+02 3.29393F+02	3.35486E+02 3.29162E+02	8.42826E+07 3.00771E+02	-1.63020E-03 3.00000E+02	-9.55144E-03	2.82681E-01	5.50200E+03
8.07380E+02 0.	3.19561F+02 3.29383F+02	3.19560E+02 3.29163E+02	8.42843F+07 3.00733E+02	-1.63021E-03 3.00000E+02	-9.55034E-03	2.82683E-01	5.52000E+03
8.12466E+02 0.	3.04393F+02 3.29373F+02	3.04393E+02 3.29164E+02	8.42859E+07 3.00698E+02	-1.63022E-03 3.00000E+02	-9.54929E-03	2.82685E-01	5.53800E+03
8.17556E+02 0.	2.89946F+02 3.29364F+02	2.89946E+02 3.29165E+02	8.42874E+07 3.00664E+02	-1.63022E-03 3.00000E+02	-9.54827E-03	2.82687E-01	5.55600E+03
8.22645E+02 0.	2.76187F+02 3.29355F+02	2.76186E+02 3.29165E+02	8.42888F+07 3.00631E+02	-1.63023E-03 3.00000E+02	-9.54729E-03	2.82688E-01	5.57400E+03
8.27733E+02 0.	2.63081F+02 3.29347F+02	2.63081E+02 3.29166E+02	8.42902E+07 3.00601E+02	-1.63024E-03 3.00000E+02	-9.54635E-03	2.82689E-01	5.59200E+03
8.32821E+02 0.	2.50599E+02 3.29339F+02	2.50599E+02 3.29167E+02	8.42915E+07 3.00572E+02	-1.63024E-03 3.00000E+02	-9.54545E-03	2.82691E-01	5.61000E+03
8.37910E+02 0.	2.38710F+02 3.29332F+02	2.38710E+02 3.29167E+02	8.42928F+07 3.00544E+02	-1.63025E-03 3.00000E+02	-9.54458E-03	2.82692E-01	5.62800E+03
8.42998F+02 0.	2.27386F+02 3.29325F+02	2.27385E+02 3.29168F+02	8.42939E+07 3.00517E+02	-1.63025E-03 3.00000E+02	-9.54374E-03	2.82692E-01	5.64600E+03
8.48087F+02 0.	2.16600F+02 3.29318F+02	2.16599F+02 3.29169F+02	8.42951E+07 3.00492E+02	-1.63026E-03 3.00000E+02	-9.54294E-03	2.82693E-01	5.66400E+03
9.53175F+02 0.	2.06326F+02 3.29311F+02	2.06326E+02 3.29169F+02	8.42962F+07 3.00469F+02	-1.63026E-03 3.00000E+02	-9.54217E-03	2.82694E-01	5.68200E+03

2.58264E+02 0.	1.96540E+02 3.29305E+02	1.96540E+02 3.29170E+02	8.42772E+07 3.00444E+02	-1.63027E-03 3.00000E+02	-9.54142E-03	2.82695E-01	5.70000E+03
8.63352E+02 0.	1.87220E+02 3.29299E+02	1.87219E+02 3.29170E+02	8.42842E+07 3.00424E+02	-1.63027E-03 3.00000E+02	-9.54071E-03	2.82695E-01	5.71800E+03
8.68441E+02 0.	1.78342E+02 3.29294E+02	1.78341E+02 3.29171E+02	8.42991E+07 3.00404E+02	-1.63028E-03 3.00000E+02	-9.54002E-03	2.82696E-01	5.73600E+03
8.73529E+02 0.	1.69885E+02 3.29288E+02	1.69885E+02 3.29171E+02	8.43000E+07 3.00384E+02	-1.63028E-03 3.00000E+02	-9.53936E-03	2.82696E-01	5.75400E+03
8.78618E+02 0.	1.61830E+02 3.29283E+02	1.61830E+02 3.29172E+02	8.43008E+07 3.00366E+02	-1.63028E-03 3.00000E+02	-9.53873E-03	2.82697E-01	5.77200E+03
8.83706E+02 0.	1.54157E+02 3.29278E+02	1.54157E+02 3.29172E+02	8.43016E+07 3.00348E+02	-1.63029E-03 3.00000E+02	-9.53811E-03	2.82697E-01	5.79000E+03
8.88795E+02 0.	1.46849E+02 3.29274E+02	1.46849E+02 3.29173E+02	8.43024E+07 3.00331E+02	-1.63029E-03 3.00000E+02	-9.53753E-03	2.82698E-01	5.80800E+03
8.93884E+02 0.	1.39887E+02 3.29269E+02	1.39887E+02 3.29173E+02	8.43031E+07 3.00315E+02	-1.63029E-03 3.00000E+02	-9.53696E-03	2.82698E-01	5.82600E+03
8.98972E+02 0.	1.32566E+02 3.29265E+02	1.32566E+02 3.29173E+02	8.43038E+07 3.00300E+02	-1.63030E-03 3.00000E+02	-9.53642E-03	2.82698E-01	5.84400E+03
9.04061E+02 0.	1.26940E+02 3.29261E+02	1.26939E+02 3.29174E+02	8.43045E+07 3.00286E+02	-1.63030E-03 3.00000E+02	-9.53590E-03	2.82698E-01	5.86200E+03
9.09149E+02 0.	1.20923E+02 3.29257E+02	1.20923E+02 3.29174E+02	8.43051E+07 3.00272E+02	-1.63030E-03 3.00000E+02	-9.53539E-03	2.82699E-01	5.88000E+03
9.14238E+02 0.	1.15192E+02 3.29254E+02	1.15191E+02 3.29175E+02	8.43057E+07 3.00259E+02	-1.63031E-03 3.00000E+02	-9.53491E-03	2.82699E-01	5.89800E+03
9.19326E+02 0.	1.09732E+02 3.29250E+02	1.09732E+02 3.29175E+02	8.43063E+07 3.00247E+02	-1.63031E-03 3.00000E+02	-9.53445E-03	2.82699E-01	5.91600E+03
9.24415E+02 0.	1.04532E+02 3.29247E+02	1.04532E+02 3.29175E+02	8.43068E+07 3.00235E+02	-1.63031E-03 3.00000E+02	-9.53400E-03	2.82699E-01	5.93400E+03
9.29504E+02 0.	9.95780E+01 3.29244E+02	9.95779E+01 3.29175E+02	8.43073E+07 3.00223E+02	-1.63031E-03 3.00000E+02	-9.53357E-03	2.82699E-01	5.95200E+03
9.34592E+02 0.	9.48592E+01 3.29241E+02	9.48591E+01 3.29176E+02	8.43078E+07 3.00213E+02	-1.63032E-03 3.00000E+02	-9.53316E-03	2.82699E-01	5.97000E+03
9.39681E+02 0.	9.03643E+01 3.29238E+02	9.03641E+01 3.29176E+02	8.43083E+07 3.00202E+02	-1.63032E-03 3.00000E+02	-9.53276E-03	2.82699E-01	5.98800E+03
9.44769E+02 0.	8.60624E+01 3.29235E+02	8.60623E+01 3.29176E+02	8.43087E+07 3.00193E+02	-1.63032E-03 3.00000E+02	-9.53238E-03	2.82700E-01	6.00600E+03

9.49854E+02 0.	8.20037E+01 3.29233E+02	4.20036E+01 3.29176E+02	8.43092E+07 3.00184E+02	-1.63032E-03 3.00000E+02	-9.53201E-03	2.82700E-01	6.02400E+03
9.54946E+02 0.	7.81143E+01 3.29230E+02	7.81142E+01 3.29177E+02	8.43094E+07 3.00175E+02	-1.63032E-03 3.00000E+02	-9.53166E-03	2.82700E-01	6.04200E+03
9.60035E+02 0.	7.44172E+01 3.29228E+02	7.44171E+01 3.29177E+02	8.43100E+07 3.00166E+02	-1.63033E-03 3.00000E+02	-9.53132E-03	2.82700E-01	6.06000E+03
9.65124E+02 0.	7.08915E+01 3.29226E+02	7.08914E+01 3.29177E+02	8.43103E+07 3.00158E+02	-1.63033E-03 3.00000E+02	-9.53100E-03	2.82700E-01	6.07800E+03
9.70212E+02 0.	6.75330E+01 3.29224E+02	6.75329E+01 3.29177E+02	8.43107E+07 3.00151E+02	-1.63033E-03 3.00000E+02	-9.53068E-03	2.82700E-01	6.09600E+03
9.75301E+02 0.	6.43337E+01 3.29222E+02	6.43336E+01 3.29177E+02	8.43110E+07 3.00144E+02	-1.63033E-03 3.00000E+02	-9.53038E-03	2.82700E-01	6.11400E+03
9.80389E+02 0.	6.12860E+01 3.29220E+02	6.12859E+01 3.29178E+02	8.43113E+07 3.00137E+02	-1.63033E-03 3.00000E+02	-9.53009E-03	2.82700E-01	6.13200E+03
9.85478E+02 0.	5.83828E+01 3.29218E+02	5.83827E+01 3.29178E+02	8.43117E+07 3.00130E+02	-1.63033E-03 3.00000E+02	-9.52981E-03	2.82700E-01	6.15000E+03
9.90567E+02 0.	5.56172E+01 3.29216E+02	5.56171E+01 3.29178E+02	8.43119E+07 3.00124E+02	-1.63034E-03 3.00000E+02	-9.52955E-03	2.82700E-01	6.16800E+03
9.95655E+02 0.	5.29827E+01 3.29214E+02	5.29826E+01 3.29178E+02	8.43122E+07 3.00118E+02	-1.63034E-03 3.00000E+02	-9.52929E-03	2.82700E-01	6.18600E+03
1.00074E+03 0.	5.04730E+01 3.29213E+02	5.04730E+01 3.29178E+02	8.43125E+07 3.00112E+02	-1.63034E-03 3.00000E+02	-9.52904E-03	2.82700E-01	6.20400E+03

TIME END DELTA T POWINT OUT ITES IN ITES
 1.00527E+03 2.82700E-01 8.43127E+07 6.22000E+03 0.

K N(K-1) PHU(K-1)
 1 1.32155E+09-1.63034E-03
 2-1.11900E+04-2.06267E-13
 3 2.22852E-02 2.41234E-18
 4 6.34851E-04 3.33238E-22
 5-5.56152E-06-3.48767E-24
 6 4.86593E-08 3.05270E-26

C(K-1,I)
 1.13617E+11 1.05108E+11 1.94709E+10 1.36497E+10 1.03362E+09 1.41430E+08 -9.61793E+05 -8.90965E+05 -1.64998E+05
 -1.15667E+05 -8.75935E+03 -1.19844E+03 8.14116E+00 7.57081E+00 1.41016E+00 1.00356E+00 8.16054E-02 1.35790E-02
 -8.50336E-05 -1.72225E-04 -1.09910E-04 -2.09081E-04 -6.49473E-05 -2.99976E-05 1.42246E-07 9.45563E-07 8.57857E-07
 1.75640E-06 5.62735E-07 2.61704E-07 -1.23946E-07 -8.26837E-09 -7.50474E-09 -1.53666E-08 -4.92347E-09 -2.28971E-09

T(K-1,J)
 3.29211E+02 3.29178E+02 3.00108E+02 3.00000E+02 -2.58088E-07 2.32894E-08 -9.19387E-07 0. 2.12026E-12
 -1.98062E-13 7.05894E-12 0. -3.98712E-17 1.56491E-18 -7.36459E-17 0. 2.20086E-19 5.23292E-22
 3.38147E-19 0. -1.92519E-21 -4.68152E-24 -2.95985E-21 0.

RUNNING TIME = 1.05

NPRT = 297

ALF/ro:311(50)