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THE CALCULATION OF TRANSIENT TEMPERATURE
DISTRIBUTIONS IN A SOLID CYLINDRICAL PIN,
COOLED ON THE SURFACE

IBM-704 PROGRAM 524/RE-147

by

J. Heestand
Applied Mathematics Division

and

D. F. Schoeberle and L. B. Miller
Reactor Engineering Division

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ABSTRACT

The IBM-704 program RE-147 is used to calculate the time and space-dependent temperature distribution in a solid cylindrical fuel pin, cooled on the surface, with internal heat generation. The fuel pin may be bare or clad, and its boundary may be cooled by either flowing or stagnant coolant. The heat generation source may also be time and space dependent.

Specifically, the Program considers the fuel pin to be composed of two regions and then solves, by the usual finite difference methods, the heat conduction partial differential equation in the two regions. Simultaneously, the axial and time variation of the coolant temperature is calculated by a finite difference approximate solution of the energy equation for the coolant. An approximate method is included to allow for the effects of solid-state phase changes. In conjunction with the phase-changing procedure, the material properties are permitted to vary from one phase to the next.

I. LIST OF SYMBOLS

<u>Symbol</u>	<u>Definition</u>	<u>Restrictions</u>
Prob. No.	Problem identification number of the form XX.YYYYYY where XX is the problem originator's identification and YYYYYY is the chronological problem identification.	
I	Number of node points in fuel and clad in r-direction.	$I \geq 5$ $J \geq 1$ $2I + 7J + 8IJ \leq U$, where $U = \begin{cases} 4056 & \text{for 8k memory} \\ 28632 & \text{for 32K memory} \end{cases}$
J	Number of node points in z direction.	

<u>Symbol</u>	<u>Definition</u>	<u>Restrictions</u>
R_b	Radius of fuel out to clad region (ft).	
R_0	Radius of pin (ft).	
R_s	Radius of center of coolant (ft).	
$\Delta\tau$	Unit time interval (sec).	
Δz	Distance between node points in z direction (ft).	
V	Velocity of coolant (ft/sec).	
ψ_0	Inlet coolant temperature ($^{\circ}\text{F}$).	Constant value for entire problem.
N	Routine temperature printouts are provided at time intervals of $N \cdot \Delta\tau$.	
β	If $n(\tau)$ is to be given as input, β is the number of time intervals between input values of $n(\tau)$.	Specify either β or p .
p	If $n(\tau)$ is to be computed as $e^{\tau/p}$ for each value of τ throughout the problem, p is the period of this function (sec).	If p is specified, NT must = 0.
τ_f	Value of τ for which problem will terminate (sec).	
P	Coolant input temperature parameter.	$\left\{ \begin{array}{l} = 0 \text{ if } \psi_j(0) \\ = \psi_1(0) \text{ for all } j. \\ = 1 \text{ if all } \psi_j(0) \\ \text{are given as} \\ \text{input.} \end{array} \right.$
T	Pin input temperature parameter.	$\left\{ \begin{array}{l} = 0 \text{ if } T_{ij}(0) \text{ is} \\ \text{to be computed.} \\ = 1 \text{ if } T_{ij}(0) \\ = T_{11}(0) \text{ for all} \\ ij. \\ = 2 \text{ if all } T_{ij}(0) \\ \text{are given as} \\ \text{input.} \end{array} \right.$
NT	Number of $n(\tau)$'s given as input.	$\left\{ \begin{array}{l} = 0 \text{ if } n(\tau) \\ = e^{\tau/p}. \\ \leq 250 \text{ if } n(\tau) \text{ is} \\ \text{input.} \end{array} \right.$

<u>Symbol</u>	<u>Definition</u>	<u>Restrictions</u>
W	Coolant motion parameter.	$\left\{ \begin{array}{l} = 0 \text{ if coolant is stagnant.} \\ = 1 \text{ if coolant is flowing.} \end{array} \right.$
k_f	Thermal conductivity of the fuel, 4 values corresponding to the 4 material phases (BTU/sec-ft-°F).	
k_b	Thermal conductivity of the clad, 4 values (BTU/sec-ft-°F).	
k_s	Thermal conductivity of the coolant, 4 values (BTU/sec-ft-°F).	
ρC_f	Density times specific heat of the fuel, 4 values (BTU/ft ³ -°F).	
ρC_b	Density times specific heat of the clad, 4 values (BTU/ft ³ -°F).	
ρC_s	Density times specific heat of the coolant, 4 values (BTU/ft ³ -°F).	
h	Film coefficient of the coolant, 4 values (BTU/sec-ft ² -°F).	
$T_{\alpha\beta_f}$ $T_{\beta\gamma_f}$ $T_{\gamma\delta_f}$	$\left. \begin{array}{l} \\ \\ \end{array} \right\}$ Transformation temperatures for the fuel (°F).	
$T_{\alpha\beta_b}$ $T_{\beta\gamma_b}$ $T_{\gamma\delta_b}$	$\left. \begin{array}{l} \\ \\ \end{array} \right\}$ Transformation temperatures for the clad (°F).	
$\psi_{\alpha\beta}$ $\psi_{\beta\gamma}$ $\psi_{\gamma\delta}$	$\left. \begin{array}{l} \\ \\ \end{array} \right\}$ Transformation temperatures for the coolant (°F).	
$\Delta T_{\alpha\beta_f}$ $\Delta T_{\beta\gamma_f}$ $\Delta T_{\gamma\delta_f}$	$\left. \begin{array}{l} \\ \\ \end{array} \right\}$ Fictitious transformation temperature changes for the fuel (°F).	

<u>Symbol</u>	<u>Definition</u>	<u>Restrictions</u>
$\left. \begin{array}{l} \Delta T_{\alpha\beta b} \\ \Delta T_{\beta\gamma b} \\ \Delta T_{\gamma\delta b} \end{array} \right\}$	Fictitious transformation temperature changes for the clad ($^{\circ}\text{F}$).	
$n(\tau)$	Function by which internal heat generation rate varies.	NT values given, 1 for each $\beta\Delta\tau$ interval.
$T_{ij}(\tau)$	Temperature of node point ij in fuel and clad at time τ ($^{\circ}\text{F}$).	
$\psi_j(\tau)$	Temperature of node point j in coolant at time τ ($^{\circ}\text{F}$).	
ξ_j	Power distribution factors in z direction.	
μ_i	Power distribution factors in r direction.	
q_0	Power normalization coefficient (BTU/sec-ft ³)	
T'_{ij}	Accumulation of heat at point ij in excess of appropriate transformation temperature, but less than corresponding fictitious transformation temperature change.	
$T_{ij}(\tau + \Delta\tau)$	New temperature of pin node point ij after one iteration.	
$\psi_j(\tau + \Delta\tau)$	New temperature of coolant node point j after one iteration.	
$PC_{T_{ij}}$	An integer varying from 4 to 1 to correspond with the current phase 1 to 4 of pin node point ij.	
PC_{ψ_j}	An integer varying from 4 to 1 to correspond with the current phase 1 to 4 of the coolant node point j.	

<u>Symbol</u>	<u>Definition</u>	<u>Restrictions</u>
B_{ij} C_{ij} D_{ij} E_{ij} F_{ij} G_{Ij} $1 - G_{Ij} - H$ H	Coefficients of the difference equations for the temperature at pin node point ij and coolant node point j.	All coefficients must be ≥ 0 .

II. MATHEMATICAL ANALYSIS

A. General Problem Description

As a part of the continuing Fast Reactor Safety Program, an interest was developed in calculating the transient temperature behavior of EBR-II core fuel pins during irradiation in the TREAT Reactor.⁽¹⁾ With an IBM-704 digital computer readily available, a logical approach seemed to be a finite difference method solution of the heat conduction partial differential equation. At the same time, a decision was made to keep the calculation method flexible enough such that various other cylindrical pin-type fuel elements could be analyzed, whether clad or unclad. Thus, a program was desired to calculate the time and space-dependent temperature distribution in a solid cylindrical fuel pin, cooled on the surface, with internal heat generation.

Figure 1 shows a typical radial section through a solid fuel pin with the associated finite coolant region. The fuel pin is assumed to be very long compared to its diameter, so that axial heat conduction in the pin can be neglected. However, axial transport of heat, due to coolant motion, is considered for the coolant region.

The partial differential equation for radial heat conduction can be written as

$$(\rho C_p) \frac{\partial T}{\partial \tau} = \frac{1}{r} \left[\frac{\partial}{\partial r} \left(kr \frac{\partial T}{\partial r} \right) \right] + q_1(r, \tau) \quad , \quad (A)$$

where

$T(r, \tau)$ = fuel or clad temperature

k = fuel or clad thermal conductivity

$q_1(r, \tau)$ = rate of heat generation in fuel region

$(\rho C_p)_1$ = volumetric heat capacity of fuel or clad.

Equation (A) is to be solved in two regions (Regions 1 and 2 may contain either fuel or cladding material), and the heat generation term may be absent for either one or both regions.

In this study, equation (A) will be simplified for ease of solution. The thermal conductivity k of the fuel or clad material will be assumed constant (independent of temperature) over a limited temperature range. Equation (A) may then be written as

$$(\rho C_p) \frac{\partial T}{\partial \tau} = k \left[\frac{\partial^2 T}{\partial r^2} + \frac{1}{r} \frac{\partial T}{\partial r} \right] + q_1(r, \tau) \quad (1)$$

For the coolant region (Region 3 of Fig. 1), the differential equation of heat transport may be written as

$$\frac{\partial \psi}{\partial \tau} = -V \frac{\partial \psi}{\partial z} + q_2(z, \tau) / (\rho C)_2, \quad (2)$$

where

$\psi(z, \tau)$ = coolant temperature

V = coolant velocity

$q_2(z, \tau)$ = rate of heat addition to coolant

$(\rho C)_2$ = volumetric heat capacity of coolant.

B. Mesh Description

In equations (1) and (2) the time variable is denoted by τ and the space variables by r and z . For a finite difference method solution of these equations, the space variables (r, z) are divided into finite increments $(\Delta r, \Delta z)$ within the three regions considered. A node point is then assigned at the midpoint of the increments, and the differential equation is expanded into a difference equation about the appropriate node point. Figure 1 shows the layout of radial node points selected for this study. This choice is identical to Fig. 12-13 of Dusenberre's standard reference work.⁽²⁾

The subscript i locates the node point along a radial path, and I denotes the total number of radial node points in Regions 1 and 2 (see Fig. 1). The subscript j locates the radial path in the axial z direction, and J denotes the total number of radial rows in the pin. The first radial point ($i = 1$) is at the exact center of the pin; the last radial node point ($i = I$) is at the outer radius of the pin (at R_0), and, to simplify the analysis, the node point ($i = I - 1$) is the only interior radial node point in Region 2. Only one radial node point is taken in the coolant region, and that is in the center of Region 3 (at radius R_s). The radial increment Δr is constant within a region, and the axial increment Δz is constant.

Figure 2 summarizes the mesh point layout for the case of upward coolant flow along the pin. If the coolant flow is downward, the node point ψ_j becomes ψ_0 , the radial row $j = 1$ is advanced one Δz unit below the top of the pin, the j -numbering system is reversed, and the last radial row, $j = J$, will fall on the lower end of the pin.

FIG. 2
MESH POINT LAYOUT
(NO SCALE)

C. Finite Difference Equations for Pin Regions

The finite difference equation, for a typical interior point (ij) is derived by transforming equation (1). The derivatives in equation (1) are replaced by their appropriate finite difference approximations. The time derivative $\partial T / \partial \tau$ is replaced by the forward difference quotient as follows:

$$\frac{\partial T}{\partial \tau} \rightarrow \frac{T_i(\tau + \Delta \tau) - T_i(\tau)}{\Delta \tau}, \quad (3)$$

where $\Delta \tau$ is the finite time increment. The space derivatives in equation (1) are replaced by the following approximations:

$$\frac{\partial^2 T}{\partial r^2} \rightarrow \frac{T_{i+1}(\tau) - 2T_i(\tau) + T_{i-1}(\tau)}{\Delta r^2} \quad (4)$$

$$\frac{\partial T}{\partial r} \rightarrow \frac{T_{i+1}(\tau) - T_{i-1}(\tau)}{2\Delta r} \quad (5)$$

and, finally, the radius r is replaced by the radius out to the node point ($r \rightarrow r_i$). After substituting in the relations (3), (4) and (5), and simultaneously adding up the heat generation during the finite time increment $\Delta\tau$, equation (1) becomes

$$\begin{aligned} \frac{T_i(\tau + \Delta\tau) - T_i(\tau)}{\Delta\tau} = \alpha \left\{ \frac{T_{i+1}(\tau) - 2T_i(\tau) + T_{i-1}(\tau)}{\Delta r^2} \right. \\ \left. + \frac{1}{r_i} \left[\frac{T_{i+1}(\tau) - T_{i-1}(\tau)}{2\Delta r} \right] \right\} \\ + \frac{1}{(\rho C)_1} \int_{\tau}^{\tau + \Delta\tau} q_1(r, \tau) d\tau / \Delta\tau \quad (6) \end{aligned}$$

The heat generation function is now represented by the product of a space-dependent and a time-dependent function:

$$q_1(r, \tau) = Q(r) n(\tau) \quad (7)$$

The integration in equation (6) is approximated by a 2-point trapezoidal rule, and equation (6) is simplified to yield

$$\begin{aligned} T_i(\tau + \Delta\tau) = T_{i+1}(\tau) \left[\frac{\alpha\Delta\tau}{\Delta r^2} + \frac{\alpha\Delta\tau}{2r_i\Delta r} \right] + T_i(\tau) \left[1 - \frac{2\alpha\Delta\tau}{\Delta r^2} \right] \\ + T_{i-1}(\tau) \left[\frac{\alpha\Delta\tau}{\Delta r^2} - \frac{\alpha\Delta\tau}{2r_i\Delta r} \right] \\ + \frac{Q(r)\Delta\tau}{(\rho C)_1} \left[\frac{n(\tau + \Delta\tau) + n(\tau)}{2} \right] \quad (8) \end{aligned}$$

Following customary practice,⁽³⁾ the modulus M is defined as

$$M = \frac{\Delta r^2}{\alpha\Delta\tau} \quad (9)$$

With this definition, equation (8) becomes

$$\begin{aligned} T_i(\tau + \Delta\tau) = T_{i-1}(\tau) \left[\frac{1}{M} \left(1 - \frac{\Delta r}{2r_i} \right) \right] + T_i(\tau) \left[1 - \frac{2}{M} \right] + T_{i+1}(\tau) \left[\frac{1}{M} \left(1 + \frac{\Delta r}{2r_i} \right) \right] \\ + \frac{Q(r)\Delta\tau}{(\rho C)_1} \left[\frac{n(\tau + \Delta\tau) + n(\tau)}{2} \right] \quad (10) \end{aligned}$$

Equation (10) can be further simplified for computation. Inspection of Fig. 1 shows that for Region 1 the radius r_i is always an integral number of units of Δr ; in fact

$$r_i = (i-1) \Delta r \quad . \quad (11)$$

Defining the coefficients in (10) as being B_i , C_i , D_i , and F_i , respectively, and using equation (11), equation (10) is written as

$$T_i(\tau + \Delta\tau) = B_i T_{i-1}(\tau) + C_i T_i(\tau) + D_i T_{i+1}(\tau) + F_i \left[\frac{n(\tau + \Delta\tau) + n(\tau)}{2} \right], \quad (12)$$

where

$$\begin{aligned} B_i &= \frac{2i-3}{2(i-1)M} \quad , & C_i &= 1 - (2/M) \quad , \\ D_i &= \frac{2i-1}{2(i-1)M} \quad , & F_i &= \frac{Q(r) \Delta\tau}{(\rho C)_1} \quad . \end{aligned}$$

Equation (12) is not valid for node point $i=1$, where $r_i = 0$ causes a singularity in equation (6); and (12) is also not valid for points $i=I-2$, $I-1$, and $i=I$, where boundary coupling is required with adjacent regions. The simplest procedure to use in deriving difference equations about these node points is to follow the method of Reference 2 directly. This procedure is illustrated for the node point $i=1$.

First, assume that a time interval $\Delta\tau$ can be chosen sufficiently small that:

1. Only the local temperature and the temperature of adjacent reference points need be considered in calculating the change of the local temperature during this time interval. Thus, only $T_1(\tau)$ and $T_2(\tau)$ need be considered in calculating $T_1(\tau + \Delta\tau)$.
2. The initial heat transfer rates may be used over the entire interval $\Delta\tau$.
3. The change of heat storage in an element may be calculated from the change of temperature of the reference point located in that element.

Consider the half-element, of radius $r_i = \frac{1}{2} \Delta r_f$, surrounding node point $i=1$. A heat balance (for conservation of energy) for this element can be written as

$$\left(\begin{array}{c} \text{Heat} \\ \text{Stored} \end{array} \right) = \left(\begin{array}{c} \text{Heat} \\ \text{conducted in} \end{array} \right) - \left(\begin{array}{c} \text{Heat} \\ \text{conducted out} \end{array} \right) + \left(\begin{array}{c} \text{Heat} \\ \text{generated} \end{array} \right) \quad (13)$$

Using the laws of heat conduction and the assumptions outlined above, equation (13) becomes

$$\left. \begin{aligned} (\rho C)_1 V_1 \left[\frac{T_1(\tau + \Delta\tau) - T_1(\tau)}{\Delta\tau} \right] &= 0 - \frac{k A_{12} [T_1(\tau) - T_2(\tau)]}{\Delta r_f} \\ &+ \int_{\tau}^{\tau + \Delta\tau} Q(r) n(\tau) V_1 d\tau / \Delta\tau \end{aligned} \right\} \quad (14)$$

where

$(\rho C)_1$ = volumetric heat capacity of material

k = thermal conductivity of material

V_1 = volume of element around point $i=1$

A_{12} = heat conduction area between elements $i=1$ and $i=2$.

For simplicity, consider the circular arc around the element to subtend a central angle of $\theta = 1$ radian, and thus the arc length and radius of the arc are numerically equal. From Fig. 1, it is easily seen that

$$\left. \begin{aligned} V_1 &= \frac{\overline{\Delta r_f^2}}{8} \Delta z \\ A_{12} &= 1/2 \overline{\Delta r_f} \Delta z \end{aligned} \right\} \quad (15)$$

Combinations of equations (14) and (15) will yield

$$\begin{aligned} (\rho C)_1 \left(\frac{\overline{\Delta r_f^2}}{8} \Delta z \right) \left[\frac{T_1(\tau + \Delta\tau) - T_1(\tau)}{\Delta\tau} \right] &= -k \frac{\overline{\Delta r_f}}{2} \Delta z \left[\frac{T_1(\tau) - T_2(\tau)}{\overline{\Delta r_f}} \right] \\ &+ \int_{\tau}^{\tau + \Delta\tau} Q(r) n(\tau) \left[\frac{\overline{\Delta r_f^2}}{8} \Delta z \right] d\tau / \Delta\tau . \end{aligned}$$

Simplification of this equation and approximation of the integration, as in equation (8), yields

$$T_1(\tau + \Delta\tau) - T_1(\tau) = \frac{4}{M} \left[T_2(\tau) - T_1(\tau) \right] + \frac{Q(r) \Delta\tau}{(\rho C)_1} \left[\frac{n(\tau + \Delta\tau) + n(\tau)}{2} \right] .$$

Finally, on collecting like terms, the difference equation becomes

$$T_1(\tau + \Delta\tau) = \left(1 - \frac{4}{M}\right) T_1(\tau) + \frac{4}{M} T_2(\tau) + \frac{Q(r)\Delta\tau}{(\rho C)_1} \left[\frac{n(\tau + \Delta\tau) + n(\tau)}{2} \right] \quad (16)$$

Equation (16) is seen to be of the exact same form as equation (12), but with the coefficients $B_1 = 0$, $C_1 = 1 - (4/M)$, and $D_1 = 4/M$.

This procedure is also followed in the derivation of difference equations for the outer three node points: $i = I-2$, $I-1$, and $i = I$. The results show that the difference equations, for any point i , can always be written in the form

$$T_{i,j}(\tau + \Delta\tau) = B_i T_{i-1,j}(\tau) + C_i T_{i,j}(\tau) + D_i T_{i+1,j}(\tau) + E_{i,j} \psi_j(\tau) + F_{i,j} \left[\frac{n(\tau + \Delta\tau) + n(\tau)}{2} \right] \quad (17)$$

where the coefficients in (17) are given herein as Table I. The first two rows in this table are seen to be the coefficient from equations (16) and (12).

Table I

Node point i	B_i	C_i	D_i	$E_{i,j}$	$F_{i,j}$
1	0	$1 - \frac{4}{M_f}$	$\frac{4}{M_f}$	0	$\frac{q_0 \Delta\tau \mu_i \xi_j}{\rho C_f}$
$1 < i < I-2$	$\frac{i-3/2}{(i-1)M_f}$	$1 - \frac{2}{M_f}$	$\frac{i-1/2}{(i-1)M_f}$	0	$\frac{q_0 \Delta\tau \mu_i \xi_j}{\rho C_f}$
$I-2$	$\frac{I-7/2}{(I-3)M_f}$	$1 - B_{I-2} - D_{I-2}$	$\frac{2(I-5/2)K_f}{(I-3)M_f}$	0	$\frac{q_0 \Delta\tau \mu_i \xi_j}{\rho C_f}$
$I-1$	$\frac{2(I-5/2)L_f}{M_b}$	$1 - B_{I-1} - D_{I-1}$	$\frac{R_0 - \bar{\Delta}r_b/2}{M_b(R_0 - \bar{\Delta}r_b)}$	0	$\frac{q_0 \Delta\tau \mu_i \xi_j}{\rho C_b}$
I	$\frac{4(2R_0 - \bar{\Delta}r_b)}{M_b(4R_0 - \bar{\Delta}r_b)}$	$I - B_I - E_{j,I}$	0	$\frac{N_b}{M_b}$	$\frac{q_0 \Delta\tau \mu_i \xi_j}{\rho C_b}$

$$G_{I,j} = \frac{N_s}{M_s}$$

$$H = \frac{v \Delta\tau}{\Delta z}$$

Table I (continued)

where

$$M_f = \frac{\overline{\Delta r_f^2}}{\alpha_f \Delta \tau}$$

$$M_b = \frac{\overline{\Delta r_b^2}}{\alpha_b \Delta \tau}$$

$$M_s = \frac{\overline{\Delta r_s^2}}{\alpha_s \Delta \tau}$$

$$K_f = \frac{1}{1 + \frac{\overline{\Delta r_b} k_f}{\overline{\Delta r_f} k_b}}$$

$$L_f = K_f \left(\frac{\overline{\Delta r_b} k_f}{(R_0 - \overline{\Delta r_b}) k_b} \right)$$

$$\alpha_f = \frac{k_f}{\rho C_f}$$

$$\alpha_b = \frac{k_b}{\rho C_b}$$

$$\alpha_s = \frac{k_s}{\rho C_s}$$

$$N_b = \begin{cases} \frac{16 k_s \overline{\Delta r_b} A_{Is}}{k_b \overline{\Delta r_s} (4R_0 - \overline{\Delta r_b}) \Delta z} & \text{for stagnant coolant} \\ \frac{8 h_j \overline{\Delta r_b} R_0}{k_b (4R_0 - \overline{\Delta r_b})} & \text{for flowing coolant} \end{cases}$$

$$A_{Is} = \frac{(R_s - R_0) \overline{\Delta z}}{\ln(R_s/R_0)}$$

$$N_s = \begin{cases} \frac{2 A_{Is}}{R_s \overline{\Delta z}} & \text{for stagnant coolant} \\ \frac{R_0 h_j \overline{\Delta r_s}}{R_s k_s} & \text{for flowing coolant} \end{cases}$$

$$\overline{\Delta r_f} = \frac{R_b}{(I-5/2)}$$

Table I (continued)

$$\overline{\Delta r_b} = 2/3 (R_0 - R_b)$$

$$\overline{\Delta r_s} = 2 (R_s - R_0)$$

A further assumption is made that the space-dependent heat generation function can be represented as:

$$Q(r) = q_0 \mu_i \xi_j \quad , \quad (18)$$

where

q_0 = Power Normalization coefficient

μ_i, ξ_j = Power distribution factors to be given pointwise in the input data.

D. Finite Difference Equations for Coolant Region

The coolant energy equation (2) can also be reduced to a simple finite difference form. The differential equation (2) was written as

$$\frac{\partial \psi}{\partial \tau} = -V \frac{\partial \psi}{\partial z} + q_2(z, \tau) / (\rho C)_2 \quad , \quad (2.1)$$

where

$\psi(z, \tau)$ = coolant temperature

V = coolant velocity

$q_2(z, \tau)$ = rate of heat addition to coolant

$(\rho C)_2$ = volumetric heat capacity of coolant.

Two cases must be considered, as the coolant may be either stagnant or flowing.

1. Stagnant Coolant

In this case, the velocity is assumed to be everywhere so negligible that heat convection can be neglected. Heat is then added to the coolant, by conduction across the boundary, from Region 2. The heat addition term is

$$q_2(z, \tau) = \frac{2k_s A_{Is}}{V_j \Delta r_s} [T_{I,j}(\tau) - \psi_j(\tau)] \quad , \quad (2.2)$$

where

- k_s = thermal conductivity of coolant
 A_{Is} = log mean area between coolant and pin surface node points.
 V_j = volume of element associated with coolant node point.

The derivatives in equation (2.1) may be approximated, as in equations (3) and (5), by the relations

$$\frac{\partial \psi}{\partial \tau} \rightarrow \frac{\psi_j(\tau + \Delta \tau) - \psi_j(\tau)}{\Delta \tau} \quad (2.3)$$

$$\frac{\partial \psi}{\partial z} \rightarrow \frac{\psi_j(\tau) - \psi_{j-1}(\tau)}{\Delta z} \quad (2.4)$$

Using the relations (2.2), (2.3) and (2.4), and since the velocity is considered negligible, equation (2.1) becomes

$$\psi_j(\tau + \Delta \tau) - \psi_j(\tau) = \frac{2A_{Is}}{M_s R_s \Delta z} [T_{I,j}(\tau) - \psi_j(\tau)] .$$

This equation can be written simply as

$$\psi_j(\tau + \Delta \tau) = G_{I,j} T_{I,j}(\tau) + (1 - G_{I,j}) \psi_j(\tau) \quad (2.5)$$

Again, the coefficient $G_{I,j}$ is given in Table I.

2. Flowing Coolant

In this case, the coolant velocity is assumed large enough that heat convection becomes the dominating mode of heat transfer to coolant. The heat addition to coolant is given by the equation

$$q_2(z, \tau) = h A_{OI} [T_{I,j}(\tau) - \psi_j(\tau)] / V_j , \quad (2.6)$$

where

- h = heat transfer film coefficient
 A_{OI} = surface area of pin neighboring element j
 V_j = volume of coolant element j .

Using the relations (2.3), (2.4) and (2.6), equation (2.1) can be simplified to the form

$$\psi_j(\tau + \Delta \tau) = H \psi_{j-1}(\tau) + [1 - H - G_{I,j}] \psi_j(\tau) + G_{I,j} T_{I,j}(\tau) , \quad (2.7)$$

where the coefficients $G_{I,j}$ and H are again given in Table I.

In summary, then, equations (17), (2.5), and (2.7) are solved in the program RE-147 utilizing the coefficients given in Table I. Equation (2.5) is considered as a special case of equation (2.7) where $H = 0$.

III. DESCRIPTION OF THE PROGRAM RE-147

A. Summary and Special Features

The program RE-147 solves equations (17) and (2.7) of Section II by means of the coefficients tabulated as TABLE I. The coolant temperature $\psi(\tau)$ is assumed to start at a constant source temperature ψ_0 , and it is then computed at intervals of Δz by using equation (2.7). A coolant temperature distribution at time $\tau = 0$ can be achieved by specifying, in the input, a value of the coolant temperature at each coolant node point. The initial values of the temperature at pin node points $T_{ij}(0)$ can be given, in the input, under one of three options to be fully described below (Section III.A.7).

Having the initial pin temperature for each node point (i,j) and the coolant temperature $\psi_1(\tau)$, the program uses equation (17) to calculate the future pin temperature $T_{i,1}(\tau + \Delta\tau)$. The calculation starts at the pin center-line ($i = 1$) and traverses the radial row ($j = 1$) out to the pin surface ($i = I$). Using the coolant source temperature ψ_0 , the pin surface temperature $T_{I,1}(\tau)$, and equation (2.7), the program next calculates the future coolant temperature $\psi_1(\tau + \Delta\tau)$. This process is repeated for all the remaining radial rows ($j = 2, \dots, J$). The sweep over all pin and coolant node points, calculating all values of $T_{i,j}(\tau + \Delta\tau)$ and $\psi_j(\tau + \Delta\tau)$, is referred to, on the problem output, as being one iteration.

The program calculates the coefficients B_{ij} , C_{ij} ,, G_{Ij} , H (see Table I) starting from a minimum amount of given input information. Only a few parameters (such as I and J), certain material properties, and the significant regional radii (R_b , R_0 , R_s) are required in the input.

Certain special features of the program, such as the phase-change procedure and the phase-dependent material properties, require considerable discussion in the order they confront the program user who is preparing the input form (see Section III B).

The details of the program RE-147 are given in Appendices A, B, and C. The detailed calculational procedure is given in the form of Flow Charts (see Appendix A). A complete Storage Map for computing machine locations is given as Appendix B. A complete listing of the ordered machine operations is given as Appendix C.

1. Choice of Units

Although the list of symbols (see page 5) suggests the various quantities are to be given in engineering units (ft, sec, Btu, °F), these quantities can be given in any consistent set of units. The metric units (cm, sec, watts, °C), for example, may prove to be more advantageous in many heat transfer calculations. The responsibility, for insuring that a self-consistent set of units is used in all input data, lies entirely with the program user.

2. Unit Time Interval

Some degree of compromise must be made in the selection of the time interval $\Delta\tau$ for the input. If $\Delta\tau$ is chosen too small, unnecessary iterations are performed and the expense of excess machine time utilization occurs. But if $\Delta\tau$ is chosen too large, some coefficients in the difference equations become negative, thus leading to oscillations in the calculated temperatures.⁽⁴⁾ To remedy this situation, the program Re-147 uses the input value of $\Delta\tau$ to calculate initial values of the coefficients. Whenever a negative coefficient is computed, whether initially or after a phase change (the coefficients contain material properties and are thus phase dependent), the value of $\Delta\tau$ is halved, and the coefficients are all recomputed and again tested for sign. The process is repeated until all the coefficients in the difference equations become positive. With each change in $\Delta\tau$, the values of the parameters N and β are adjusted to insure that the time intervals $N\Delta\tau$ and $\beta\Delta\tau$ are unchanged. The new values of $\Delta\tau$, N , and β are then printed on the output.

3. Coolant Velocity

The coolant velocity V must be input as zero if the stagnant coolant option (see Section II.D) is chosen. Another interesting class of problems, which this program will solve, is the calculation of temperatures in a pin with constant temperature coolant on the boundary (the infinite heat-sink problem). This class of problems also requires zero velocity in the input. If the flowing coolant option is chosen, the velocity may be zero or finite.

4. Temperature Printouts

The frequency of temperature printouts is controlled by the program user who specifies an integer N in the input. Routine temperature printouts are provided at time intervals of $N\Delta\tau$.

5. The Parameter β or p

As shown by equation (17), a time dependent function $n(\tau)$ represents the time rate of variation of internal heat generation in the pin. Two options are available in the program for specifying the function $n(\tau)$.

(1) If an exponential heating rate is desired, that is,

$$n(\tau) = n(0) \exp(\tau/p) \quad ,$$

the program takes $n(0) = 1.00$; the parameter NT must be input as the integer zero, and the parameter p is the period of increase of the exponential function. The program calculates a value of $n(\tau)$ at each time interval $\Delta\tau$ for use in equation (17).

(2), The second option available is a pointwise specification of the function $n(\tau)$. Values of the function are given, in the input, for time intervals of $\beta \Delta\tau$ starting with $n(0)$ at time $\tau = 0$. The parameter NT must then be given as the number of $n(\tau)$ points given in the input. In order to obtain maximum accuracy in the temperature calculations, the parameter β should be chosen as small as possible, thus giving a large number of points on the function $n(\tau)$. In this second option, linear interpolation is used to compute intermediary values of $n(\tau)$, since equation (17) requires a value of $n(\tau)$ for every time interval $\Delta\tau$.

6. Initial Coolant Temperatures

The input parameter P determines the number of values of the initial coolant temperatures to be given. Two options are available.

(1) If P is chosen as zero, the initial temperature is space independent, only one value is given in the input, and thus $\psi_j(0) = \psi_1(0)$ for all j.

(2) If P is chosen as one, an initial coolant temperature distribution is specified by giving a value of $\psi_j(0)$ at each coolant node point.

7. Initial Pin Temperatures

The input parameter T determines the number of values of the initial pin temperatures to be given. Three options are available.

(1) A pointwise input of the initial temperature is made by specifying $T = 2$ and then giving all values of $T_{i,j}(0)$ as input.

(2) A space-independent initial pin temperature is achieved by specifying $T = 1$ and then giving a single value of $T_{i,j}(0)$ as input.

(3) In the third option ($T = 0$), suitable only for a clad pin with space-independent heat generation, the initial pin temperatures are computed from the following equations:

$$T_{ij}(0) = \frac{q_0 \zeta_j R_b^2}{2k_{b1}} \left[\frac{k_{b1}}{h_1 R_0} + \frac{k_{b1}}{2k_{f1}} + \log_e \frac{R_0}{R_b} - \frac{r_i^2 k_{b1}}{2R_b^2 k_{f1}} \right] + \psi_j(0) ,$$

where

$$r_i = (i - 1) \Delta r_f, \quad 1 \leq i \leq I - 2 ,$$

and

$$T_{ij}(0) = \frac{q_0 \zeta_j R_b^2}{2k_{b1}} \left[\frac{k_{b1}}{h_1 R_0} + \log_e \frac{R_0}{r_i} \right] + \psi_j(0) ,$$

where

$$r_1 = R_b + (1/2)\Delta r_b \text{ for } i = 1 - 1$$

$$r_1 = R_0 \quad \text{for } i = 1 ,$$

and all other symbols are defined in Section I. The subscript 1 denotes material properties of the first (α) phase.

8. Coolant Motion Parameter

A parameter, W , expresses the choice of either the flowing or the stagnant coolant options. For the flowing coolant option, using the film coefficient h to couple coolant and pin surface temperatures, specify $W = 1$. For the stagnant coolant option, specify $W = 0$ along with zero velocity.

9 Phase-dependent Material Properties

In general material properties (such as density, specific heat, and thermal conductivity) are a function of temperature. In this program, the variation of a property with temperature is approximated by dividing the temperature-property diagram into four regions, hereafter called phases. The material phases are labelled α , β , γ , and δ in that order. The material phases are separated by the "transformation temperatures" which are included in the input. Average values (averaged over the limited temperature range of a phase) of density, specific heat, and thermal conductivity are then input for each material and each phase. The selection of the three transformation temperatures, for any material which does not exhibit real physical phase transformations, is entirely at the discretion of the problem originator.

10 Film Coefficients for the Coolant

Four values of the film coefficient h must be specified. When the stagnant coolant option ($W = 0$) is chosen, the film coefficient is not used in computing the coefficients $E_{I,j}$ and $G_{I,j}$, and any decimal number, including 0.0, will satisfy the requirement.

If the flowing coolant ($W = 1$) option is chosen, the film coefficient is coolant-phase dependent, and an average value of h is specified for each phase. When the coolant temperature exceeds a transformation temperature during a calculation, the coefficients utilizing h are changed appropriately.

11. Material Phase Changes

Certain materials, notably natural uranium and its alloys, undergo solid-state phase changes wherein the enthalpy of the material will

increase over a limited range while the material remains at constant temperature. The program RE-147 uses the approximate method outlined in Reference 2, pages 180-186, in treating the phase changes.

The method is described in the following manner, using the change from phase α to phase β as an example. As a pin node point temperature $T_{i,j}(\tau + \Delta\tau)$ is computed, it is compared with the appropriate transformation temperature (for this example, $T_{\alpha\beta}$). If $T_{i,j}(\tau + \Delta\tau) < T_{\alpha\beta}$, the calculation process continues normally. But if $T_{i,j}(\tau + \Delta\tau) \geq T_{\alpha\beta}$, then $T_{i,j}(\tau + \Delta\tau)$ is set equal to $T_{\alpha\beta}$ and the excess, $[T_{i,j}(\tau + \Delta\tau) - T_{\alpha\beta}]$ is accumulated as T'_{ij} . When the excess temperature T'_{ij} exceeds the appropriate fictitious transformation temperature change (for this example, $\Delta T_{\alpha\beta}$), point (i,j) is considered to be in a new phase β , and $T_{i,j}(\tau + \Delta\tau)$ is set equal to $[T_{\alpha\beta} + T'_{ij} - \Delta T_{\alpha\beta}]$; further, T'_{ij} is set equal to zero, and new coefficients for point (i,j) are computed. When a coolant node point temperature $\psi_j(\tau + \Delta\tau)$ exceeds the appropriate transformation temperature (for this example, $\psi_{\alpha\beta}$), the point j is considered to be in a new phase (β), and coefficients are changed accordingly. When $\psi_j(\tau + \Delta\tau) \geq \psi_{\gamma\delta}$, the coolant temperature is held constant ($\psi_j = \psi_{\gamma\delta}$) for the remainder of the problem.

The fictitious transformation temperature change is defined simply as the ratio of heat of transformation to specific heat of the previous phase. For example,

$$\Delta T_{\alpha\beta} = \Delta H_{\alpha\beta} / C_{\alpha}$$

where

$\Delta H_{\alpha\beta}$ = Heat of transformation, from α phase to β phase, per unit mass.

C_{α} = Specific heat of material in α phase, per unit mass.

12. Space-dependent Heat Generation

In equations (12) and (16) of Section II.C, the space-dependent heat generation function $Q(r)$ appears. An axial variation of the heat generation rate can be introduced without affecting the validity of either equation; in fact, only the coefficient $F_{i,j}$ (see Table I) of equation (17) will be affected. This stipulation, however, requires an assumption that the axial variation is not large enough to affect the previous assumption (page 9) of negligible axial heat conduction in the pin.

This axial variation of heat generation is included in the program, and the function $Q(r)$ is assumed to be of the form

$$Q(r) = q_0 \mu(r) \zeta(z) \quad , \quad (18)$$

where

q_0 = Power normalization coefficient
 $\mu(r)$ = Function by which Q varies radially
 $\xi(z)$ = Function by which Q varies axially.

A typical radial row of node points (see Fig. 2) in the pin is selected, and values of the function $\mu(r)$ are given pointwise in the input as μ_i , $1 \leq i \leq I$. Similarly, a typical axial column of node points is selected, and values of the function $\xi(z)$ are given pointwise in the input as ξ_j , for $1 \leq j \leq J$. A useful normalization for equation (18) is

$$\int \mu(r) \xi(z) dV = 1$$

where

V = volume of pin, or volume of heat-generating section of the pin.

With this normalization, the input parameter q_0 is used to scale the heat generation rate to the desired level.

To specify the generation of a given amount of energy per unit volume (ΔH) between $\tau = 0$ and $\tau = \tau_f$, make

$$q_0 = \frac{\Delta H}{\int_0^{\tau_f} n(\tau) d\tau \int_0^{V_{\text{total}}} \mu(r) \xi(z) dV}$$

For space-independent heat generation in the pin, all appropriate μ_i and ξ_j are input as μ_i , $\xi_j = 1.00$. For any subregion not generating heat, simply input $\mu_i = 0$.

13. Constant Coolant Temperature Problems

To calculate the class of problems which consider the coolant as an infinite heat sink (and thus with coolant temperature a constant) requires that the coefficients $G_{I,j}$ and H of equation (2.7) be zero. This requirement is achieved by taking zero velocity ($V = 0$) and giving the coolant a near-infinite heat capacity (set $\rho C_s = 10^{36}$ in the input for all four values, using the format IE36 exactly).

14. Additional Types of Problems

The program RE-147 as written should contain sufficient flexibility to be useful in calculating many types of problems not yet conceived by the authors. The class of cooling problems, where the pin is initially at high temperature and is then cooled, can be treated with this program. However, no provision is included for cooling back through a phase change (going from the δ phase to the γ phase, for example). Any calculation of cooling problems, with this program, is necessarily a single-phase study.

B. Input

If a decimal point follows an input item on the input form given below, then the value specified must either contain its decimal point or be written in standard floating-point notation as a fraction and E followed by the base 10 exponent. For example, π may be written as 3.14159, as 0.314159E1 or as 31.4159E-1. Items not followed by a decimal point are to be specified as integers. A comma must separate items, but the last item on a card must not be followed by a comma. No blanks may appear within or between items on a card. A sample input form is given on page 27.

Any desired number of problems may be run consecutively without re-reading the binary program deck.

All data for a problem similar to the preceding one need not be re-given. The problem number, $\Delta\tau$, N , β or p , $T_{i,j}(0)$ and $\psi_j(0)$ must be re-specified along with any desired parameter changes. (Be sure the proper decimal location for each item is in the location column. See Appendix B for proper decimal location.)

C. Operating Instructions

Reader: 72-72 board.

Punch: Not used.

Printer: SHARE board #2 and 120 column paper if sense switch #3 is down Not used if sense switch #3 is up.

Drums: Not used.

Underflow Switch: Not used.

Tapes: #0 - Blank for output if sense switch #5 is up. Not used if sense switch #5 is down.

#3 - Input data tape if sense switch #1 is up. Not used if sense switch #1 is down.

Sense Switch Settings: Normally sense switches #1 and 2 are down #3, 4, 5 and 6, up. See page 28 for details.

Running Procedure:

1. Ready binary program deck followed by input data cards in reader.
2. Set sense switches.
3. Ready tape #0.
4. Clear and load cards.
5. Final stop - 3320₈ HTR 660₈ with the sign of the accumulator positive. Write End of File on output tape manually if one is desired.

SHARE 704 SYMBOLIC CODING FORM

PROBLEM 524/RE147 INPUT FORM											
CODER J HEESTAND											
DATE JUNE 24, 1960											
PAGE 1 OF 1											
H	LOCATION	OP	ADDRESS, TAG DECREMENT	COMMENTS	I.D.						
1	2	6	7	8	10	11	12	72	73	80	
	99	DEC	PROB NO., I, J, R _b , R _o , R _s , ΔT, Δg, v, ψ		GEN. DATA						
		DEC	N, β, α _p , τ _f , P, T, NT, W		PARAMS.						
		DEC	k _{f1} , k _{f2} , k _{f3} , k _{f4}		K(F)						
		DEC	k _{b1} , k _{b2} , k _{b3} , k _{b4}		K(B)						
		DEC	k _{s1} , k _{s2} , k _{s3} , k _{s4}		K(S)						
		DEC	ρ _{cf1} , ρ _{cf2} , ρ _{cf3} , ρ _{cf4}		RHO*(F)						
		DEC	ρ _{cb1} , ρ _{cb2} , ρ _{cb3} , ρ _{cb4}		RHO*(B)						
		DEC	ρ _{cs1} , ρ _{cs2} , ρ _{cs3} , ρ _{cs4}		RHO*(S)						
		DEC	h ₁ , h ₂ , h ₃ , h ₄		H						
		DEC	T _{αβf} , T _{αγf} , T _{γδf}		TT(F)						
		DEC	T _{αβb} , T _{αγb} , T _{γδb}		TT(B)						
		DEC	ψ _{αβ} , ψ _{αγ} , ψ _{γδ}		TT(S)						
		DEC	ΔT _{αβf} , ΔT _{αγf} , ΔT _{γδf} , ΔT _{αβb} , ΔT _{αγb} , ΔT _{γδb}		DTT(F,B)						
		DEC	n(τ) ₁ , n(τ) ₂ , ..., n(τ) _{NT} . if NT ≠ 0; nothing if NT = 0		N(TAU)						
32767-I-25-15		DEC	T _{1,1} (0), T _{2,1} (0), ..., T _{2,J} (0). if T = 2; T _{1,1} (0). if T = 1; nothing if T = 0		T(I,J,0)						
32767-I-25		DEC	ψ ₁ (0), ψ ₂ (0), ..., ψ _J (0). if P = 1; ψ ₁ (0). if P = 0		PSI(J,0)						
32767-I-5		DEC	ξ ₁ , ξ ₂ , ..., ξ _J		ZETA						
32767-I		DEC	μ ₁ , μ ₂ , ..., μ _J		MU						
32767		DEC	q ₀		Q(0)						
		TRA	3,4								

Program Stops: There are no programmed stops in the main program except the final stop. The following are error stops in the input routine (NY INP 1):

- 642₈ HTR 3,4 Negative input count. Should never occur.
- 711₈ HTR 647₈ Illegal pseudo operation on input data card.
Ready corrected card with those following and press START.
- 1227₈ HTR 1265₈ Out-of-range decimal data. Correct card, ready all input data for the problem, transfer to 3316₈ and START.
- 1510₈ HTR 1451₈ Illegal punch on input data card. Ready corrected card with those following and press START.
- 3320₈ HTR 660₈ Acc. - Redundancy check reading input. Press START to continue.

Acc. + End of file reading input cards - could indicate missing TRA 3, 4 card or end of problem.

Off-line Printing: Print output tape on 120 column paper under program control.

Role of Sense Switches and Sense Lights

- Sense Switch #1: up - problem input on tape #3.
down - problem input on cards.
- Sense Switch #2: up - the problem will terminate the first time a complete row melts.
down - the problem will continue until $\tau = \tau_f$ or $n(\tau) = n(\tau)_{NT}$, whichever occurs first.
- Sense Switch #3: up - no on-line printer output.
down - on-line printer output.
- Sense Switch #4: up
- Sense Switch #5: up - tape output.
down - no tape output.
- Sense Switch #6: Not used.
- Sense Light #1: Not used.
- Sense Light #2: Turned on when B_{I-1} and C_{I-1} are changed because of a phase change for point I-2. The old values of B_{I-1} C_{I-1} are saved and used for a calculating T_{I-1} for the current iteration. The light is then turned off.
- Sense Light #3: Turned on the first time a complete row melts and kept on for the duration of the problem.

Sense Light #4 Turned on the first time a complete row melts as a signal to avoid printing temperatures twice in case $\tau = 0 \pmod{NT \cdot \Delta\tau}$ at the same time. It is turned off before the start of the next iteration.

All sense lights are turned off at the start of a problem.

D. Output

The problem output consists of the following:

1. Program name and problem number.
2. All input data.
3. Initial temperature at each node point.
4. Value of $\Delta\tau$, β and N at the start of the iterations.
5. Initial coefficients for each node point.
6. Temperature at each node point at time intervals of $N \cdot \Delta\tau$.
7. Temperature at each node point the first time a complete row has melted.
8. New values of $\Delta\tau$, β and N if negative coefficients were computed.
9. Temperature and final coefficients for each node point when the problem terminates normally.
10. Error comments in case $\ln x$, $x \leq 0$; or e^x , $|x| \geq 88$, is requested.

The format is based on 59 lines per page. To alter this, change card number 2038 in the SAP listing as desired.

E. Sample Problems

1. Sample Problem No. 1.

The object of the first sample problem (problem no. 35.00025) is to calculate the space and time-dependent temperatures in an EBR-II core fuel pin, contained in a helium atmosphere which is inside a graphite crucible type capsule, subjected to transient heating such as would occur if the pin were irradiated in the Transient Reactor Test Facility (TREAT).

The core pin⁽⁵⁾ consists of a uranium-fissium alloy fuel rod, 14.22 inches in length and 0.144 inch in diameter, sodium bonded to a stainless steel jacket of 0.156-inch inside diameter and 0.174-inch outside diameter. The graphite crucible has an inner radius of 0.88 inch and an outer radius of 1.59 inches.

Heat is lost from the pin through radiation to the graphite capsule and by convection transfer through the helium atmosphere. A film coefficient ($h = 0.011151 \text{ Btu/sec-ft}^2 - ^\circ\text{F}$) accounts for this heat loss, and the graphite capsule is assumed to absorb the heat with negligible rise in its own temperature. Heat generation occurs in the fuel rod due to fissioning of the isotope U^{235} during the irradiation.

Since the ratio of the length to the diameter of this fuel pin is sufficiently large to warrant neglecting the end effects, the problem reduces to a one-space dimension analysis. The number of axial node points is taken as one; the choice of ten radial node points represents the usual compromise between conservation of machine time and accuracy.

The unit time interval (initially taken as 0.002 sec) is deliberately chosen large enough to insure that at least one of the coefficients in the difference equations is negative. As explained in Section III.A, the program arrives at a working value of $\Delta\tau = 0.001 \text{ sec}$.

The flowing coolant equation is used ($W = 1$), the film coefficient h accounts for all heat loss from the pin, and the heat capacity of the coolant (graphite crucible) is made "infinitely" large so that the coolant temperature remains constant at 80°F .

Values for physical properties of the materials are taken from standard references.⁽⁶⁾ The separate bond and clad regions of the core pin are replaced by an equivalent material having an identical volumetric heat capacity and thermal resistance.

The space-dependent heat generation function $\mu(r)$ is given in Fig. 3. The power-distribution rate results from a one-energy group, P-3-type calculation on a cell model of the EBR-II core fuel pin.⁽⁷⁾ The time-dependent heat generation function $n(\tau)$ is taken from an experimental power curve for an actual TREAT transient, and it is exhibited as Fig. 4.⁽⁷⁾

A complete input sheet and set of problem output sheets follows. The 671 temperature iterations (time cycles) required less than two minutes of machine time, including the time to read in the binary program deck.

2. Sample Problem No. 2

The object of the second sample problem (problem No. 26.00029) is to calculate the space and time-dependent temperatures in an EBR-II core fuel pin being heated at an exponentially increasing time rate, and cooled by sodium flowing axially past the pin. The sodium is assumed to enter a 0.375-inch (inside diameter) pipe, which surrounds the pin, at a temperature of 700°F . The sodium coolant flow velocity is chosen as $V = 25.0 \text{ ft/sec}$.

FIG. 3
THERMAL POWER ATTENUATION
IN A 3.09% FUEL PIN

The fuel pin under study is identical to that of Sample Problem No. 1, so the same pin dimensions and material properties are input except for a small change in clad properties (due to a different choice of temperature ranges for specifying the cladding material properties). Sodium properties are chosen⁽⁶⁾ for the coolant region, and a film coefficient of $h = 2.60 \text{ Btu}/(\text{sec})(\text{ft}^2)(^\circ\text{F})$ is calculated for the above coolant flow and temperature conditions.

Seven radial node points ($I = 7$) are taken for each row in the fuel pin, and nine radial rows ($J = 9$) are taken to describe the effect of axially varying coolant temperature. To achieve the exponential time rate of heat generation, the value of $\beta = p = 0.100 \text{ sec}$ is input for the exponential period, and the parameter NT is input as zero.

A flat power shape is assumed for the axial direction in the pin (all $\xi_j = 1.0$), and the radial power distribution is again taken from Fig. 3. The individual values of μ_i are different for this problem, due to the selection of different nodal point radii.

FIG. 4
POWER VS. TIME FOR SAMPLE PROBLEM #1
(FROM TREAT TRANSIENT #47)

The parameters selected for this problem, such as H , V , the heating rate period p , and the initial temperatures, are all within the range of interest, for these parameters, of the Fast Reactor Safety Program.

A complete input sheet and set of problem output sheets follows. The 300 temperature calculations required less than two minutes of machine running time, including the time to read in the binary program deck.

SHARE 704 SYMBOLIC CODING FORM

PROBLEM 35.00025		524/RE 147		Sample Problem 1	
CODER L. Miller				DATE June 24, 1960	
				PAGE 1 OF 1	
H	LOCATION	OP	ADDRESS, TAG DECREMENT	COMMENTS	I.D.
1	2	6 7 8	10 11 12	72 73	80
	9 9	D E C	35.00025,10,1,.006,.00725,.02707,.002,1.0,0,80.		GEN. DATA
		D E C	10,5.0,.99,0,1,68,1		PARAMS.
		D E C	.00383,.00661,.00772,.00853		K(F)
		D E C	.003533,.003819,.004403,.00525		K(B)
		D E C	.00304,.00338,.00382,.00403		K(S)
		D E C	40.3,60.5,198.42,40.7		RHO*(C(F)
		D E C	45.4,48.1,50.2,51.5		RHO*(C(B)
		D E C	1E36,1E36,1E36,1E36		RHO*(C(S)
		D E C	.011151,.011151,.011151,.011151		H
		D E C	1233.,1850.,1976.		TT(F)
		D E C	208.,800.,1600.		TT(B)
		D E C	300.,500.,700.		TT(S)
		D E C	144.77,0,0,25.66,0,0		DTT(F,B)
		D E C	.027,.029,.031,.032,.033,.035,.036,.037,.039,.040,.042,.044		N(TAU) 1
		D E C	.048,.050,.052,.056,.060,.063,.066,.070,.076,.079,.085,.090		N(TAU) 2
		D E C	.096,.103,.110,.116,.124,.133,.140,.150,.159,.160,.179,.190		N(TAU) 3
		D E C	.205,.218,.230,.245,.262,.280,.295,.314,.352,.375,.395		N(TAU) 4
		D E C	.417,.440,.460,.485,.514,.540,.565,.597,.622,.635,.650,.655		N(TAU) 5
		D E C	.640,.610,.575,.520,.435,.345,.250,.175		N(TAU) 6
	3.2.7.4.5	D E C	104.0		T(I,J,O)
	3.2.7.5.5	D E C	80.0		PSI(J,O)
	3.2.7.5.6	D E C	1.0		ZETA
	3.2.7.5.7	D E C	.9755,.9756,.977,.9802,.9860,.9947, 1.0070,1.0233,0,0		MU
	3.2.7.6.7	D E C	868888.0		Q(O)
		T R A	3,4		

INPUT

GENERAL DATA

I= 10 J= 1 R(B)= 0.00600 R(I)= 0.00725 R(S)= 0.02707
 DELTA TAU= 0.0020000 DELTA Z= 1.00000 V=0. PSI(I,TAU)= 80.000

PROBLEM PARAMETERS

N= 10 BETA= 0.5000E 01 FINAL TAU= 0.9900 P=0 T=1 NT= 68 W=1

MATERIAL PROPERTIES

K(F)	K(B)	K(S)	RHO*(C(F))	RHO*(C(B))	RHO*(C(S))	H
3.83000E-03	3.53300E-03	3.04000E-03	4.03000E 01	4.54000E 01	1.00000E 36	1.11510E-02
6.61000E-03	3.81900E-03	3.38000E-03	6.05000E 01	4.81000E 01	1.00000E 36	1.11510E-02
7.72000E-03	4.40300E-03	3.82000E-03	1.98420E 02	5.02000E 01	1.00000E 36	1.11510E-02
8.53000E-03	5.25000E-03	4.03000E-03	4.07000E 01	5.15000E 01	1.00000E 36	1.11510E-02

TT(F)	TT(B)	TT(S)	DELTA TT(F)	DELTA TT(B)
1233.000	208.000	300.000	144.770	25.660
1850.000	800.000	500.000	0.	0.
1976.000	1600.000	700.000	0.	0.

N(TAU) (READ ACROSS)

2.70000E-02	2.90000E-02	3.10000E-02	3.20000E-02	3.30000E-02	3.50000E-02	3.60000E-02	3.70000E-02
3.90000E-02	4.00000E-02	4.20000E-02	4.40000E-02	4.80000E-02	5.00000E-02	5.20000E-02	5.60000E-02
6.00000E-02	6.30000E-02	6.60000E-02	7.00000E-02	7.60000E-02	7.90000E-02	8.50000E-02	9.00000E-02
9.60000E-02	1.03000E-01	1.10000E-01	1.16000E-01	1.24000E-01	1.33000E-01	1.40000E-01	1.50000E-01
1.59000E-01	1.60000E-01	1.79000E-01	1.90000E-01	2.05000E-01	2.18000E-01	2.30000E-01	2.45000E-01
2.62000E-01	2.80000E-01	2.95000E-01	3.14000E-01	3.34000E-01	3.52000E-01	3.75000E-01	3.95000E-01
4.17000E-01	4.40000E-01	4.60000E-01	4.85000E-01	5.14000E-01	5.40000E-01	5.65000E-01	5.97000E-01
6.22000E-01	6.35000E-01	6.50000E-01	6.55000E-01	6.40000E-01	6.10000E-01	5.75000E-01	5.20000E-01
4.35000E-01	3.45000E-01	2.50000E-01	1.75000E-01				

Q(I)= 8.68888E 05

MU (READ ACROSS)

0.975500 0.975600 0.977000 0.980200 0.986000 0.994700 1.007000 1.023300 0. 0.

RE-147 CYCLOPS PROBLEM NO. 35.00025

ZETA (READ ACROSS)
1.000000

RE-147 CYCLOPS PROBLEM NO. 35.00025

OUTPUT

TEMPERATURES AT TAU= 0. ITERATION NO. 0
 104.000 104.000 104.000 104.000 104.000 104.000 104.000 104.000 104.000 80.000

DELTA TAU= 0.00099999 BETA= 0.1000E 02 N= 20

INITIAL COEFFICIENTS

B 0. 0.7425E-01 0.1114E-00 0.1237E-00 0.1299E-00 0.1336E-00 0.1361E-00 0.1379E-00 0.1111E-00 0.2175E-00

C 0.4060E-00 0.7030E 00 0.7030E 00 0.7030E 00 0.7030E 00 0.7030E 00 0.7030E 00 0.7127E 00 0.7695E 00 0.7819E 00

D 0.5940E 00 0.2227E-00 0.1856E-00 0.1732E-00 0.1671E-00 0.1633E-00 0.1609E-00 0.1494E-00 0.1193E-00 0.

E 0.6069E-03

F 0.2103E 02 0.2103E 02 0.2106E 02 0.2113E 02 0.2126E 02 0.2145E 02 0.2171E 02 0.2206E 02 0. 0.

G 0.

1-G-H 0.1000E 01

H 0.

TEMPERATURES AT TAU= 0.02000 ITERATION NO. 20
 116.225 116.225 116.216 116.161 115.967 115.449 114.296 112.071 108.019 106.736 80.000

TEMPERATURES AT TAU= 0.04000 ITERATION NO. 40
 129.326 129.250 128.999 128.488 127.574 126.052 123.667 120.130 114.829 113.070 80.000

TEMPERATURES AT TAU= 0.06000 ITERATION NO. 60
 142.466 142.290 141.741 140.746 139.181 136.880 133.639 129.230 123.033 120.955 80.000

TEMPERATURES AT TAU= 0.08000 ITERATION NO. 80
 155.563 155.305 154.515 153.133 151.062 148.166 144.281 139.208 132.298 129.968 80.000

RE-147 CYCLOPS PROBLEM NO. 35.00025

TEMPERATURES AT TAU=	0.10000	ITERATION NO.	100							
169.057	168.736	167.759	166.077	163.608	160.234	155.805	150.135	142.534	139.957	80.000
TEMPERATURES AT TAU=	0.12000	ITERATION NO.	120							
183.659	183.286	182.156	180.225	177.417	173.615	168.662	162.340	153.828	150.951	80.000
TEMPERATURES AT TAU=	0.14000	ITERATION NO.	140							
199.993	199.572	198.297	196.120	192.957	188.677	183.102	176.005	166.528	163.298	80.000
TEMPERATURES AT TAU=	0.16000	ITERATION NO.	160							
218.254	217.781	216.349	213.906	210.362	205.575	199.341	191.383	180.676	177.039	80.000
TEMPERATURES AT TAU=	0.18000	ITERATION NO.	180							
238.818	238.287	236.681	233.939	229.956	224.568	217.549	208.604	196.632	192.544	80.000
TEMPERATURES AT TAU=	0.20000	ITERATION NO.	200							
261.804	261.208	259.403	256.325	251.852	245.755	237.541	226.065	208.000	206.912	80.000
TEMPERATURES AT TAU=	0.22000	ITERATION NO.	220							
287.716	286.990	284.760	280.836	274.899	266.542	255.336	240.744	221.273	208.000	80.000
TEMPERATURES AT TAU=	0.24000	ITERATION NO.	240							
315.829	314.895	312.050	307.150	299.972	290.260	277.796	262.435	243.631	237.386	80.000
TEMPERATURES AT TAU=	0.26000	ITERATION NO.	260							
347.254	346.198	343.012	337.626	329.920	319.713	306.749	290.646	270.400	263.754	80.000
TEMPERATURES AT TAU=	0.28000	ITERATION NO.	280							
383.335	382.212	378.824	373.095	364.878	353.931	339.896	322.260	299.816	292.449	80.000
TEMPERATURES AT TAU=	0.30000	ITERATION NO.	300							
425.267	424.057	420.402	414.198	405.247	393.234	377.695	357.996	332.753	324.458	80.000
TEMPERATURES AT TAU=	0.32000	ITERATION NO.	320							
473.235	471.904	467.879	461.028	451.107	437.735	420.363	398.246	369.783	360.431	80.000
TEMPERATURES AT TAU=	0.34000	ITERATION NO.	340							
525.789	524.306	519.818	512.173	501.102	486.198	466.895	442.398	410.844	400.498	80.000

RE-147 CYCLOPS PROBLEM NO. 35.00025

TEMPERATURES AT TAU=	0.36000	ITERATION NO.	360							
587.590	585.940	580.947	572.434	560.081	543.375	521.584	493.690	457.534	445.671	80.000
TEMPERATURES AT TAU=	0.38000	ITERATION NO.	380							
658.470	656.614	650.993	641.388	627.410	608.448	583.654	551.897	510.849	497.340	80.000
TEMPERATURES AT TAU=	0.40000	ITERATION NO.	400							
738.320	736.215	729.839	718.946	703.094	681.605	653.533	617.597	571.100	555.813	80.000
TEMPERATURES AT TAU=	0.42000	ITERATION NO.	420							
829.236	826.851	819.625	807.279	789.307	764.931	733.064	692.263	639.550	622.189	80.000
TEMPERATURES AT TAU=	0.44000	ITERATION NO.	440							
931.320	928.615	920.420	906.420	886.052	858.452	822.417	776.333	716.804	697.204	80.000
TEMPERATURES AT TAU=	0.46000	ITERATION NO.	460							
1045.799	1042.737	1033.461	1017.622	994.592	963.412	922.750	870.826	803.854	781.785	80.000
TEMPERATURES AT TAU=	0.48000	ITERATION NO.	480							
1173.537	1170.053	1159.487	1141.387	1114.953	1078.993	1031.931	971.801	899.739	877.571	80.000
TEMPERATURES AT TAU=	0.50000	ITERATION NO.	500							
1233.000	1233.000	1233.000	1233.000	1233.000	1205.030	1153.958	1087.188	1007.238	982.609	80.000
TEMPERATURES AT TAU=	0.52000	ITERATION NO.	520							
1315.854	1312.950	1304.376	1290.471	1269.679	1233.000	1233.000	1196.493	1120.579	1095.918	80.000
TEMPERATURES AT TAU=	0.54000	ITERATION NO.	540							
1425.508	1422.159	1412.025	1394.932	1370.951	1339.646	1297.145	1233.000	1198.238	1184.476	80.000
TEMPERATURES AT TAU=	0.56000	ITERATION NO.	560							
1544.186	1540.420	1529.118	1510.303	1484.207	1451.312	1412.063	1366.241	1297.319	1269.933	80.000
TEMPERATURES AT TAU=	0.58000	ITERATION NO.	580							
1672.286	1668.765	1658.235	1640.742	1616.280	1584.681	1545.540	1498.123	1425.317	1395.961	80.000
TEMPERATURES AT TAU=	0.60000	ITERATION NO.	600							
1807.032	1803.584	1793.233	1775.905	1751.428	1719.481	1679.598	1631.174	1557.303	1527.165	80.000

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TEMPERATURES AT TAU= 0.62000 ITERATION NO. 620
1881.100 1879.300 1874.026 1866.082 1855.240 1836.903 1799.362 1750.944 1685.585 1660.216 80.000

TEMPERATURES AT TAU= 0.64000 ITERATION NO. 640
1916.706 1915.111 1910.365 1902.525 1891.572 1877.395 1859.292 1838.187 1793.382 1774.310 80.000

TEMPERATURES AT TAU= 0.66000 ITERATION NO. 660
1938.427 1936.870 1932.210 1924.469 1913.707 1900.104 1884.093 1866.815 1847.601 1837.692 80.000

TEMPERATURES AT TAU= 0.67100 ITERATION NO. 671
1944.066 1942.522 1937.908 1930.280 1919.779 1906.757 1892.061 1877.496 1863.086 1855.187 80.000

FINAL COEFFICIENTS

B 0. 0.3040E-01 0.4559E-01 0.5066E-01 0.5319E-01 0.5471E-01 0.5573E-01 0.5645E-01 0.1661E-00 0.2849E-00

C 0.7568E 00 0.8784E 00 0.8784E 00 0.8784E 00 0.8784E 00 0.8784E 00 0.8784E 00 0.8921E 00 0.6776E 00 0.7146E 00

D 0.2432E-00 0.9119E-01 0.7599E-01 0.7092E-01 0.6839E-01 0.6687E-01 0.6586E-01 0.5145E-01 0.1563E-00 0.

E 0.5350E-03

F 0.4272E 01 0.4272E 01 0.4278E 01 0.4292E 01 0.4318E 01 0.4356E 01 0.4410E 01 0.4481E 01 0. 0.

G 0.

1-G-H 0.1000E 01

H 0.

N(TAU) USED UP. END OF PROBLEM NO. 35.00025

SHARE 704 SYMBOLIC CODING FORM

[illegible]

RE-147 CYCLOPS PROBLEM NO. 26.00029

INPUT

GENERAL DATA

I= 7 J= 9 R(B)= 0.00600 R(O)= 0.00725 R(S)= 0.01925
DELTA TAU= 0.00099999 DELTA Z= 0.13167 V=0.25000E 02 PSI(O,TAU)= 700.000

PROBLEM PARAMETERS

N= 25 BETA= 1.0000E-01 FINAL TAU= 0.3000 P=0 T=1 NT= 0 W=1

MATERIAL PROPERTIES

K(F)	K(B)	K(S)	RHO*(F)	RHO*(B)	RHO*(S)	H
3.83300E-03	3.04000E-03	1.16700E-02	4.02700E 01	4.26400E 01	1.70700E 01	2.60000E 00
6.61100E-03	3.38000E-03	1.01400E-02	6.05000E 01	4.50000E 01	1.66800E 01	2.60000E 00
7.72200E-03	3.82000E-03	8.83000E-03	1.98420E 02	4.98700E 01	1.68200E 01	2.60000E 00
8.53000E-03	4.03000E-03	8.83000E-03	4.07000E 01	4.98700E 01	1.68200E 01	2.60000E 00

TT(F)	TT(B)	TT(S)	DELTA TT(F)	DELTA TT(B)
1233.000	208.000	900.000	144.770	0.
1850.000	800.000	1300.000	0.	0.
1976.000	1600.000	1618.000	0.	0.

Q(O)= 4.00000E 04

MU (READ ACROSS)

0.975000 0.975500 0.980500 0.993000 1.016500 0. 0.

ZETA (READ ACROSS)

1.000000 1.000000 1.000000 1.000000 1.000000 1.000000 1.000000 1.000000

OUTPUT

[illegible]

DELTA TAU= 0.00099999 BETA= 1.0000E-01 N= 25

INITIAL COEFFICIENTS

[illegible][illegible]

RE-147 CYCLOPS PROBLEM NO. 26.00029

D	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
	0.2142E-00	0.8031E-01	0.6693E-01	0.6246E-01	0.7050E-01	0.1152E-00	0.
E	0.1428E-00	0.1428E-00	0.1428E-00	0.1428E-00	0.1428E-00	0.1428E-00	0.1428E-00
F	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
	0.9685E 00	0.9690E 00	0.9739E 00	0.9863E 00	0.1010E 01	0.	0.
G	0.2390E-02	0.2390E-02	0.2390E-02	0.2390E-02	0.2390E-02	0.2390E-02	0.2390E-02
1-G-H	0.8077E 00	0.8077E 00	0.8077E 00	0.8077E 00	0.8077E 00	0.8077E 00	0.8077E 00
H	0.1899E-00						
TEMPERATURES AT TAU= 0.02500							
			ITERATION NO.	25			
727.465	727.375	726.906	725.116	719.724	708.499	704.314	700.038
727.465	727.375	726.906	725.116	719.724	708.501	704.322	700.062
727.465	727.375	726.906	725.116	719.724	708.502	704.326	700.075
727.465	727.375	726.906	725.116	719.724	708.503	704.328	700.082
727.465	727.375	726.906	725.116	719.724	708.503	704.329	700.085
727.465	727.375	726.906	725.116	719.724	708.503	704.329	700.087
727.465	727.375	726.906	725.116	719.724	708.503	704.329	700.087
727.465	727.375	726.906	725.116	719.724	708.503	704.329	700.087

RE-147 CYCLOPS PROBLEM NO. 26.00029

727.465	727.375	726.906	725.116	719.724	708.503	704.329	700.087
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TEMPERATURES AT TAU= 0.05000			ITERATION NO.		50		
760.909	760.210	757.718	751.941	740.080	720.913	711.604	700.124
760.910	760.211	757.719	751.945	740.091	720.940	711.656	700.229
760.910	760.211	757.720	751.947	740.099	720.961	711.697	700.315
760.910	760.211	757.720	751.948	740.104	720.975	711.728	700.382
760.910	760.211	757.720	751.949	740.107	720.985	711.750	700.434
760.910	760.211	757.720	751.950	740.109	720.991	711.765	700.472
760.910	760.211	757.720	751.950	740.110	720.995	711.775	700.498
760.910	760.211	757.720	751.950	740.111	720.997	711.781	700.515
760.910	760.211	757.720	751.950	740.111	720.998	711.785	700.525

TEMPERATURES AT TAU= 0.07500			ITERATION NO.		75		
800.390	798.834	793.684	783.141	763.877	735.383	720.103	700.227
800.393	798.838	793.692	783.160	763.916	735.456	720.220	700.430
800.395	798.841	793.699	783.174	763.948	735.519	720.323	700.610
800.397	798.843	793.704	783.185	763.974	735.571	720.410	700.769
800.398	798.845	793.707	783.193	763.994	735.613	720.484	700.907
800.398	798.846	793.709	783.199	764.009	735.647	720.546	701.025
800.399	798.846	793.711	783.204	764.021	735.674	720.596	701.123
800.399	798.847	793.712	783.206	764.029	735.694	720.635	701.205
800.399	798.847	793.712	783.208	764.034	735.709	720.665	701.269

TEMPERATURES AT TAU= 0.10000			ITERATION NO.		100		
847.739	845.159	836.844	820.631	792.487	752.629	730.204	700.348
847.753	845.176	836.870	820.678	792.569	752.765	730.404	700.667
847.764	845.189	836.892	820.717	792.642	752.887	730.584	700.959
847.772	845.200	836.910	820.750	792.704	752.994	730.746	701.226
847.779	845.208	836.924	820.777	792.757	753.088	730.891	701.467
847.783	845.214	836.935	820.800	792.803	753.170	731.019	701.684
847.787	845.219	836.944	820.818	792.840	753.240	731.131	701.878
847.789	845.222	836.950	820.832	792.871	753.300	731.229	702.051
847.791	845.224	836.955	820.843	792.896	753.350	731.313	702.202

TEMPERATURES AT TAU= 0.12500			ITERATION NO.		125		
905.642	901.833	889.704	866.614	827.591	773.650	742.487	700.494
905.677	901.872	889.760	866.702	827.733	773.867	742.789	700.954
905.706	901.906	889.809	866.780	827.860	774.064	743.067	701.380

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905.731	901.935	889.851	866.848	827.975	774.243	743.322	701.775
905.751	901.959	889.887	866.908	828.077	774.406	743.555	702.140
905.768	901.978	889.917	866.959	828.167	774.552	743.767	702.475
905.781	901.995	889.942	867.004	828.247	774.683	743.959	702.783
905.792	902.008	889.963	867.042	828.316	774.799	744.133	703.064
905.800	902.018	889.981	867.074	828.376	774.902	744.288	703.320

TEMPERATURES AT TAU= 0.15000

ITERATION NO. 150

977.528	972.215	955.411	923.838	871.291	799.697	757.683	700.675
977.596	972.290	955.510	923.983	871.510	800.014	758.111	701.307
977.656	972.357	955.599	924.114	871.710	800.308	758.510	701.898
977.708	972.416	955.679	924.232	871.894	800.578	758.880	702.450
977.754	972.467	955.749	924.338	872.060	800.827	759.222	702.964
977.793	972.511	955.810	924.433	872.211	801.055	759.539	703.443
977.826	972.550	955.864	924.518	872.100	800.862	759.830	703.888
977.854	972.582	955.911	924.592	872.223	801.052	760.099	704.300
977.878	972.610	955.952	924.658	872.333	801.225	760.345	704.682

TEMPERATURES AT TAU= 0.17500

ITERATION NO. 175

1067.580	1060.275	1037.135	993.519	920.721	826.442	773.516	700.869
1067.671	1060.366	1037.229	993.628	920.900	826.767	774.018	701.692
1067.776	1060.481	1037.374	993.832	921.200	827.188	774.566	702.471
1067.869	1060.583	1037.507	994.020	921.479	827.581	775.081	703.207
1067.953	1060.676	1037.626	994.191	921.736	827.946	775.562	703.902
1068.027	1060.758	1037.734	994.348	921.973	828.286	776.012	704.555
1068.066	1060.795	1037.764	994.379	922.051	828.480	776.353	705.166
1068.124	1060.859	1037.851	994.508	922.250	828.771	776.742	705.738
1068.175	1060.916	1037.928	994.624	922.432	829.038	777.103	706.272

TEMPERATURES AT TAU= 0.20000

ITERATION NO. 200

1180.219	1170.286	1139.003	1080.787	985.199	863.110	794.770	701.118
1180.331	1170.406	1139.155	1081.010	985.554	863.641	795.488	702.175
1180.497	1170.586	1139.376	1081.308	985.973	864.207	796.208	703.175
1180.649	1170.750	1139.581	1081.585	986.365	864.739	796.887	704.121
1180.787	1170.900	1139.768	1081.841	986.732	865.239	797.527	705.016
1180.913	1171.037	1139.940	1082.079	987.073	865.708	798.130	705.863
1180.956	1171.086	1140.011	1082.202	987.301	866.079	798.655	706.663
1181.058	1171.198	1140.154	1082.402	987.595	866.489	799.188	707.420
1181.150	1171.299	1140.284	1082.586	987.867	866.872	799.688	708.134

RE-147 CYCLOPS PROBLEM NO. 26.00029

TEMPERATURES AT TAU= 0.22500			ITERATION NO.		225		
1233.000	1233.000	1233.000	1188.953	1069.816	915.405	830.830	701.534
1233.000	1233.000	1233.000	1189.325	1070.467	916.289	831.900	702.969
1233.000	1233.000	1233.000	1189.738	1071.144	917.165	832.932	704.311
1233.000	1233.000	1233.000	1190.067	1071.663	917.857	833.805	705.563
1233.000	1233.000	1233.000	1190.436	1072.270	918.639	834.720	706.738
1233.000	1233.000	1233.000	1190.785	1072.844	919.377	835.583	707.843
1233.000	1233.000	1233.000	1190.991	1073.208	919.906	836.281	708.885
1233.000	1233.000	1233.000	1191.302	1073.722	920.566	837.051	709.870
1233.000	1233.000	1233.000	1191.534	1074.095	921.074	837.699	710.801

TEMPERATURES AT TAU= 0.25000			ITERATION NO.		250		
1344.726	1335.483	1304.840	1233.000	1154.687	973.131	867.390	701.989
1345.008	1335.779	1305.091	1233.000	1155.315	974.145	868.704	703.876
1344.421	1335.053	1304.337	1233.000	1155.929	975.124	869.960	705.661
1344.725	1335.356	1304.569	1233.000	1156.454	975.988	871.103	707.345
1345.028	1335.661	1304.806	1233.000	1156.993	976.851	872.212	708.930
1345.312	1335.946	1305.029	1233.000	1157.501	977.661	873.254	710.418
1345.466	1336.103	1305.154	1233.000	1157.907	978.347	874.179	711.814
1345.713	1336.352	1305.349	1233.000	1158.358	979.065	875.098	713.122
1345.914	1336.554	1305.505	1233.000	1158.738	979.692	875.928	714.349

TEMPERATURES AT TAU= 0.27500			ITERATION NO.		275		
1489.204	1475.161	1432.769	1358.769	1233.000	1025.593	900.091	702.395
1489.667	1475.682	1433.432	1359.440	1233.000	1026.730	901.704	704.693
1489.326	1475.428	1433.415	1359.654	1233.000	1027.748	903.194	706.899
1489.021	1475.032	1432.870	1359.221	1233.000	1028.524	904.464	709.011
1489.472	1475.530	1433.480	1359.822	1233.000	1029.512	905.869	711.030
1489.897	1475.999	1434.054	1360.387	1233.000	1030.445	907.200	712.954
1490.176	1476.317	1434.465	1360.814	1233.000	1031.281	908.423	714.780
1490.551	1476.730	1434.966	1361.284	1233.000	1032.081	909.592	716.508
1490.854	1477.066	1435.375	1361.670	1233.000	1032.805	910.671	718.140

TEMPERATURES AT TAU= 0.30000			ITERATION NO.		300		
1676.737	1656.982	1595.093	1484.557	1323.300	1099.753	940.936	702.813
1677.287	1657.556	1595.805	1485.678	1324.968	1101.578	943.008	705.487
1677.267	1657.590	1596.043	1486.367	1326.226	1103.112	944.879	708.063
1676.897	1657.261	1595.869	1486.531	1326.869	1104.193	946.450	710.554

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1677.404	1657.788	1596.510	1487.524	1328.338	1105.808	948.300	712.963
1677.847	1658.206	1596.872	1487.937	1329.291	1107.717	950.555	715.294
1678.201	1658.583	1597.362	1488.722	1330.465	1109.093	952.202	717.533
1678.624	1659.027	1597.912	1489.561	1331.679	1110.471	953.815	719.676
1678.973	1659.396	1598.382	1490.300	1332.771	1111.737	955.323	721.722

FINAL COEFFICIENTS

B

0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00
0.	0.3073E-01	0.4610E-01	0.5122E-01	0.5378E-01	0.1072E-00	0.2141E-00

C

0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00
0.7541E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8771E 00	0.8798E 00	0.7753E 00	0.6571E 00

D

0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.
0.2459E-00	0.9220E-01	0.7683E-01	0.7171E-01	0.6644E-01	0.1175E-00	0.

E

0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00	0.1288E-00
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RE-147 CYCLOPS PROBLEM NO. 26.00029

F	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
	0.6446E 00 0.6450E 00 0.6483E 00 0.6565E 00 0.6721E 00 0.	0.
G	0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02 0.2390E-02	
1-G-H	0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00 0.8077E 00	
H	0.1899E-00	

TAU=FINAL TAU. END OF PROBLEM NO. 26.00029

APPENDIX A
FLOW CHARTS

FLOW CHARTS

READ INPUT, INITIALIZE CODE, PRINT INPUT

COMPUTE INTERMEDIARY QUANTITIES

COMPUTE INITIAL TEMPERATURES

PRINT INITIAL TEMPERATURES

COMPUTE INITIAL PHASES

COMPUTE INITIAL PHASES (CONT.)

COMPUTE INITIAL COEFFICIENTS

COMPUTE (CONT.) AND TEST INITIAL COEFFICIENTS

PRINT INITIAL COEFFICIENTS

PRINT NEW $\Delta\tau$, β , N

ITERATIONS

ITERATIONS (CONT.)

ITERATIONS (CONT.)

ITERATIONS (CONT.)

ITERATIONS (CONT.)

SUB - TEMPERATURE PRINT SUBROUTINE

SUBBB - PREPARATION FOR, AND USE OF SUB

SUBBP - ROW OVERFLOW TEST SUBROUTINE

SUBBQ - COLUMN OVERFLOW TEST SUBROUTINE

SUBX - FINAL REMARK SPACE TEST SUBROUTINE

APPENDIX BStorage Map

<u>Oct.</u>	<u>Dec.</u>	<u>Label</u>	<u>Oct.</u>	<u>Dec.</u>	<u>Label</u>
143	99	Prob. No.	167	119	k_{f_4}
144	100	I	170	120	k_{b_1}
145	101	J	171	121	k_{b_2}
146	102	R_b	172	122	k_{b_3}
147	103	R_0	173	123	k_{b_4}
150	104	R_s	174	124	k_{s_1}
151	105	$\Delta\tau$	175	125	k_{s_2}
152	106	Δz	176	126	k_{s_3}
153	107	V	177	127	k_{s_4}
154	108	$\psi_0(\tau)$	200	128	ρ^{cf_1}
155	109	N	201	129	ρ^{cf_2}
156	110	β or p	202	130	ρ^{cf_3}
157	111	τ_f	203	131	ρ^{cf_4}
160	112	P	204	132	ρ^{cb_1}
161	113	T	205	133	ρ^{cb_2}
162	114	NT	206	134	ρ^{cb_3}
163	115	W	207	135	ρ^{cb_4}
164	116	k_{f_1}	210	136	ρ^{cs_1}
165	117	k_{f_2}	211	137	ρ^{cs_2}
166	118	k_{f_3}	212	138	ρ^{cs_3}

Oct.	Dec.	Label	Oct.	Dec.	Label
213	139	ρc_{s_4}	.	.	.
214	140	h_1	.	.	.
215	141	h_2	.	.	.
216	142	h_3	630	408	$n(\tau)_{250}$
217	143	h_4	631	409	NY INP 1
220	144	$T_{\alpha\beta f}$	.	.	.
221	145	$T_{\beta\gamma f}$	.	.	.
222	146	$T_{\gamma\delta f}$	.	.	.
223	147	$T_{\alpha\beta b}$	1725	981	NY OUT 1
224	148	$T_{\beta\gamma b}$	.	.	.
225	149	$T_{\gamma\delta b}$	.	.	.
226	150	$\psi_{\alpha\beta}$	.	.	.
227	151	$\psi_{\beta\gamma}$	3062	1586	GE LN
230	152	$\psi_{\gamma\delta}$	.	.	.
231	153	$\Delta T_{\alpha\beta f}$	.	.	.
232	154	$\Delta T_{\beta\gamma f}$	.	.	.
233	155	$\Delta T_{\gamma\delta f}$	3140	1632	PROGRAM
234	156	$\Delta T_{\alpha\beta b}$	.	.	.
235	157	$\Delta T_{\beta\gamma b}$	.	.	.
236	158	$\Delta T_{\gamma\delta b}$	.	.	.
237	159	$n(\tau)_1$	3142	1634	.
240	160	$n(\tau)_2$	3150	1640	Δr_f

Oct.	Dec.	Label	Oct.	Dec.	Label
3151	1641	Δr_b	3175	1661	M_{s_4}
3152	1642	Δr_s	3176	1662	$N_{b_{11}}$
3153	1643	$(\Delta r_f)^2/\Delta \tau$	3177	1663	$N_{b_{12}}$
3154	1644	$(\Delta r_b)^2/\Delta \tau$	3200	1664	$N_{b_{13}}$
3155	1645	$(\Delta r_s)^2/\Delta \tau$	3201	1665	$N_{b_{14}}$
3156	1646	$\Delta r_b/\Delta r_f$	3202	1666	$N_{b_{21}}$
3157	1647	$\Delta r_b/(R_0 - \Delta r_b)$	3203	1667	$N_{b_{22}}$
3160	1648	$\frac{8\Delta r_b R_0}{4R_0 - \Delta r_b}$ or $\frac{16\Delta r_b A_{Is}}{\Delta z \Delta r_s (4R_0 - \Delta r_b)}$	3204	1668	$N_{b_{23}}$
3161	1649	$R_0 \Delta r_s / R_s$ or A_{Is}	3205	1669	$N_{b_{24}}$
3162	1650	M_{f_1}	3206	1670	$N_{b_{31}}$
3163	1651	M_{f_2}	3207	1671	$N_{b_{32}}$
3164	1652	M_{f_3}	3210	1672	$N_{b_{33}}$
3165	1653	M_{f_4}	3211	1673	$N_{b_{34}}$
3166	1654	M_{b_1}	3212	1674	$N_{b_{41}}$
3167	1655	M_{b_2}	3213	1675	$N_{b_{42}}$
3170	1656	M_{b_3}	3214	1676	$N_{b_{43}}$
3171	1657	M_{b_4}	3215	1677	$N_{b_{44}}$
3172	1658	M_{s_1}	3216	1678	$K_{f_{11}}$
3173	1659	M_{s_2}	3217	1679	$K_{f_{12}}$
3174	1660	M_{s_3}	3220	1680	$K_{f_{13}}$
			3221	1681	$K_{f_{14}}$
			3222	1682	$K_{f_{21}}$
			3223	1683	$K_{f_{22}}$

Oct.	Dec.	Label	Oct.	Dec.	Label
3224	1684	$K_{f_{23}}$	3252	1706	$L_{f_{41}}$
3225	1685	$K_{f_{24}}$	3253	1707	$L_{f_{42}}$
3226	1686	$K_{f_{31}}$	3254	1708	$L_{f_{43}}$
3227	1687	$K_{f_{32}}$	3255	1709	$L_{f_{44}}$
3230	1688	$K_{f_{33}}$	3256	1710	N_{s_1}
3231	1689	$K_{f_{34}}$	3257	1711	N_{s_2}
3232	1690	$K_{f_{41}}$	3260	1712	N_{s_3}
3233	1691	$K_{f_{42}}$	3261	1713	N_{s_4}
3234	1692	$K_{f_{43}}$	3262	1714	H
3235	1693	$K_{f_{44}}$	3270	1720	PROGRAM
3236	1694	$L_{f_{11}}$	.	.	.
3237	1695	$L_{f_{12}}$	.	.	.
3240	1696	$L_{f_{13}}$	.	.	.
3241	1697	$L_{f_{14}}$	7636	.	COMMON
3242	1698	$L_{f_{21}}$	.	.	.
3243	1699	$L_{f_{22}}$	.	.	.
3244	1700	$L_{f_{23}}$	.	.	.
3245	1701	$L_{f_{24}}$	7672	.	GE EXP
3246	1702	$L_{f_{31}}$	.	.	.
3247	1703	$L_{f_{32}}$	.	.	.
3250	1704	$L_{f_{33}}$	.	.	.
3251	1705	$L_{f_{34}}$			

<u>Oct.</u>	<u>Dec.</u>	<u>Label</u>
10011	4105	PROGRAM
.	.	.
.	.	.
.	.	.
10046	4134	.

<u>Dec.</u>	<u>Label</u>	<u>Dec.</u>	<u>Label</u>
32766-2I-7J-8IJ	PRINT TEMPORARIES	32767-I-4J-3IJ	E_j
32767-I-7J-8IJ	PC_{Ψ_j}	32767-I-3J-3IJ	F_{ij}
32767-I-6J-8IJ	T'_{ij}	32767-I-3J-2IJ	$T_{ij}(\tau + \Delta\tau)$
32767-I-6J-7IJ	$PC_{T_{ij}}$	32767-I-3J-1IJ	$\Psi_j(\tau + \Delta\tau)$
32767-I-6J-6IJ	1-G _j -H	32767-I-2J-1IJ	$T_{ij}(\tau)$
32767-I-5J-6IJ	G_j	32767-I-2J	$\Psi_j(\tau)$
32767-I-4J-6IJ	B_{ij}	32767-I-J	ξ_j
32767-I-4J-5IJ	C_{ij}	32767-I	μ_i
32767-I-4J-4IJ	D_{ij}	32767	q_0

APPENDIX CSHARE Assembly Program Listing

The following 63 pages give a complete listing of the SAP statements which form the program RE-147. The program, as listed here, is for an IBM-704 with a 32K memory. For use on a 704 of different memory size, change card number 2024 appropriately.

SUBROUTINES USED:

NY INPI

NY OUT1

GE LN

GE EXP

				524/RE-147 HEAT TRANSFER PROGRAM J. HEESTAND	524 0000
		00631	ORG 409		524 0001
		00631	INP1 LIB 4		524 0002
		01725	ORG 981		524 0003
		01725	OUT1 LIB 4		524 0004
		03270	ORG 1720		524 0005
		P	HED		524 0006
		00631	INP1 SYN I\$INP1		524 0007
		01725	OUT1 SYN O\$OUT1		524 0008
		01753	BLK5 SYN O\$BLK5		524 0009
		02547	WOT SYN O\$WOT		524 0010
03270	0	50000	0 07632 BEGIN CLA C40	CHANGE OUT1	524 0011
03271	0	60100	0 01753 STO BLK5		524 0012
03272	0	50000	0 02550 CLA WOT+1	CHANGE OUTPUT TAPE TO 0	524 0013
03273	0	40000	0 07613 ADD C24		524 0014
03274	0	60100	0 02550 STO WOT+1		524 0015
03275	0	76000	0 00165 SWT 5	IS OUTPUT ON TAPE	524 0016
03276	0	02000	0 03300 TRA BEGIN+8		524 0017
03277	0	02000	0 03304 TRA END	NO--GO TO END	524 0018
03300	0	50000	0 07021 CLA F0+1	YES--INSERT CARRIAGE	524 0019
03301	0	40200	0 07622 SUB C31	CONTROL CHARACTER FOR	524 0020
03302	0	60100	0 07021 STO F0+1	OFFLINE PRINTER RESTORE	524 0021
03303	0	02000	0 03316 TRA START		524 0022
03304	0	76100	0 00000 END NOP		524 0023
03305	0	76100	0 00000 NOP		524 0024
03306	0	76000	0 00165 SWT 5	IS OUTPUT ON LINE	524 0025
03307	0	02000	0 03316 TRA START	NO--GO TO START	524 0026
03310	0	76600	0 00361 WPR	YES--RESTORE PRINTER	524 0027
03311	0	76000	0 00361 SPR 1		524 0028
03312	0	02000	0 03316 TRA START		524 0029
03313	0	76100	0 00000 NOP		524 0030
03314	0	76100	0 00000 NOP		524 0031
03315	0	76100	0 00000 NOP		524 0032
				READ INPUT, INITIALIZE, AND PRINT INPUT	524 0033
03316	0	07400	4 00631 START TSX INP1,4	READ IN ALL INPUT	524 0034
03317	0	00000	0 00143 99,0,0		524 0035
03320	0	00000	0 00660 HTR INP1+23		524 0036
03321	0	76000	0 00140 SLF	TURN OFF SENSE LIGHTS	524 0037
03322	0	50000	0 07604 CLA C17	PAGE=1	524 0038
03323	0	60100	0 07557 STO PAGE		524 0039

03324	0	50000	0	00143	CLA 99		524	0040
03325	0	60100	0	07556	STO PROB		524	0041
03326	0	56000	0	00144	LDQ 100	P2=IXJ	524	0042
03327	0	20000	0	00145	MPY 101		524	0043
03330	-0	60000	0	07535	STQ P2		524	0044
03331	0	50000	0	00144	CLA 100	ROW=(I+9)/10	524	0045
03332	0	40000	0	07610	ADD C21		524	0046
03333	0	76500	0	00043	LRS 35		524	0047
03334	0	22000	0	07611	DVH C22		524	0048
03335	-0	60000	0	07562	STQ ROW		524	0049
03336	0	50000	0	00145	CLA 101	ROWP=(J+9)/10	524	0050
03337	0	40000	0	07610	ADD C21		524	0051
03340	0	76500	0	00043	LRS 35		524	0052
03341	0	22000	0	07611	DVH C22		524	0053
03342	-0	60000	0	07563	STQ ROWP	ROWQ=(I+12)/12	524	0054
03343	0	50000	0	00144	CLA 100		524	0055
03344	0	40000	0	07623	ADD C32		524	0056
03345	0	76500	0	00043	LRS 35		524	0057
03346	0	22000	0	07623	DVH C32		524	0058
03347	-0	60000	0	07564	STQ ROWQ	T2=(NT+7)8	524	0059
03350	0	50000	0	00162	CLA 114		524	0060
03351	0	40000	0	07612	ADD C23		524	0061
03352	0	76500	0	00043	LRS 35		524	0062
03353	0	22000	0	07613	DVH C24		524	0063
03354	-0	60000	0	07541	STQ T2		524	0064
03355	0	50000	0	07621	CLA C30	158+NT	524	0065
03356	0	40000	0	00162	ADD 114		524	0066
03357	0	73400	4	00000	PAX 0,4		524	0067
03360	-0	63400	4	04053	SXD S4+1,4		524	0068
03361	0	40000	0	07606	ADD C19	160+NT	524	0069
03362	0	62100	0	06300	STA I25+4		524	0070
03363	0	62100	0	06307	STA I25+11		524	0071
03364	0	40000	0	07604	ADD C17	161+NT	524	0072
03365	0	62100	0	06277	STA I25+3		524	0073
03366	0	50000	0	07577	CLA C12	32767-I	524	0074
03367	0	40200	0	00144	SUB 100		524	0075
03370	0	62100	0	04077	STA S6		524	0076
03371	0	62100	0	04457	STA IT2+3		524	0077
03372	0	62100	0	04110	STA S7+1		524	0078
03373	0	62100	0	05010	STA IC26+22		524	0079

03374	0	62100	0	05060	STA IC27+37		524	0080
03375	0	62100	0	05133	STA IC28+39		524	0081
03376	0	62100	0	05211	STA IC29+43		524	0082
03377	0	62100	0	05263	STA IC30+39		524	0083
03400	0	40200	0	07604	SUB C17	32766-I	524	0084
03401	0	73400	4	00000	PAX 0,4		524	0085
03402	-0	63400	4	04101	SXD S6+2,4		524	0086
03403	0	40200	0	00145	SUB 101	32766-I-J	524	0087
03404	0	62100	0	06034	STA I19+8		524	0088
03405	0	40000	0	07604	ADD C17	32767-I-J	524	0089
03406	0	62100	0	04364	STA IT+7		524	0090
03407	0	62100	0	04473	STA IT3+8		524	0091
03410	0	62100	0	04517	STA IT4+14		524	0092
03411	0	62100	0	04524	STA IT5+2		524	0093
03412	0	62100	0	04661	STA IC18		524	0094
03413	0	62100	0	06504	STA SUB+10		524	0095
03414	0	62100	0	05462	STA I2+8		524	0096
03415	0	62100	0	06037	STA I19+11		524	0097
03416	0	62100	0	06163	STA I23+10		524	0098
03417	0	62100	0	04101	STA S6+2		524	0099
03420	0	40200	0	00145	SUB 101	32767-I-2J	524	0100
03421	0	62100	0	04363	STA IT+6		524	0101
03422	0	62100	0	04474	STA IT3+9		524	0102
03423	0	62100	0	04520	STA IT4+15		524	0103
03424	0	62100	0	04525	STA IT5+3		524	0104
03425	0	62100	0	04535	STA IT6+6		524	0105
03426	0	62100	0	04572	STA IC9		524	0106
03427	0	62100	0	04625	STA IC10		524	0107
03430	0	62100	0	06477	STA SUB+5		524	0108
03431	0	62100	0	05502	STA I3+13		524	0109
03432	0	62100	0	06157	STA I23+6		524	0110
03433	0	62100	0	06044	STA I19+16		524	0111
03434	0	40000	0	07604	ADD C17	32768-I-2J	524	0112
03435	0	62100	0	05506	STA I3+17		524	0113
03436	0	40200	0	07606	SUB C19	32766-I-2J	524	0114
03437	0	62100	0	05470	STA I3+3		524	0115
03440	0	62100	0	05476	STA I3+9		524	0116
03441	0	62100	0	06046	STA I19+18		524	0117
03442	0	40000	0	07604	ADD C17		524	0118
03443	0	40200	0	07535	SUB P2	32767-I-2J-IJ	524	0119

03444	0	62100	0	04534	STA	I7+5		524	0120
03445	0	62100	0	06051	STA	I19+21		524	0121
03446	0	62100	0	06152	STA	I23+1		524	0122
03447	0	62100	0	06162	STA	I23+9		524	0123
03450	0	40200	0	00145	SUB	101	32767-I-3J-IJ	524	0124
03451	0	62100	0	05531	STA	I4+1		524	0125
03452	0	62100	0	05547	STA	I6+7		524	0126
03453	0	62100	0	05560	STA	I7+7		524	0127
03454	0	62100	0	05563	STA	I8+1		524	0128
03455	0	62100	0	05567	STA	I9+1		524	0129
03456	0	62100	0	06156	STA	I23+5		524	0130
03457	0	40200	0	07535	SUB	P2	32767-I-3J-2IJ	524	0131
03460	0	62100	0	05011	STA	IC26+23		524	0132
03461	0	62100	0	05061	STA	IC27+38		524	0133
03462	0	62100	0	05134	STA	IC28+40		524	0134
03463	0	62100	0	05212	STA	IC29+44		524	0135
03464	0	62100	0	05264	STA	IC30+40		524	0136
03465	0	62100	0	05452	STA	I2		524	0137
03466	0	62100	0	05627	STA	I12+33		524	0138
03467	0	62100	0	05632	STA	I12+36		524	0139
03470	0	62100	0	05663	STA	I13+23		524	0140
03471	0	62100	0	05666	STA	I13+26		524	0141
03472	0	62100	0	05706	STA	I14		524	0142
03473	0	62100	0	05711	STA	I14+3		524	0143
03474	0	62100	0	05755	STA	I15		524	0144
03475	0	62100	0	05760	STA	I15+3		524	0145
03476	0	62100	0	06017	STA	I16+6		524	0146
03477	0	62100	0	06022	STA	I16+9		524	0147
03500	0	40200	0	07535	SUB	P2	32767-I-3J-3IJ	524	0148
03501	0	62100	0	05233	STA	IC30+15		524	0149
03502	0	62100	0	05252	STA	IC30+30		524	0150
03503	0	62100	0	06751	STA	SUBB+65		524	0151
03504	0	62100	0	05461	STA	I2+7		524	0152
03505	0	62100	0	06002	STA	I15+21		524	0153
03506	0	62100	0	06005	STA	I15+24		524	0154
03507	0	62100	0	06120	STA	I21+34		524	0155
03510	0	62100	0	06123	STA	I21+37		524	0156
03511	0	62100	0	06145	STA	I22+15		524	0157
03512	0	40200	0	07604	SUB	C17	32766-I-3J-3IJ	524	0158
03513	0	62100	0	06140	STA	I22+10		524	0159

03514	0	73400	4	00000	PAX	0,4		524	0160
03515	-0	63400	4	06742	SXD	SUBB+58,4		524	0161
03516	0	40000	0	00144	ADD	100	32766-3J-3IJ	524	0162
03517	0	73400	4	00000	PAX	0,4		524	0163
03520	-0	63400	4	06751	SXD	SUBB+65,4		524	0164
03521	0	40200	0	00144	SUB	100	32766-I-4J-3IJ	524	0165
03522	0	40200	0	00145	SUB	101		524	0166
03523	0	62100	0	05731	STA	I14+19		524	0167
03524	0	62100	0	05734	STA	I14+22		524	0168
03525	0	62100	0	05750	STA	I14+34		524	0169
03526	0	40000	0	07604	ADD	C17	32767-I-4J-3IJ	524	0170
03527	0	62100	0	04775	STA	IC26+11		524	0171
03530	0	62100	0	05041	STA	IC27+22		524	0172
03531	0	62100	0	05117	STA	IC28+27		524	0173
03532	0	62100	0	05121	STA	IC28+29		524	0174
03533	0	62100	0	05175	STA	IC29+31		524	0175
03534	0	62100	0	05200	STA	IC29+34		524	0176
03535	0	62100	0	05254	STA	IC30+32		524	0177
03536	0	62100	0	06742	STA	SUBB+58		524	0178
03537	0	62100	0	05505	STA	I3+16		524	0179
03540	0	62100	0	05623	STA	I12+29		524	0180
03541	0	62100	0	05626	STA	I12+32		524	0181
03542	0	62100	0	05651	STA	I13+13		524	0182
03543	0	62100	0	05656	STA	I13+18		524	0183
03544	0	62100	0	05661	STA	I13+21		524	0184
03545	0	62100	0	05712	STA	I14+4		524	0185
03546	0	62100	0	05715	STA	I14+7		524	0186
03547	0	62100	0	05745	STA	I14+31		524	0187
03550	0	62100	0	06013	STA	I16+2		524	0188
03551	0	62100	0	06015	STA	I16+4		524	0189
03552	0	40000	0	07604	ADD	C17	32768-I-4J-3IJ	524	0190
03553	0	62100	0	05701	STA	I13+37		524	0191
03554	0	40200	0	07535	SUB	P2	32768-I-4J-4IJ	524	0192
03555	0	62100	0	05702	STA	I13+38		524	0193
03556	0	62100	0	05671	STA	I13+29		524	0194
03557	0	40200	0	07604	SUB	C17	32767-I-4J-4IJ	524	0195
03560	0	62100	0	05001	STA	IC26+15		524	0196
03561	0	62100	0	05047	STA	IC27+28		524	0197
03562	0	62100	0	05123	STA	IC28+31		524	0198
03563	0	62100	0	05201	STA	IC29+35		524	0199

03564	0	62100	0	05253	STA	IC30+31		524	0200
03565	0	62100	0	05331	STA	IC35+2		524	0201
03566	0	62100	0	06722	STA	SUBB+42		524	0202
03567	0	62100	0	05501	STA	I3+12		524	0203
03570	0	62100	0	05622	STA	I12+28		524	0204
03571	0	62100	0	05662	STA	I13+22		524	0205
03572	0	62100	0	05746	STA	I14+32		524	0206
03573	0	62100	0	06006	STA	I15+25		524	0207
03574	0	62100	0	06016	STA	I16+5		524	0208
03575	0	62100	0	06146	STA	I22+16		524	0209
03576	0	62100	0	06173	STA	I23+18		524	0210
03577	0	40200	0	07604	SUB	C17	32766-I-4J-4IJ	524	0211
03600	0	62100	0	06141	STA	I22+11		524	0212
03601	0	62100	0	05752	STA	I14+36		524	0213
03602	0	40000	0	00144	ADD	100	32766-4J-4IJ	524	0214
03603	0	73400	4	00000	PAX	0,4		524	0215
03604	-0	63400	4	06722	SXD	SUBB+42,4		524	0216
03605	0	40200	0	07535	SUB	P2	32766-4J-5IJ	524	0217
03606	0	73400	4	00000	PAX	0,4		524	0218
03607	-0	63400	4	06704	SXD	SUBB+28,4		524	0219
03610	0	40200	0	00144	SUB	100	32766-I-4J-5IJ	524	0220
03611	0	62100	0	06137	STA	I22+9		524	0221
03612	0	62100	0	05751	STA	I14+35		524	0222
03613	0	40000	0	07604	ADD	C17	32767-I-4J-5IJ	524	0223
03614	0	62100	0	04772	STA	IC26+8		524	0224
03615	0	62100	0	05035	STA	IC27+18		524	0225
03616	0	62100	0	05107	STA	IC28+19		524	0226
03617	0	62100	0	05122	STA	IC28+30		524	0227
03620	0	62100	0	05161	STA	IC29+19		524	0228
03621	0	62100	0	05177	STA	IC29+33		524	0229
03622	0	62100	0	05247	STA	IC30+27		524	0230
03623	0	62100	0	05251	STA	IC30+29		524	0231
03624	0	62100	0	06704	STA	SUBB+28		524	0232
03625	0	62100	0	05475	STA	I3+8		524	0233
03626	0	62100	0	05610	STA	I12+18		524	0234
03627	0	62100	0	05613	STA	I12+21		524	0235
03630	0	62100	0	05634	STA	I13		524	0236
03631	0	62100	0	05637	STA	I13+3		524	0237
03632	0	62100	0	05660	STA	I13+20		524	0238
03633	0	62100	0	05735	STA	I14+23		524	0239

03634	0	62100	0	05742	STA	I14+28		524	0240
03635	0	62100	0	05744	STA	I14+30		524	0241
03636	0	62100	0	05761	STA	I15+4		524	0242
03637	0	62100	0	05764	STA	I15+7		524	0243
03640	0	62100	0	06004	STA	I15+23		524	0244
03641	0	62100	0	06144	STA	I22+14		524	0245
03642	0	40000	0	07604	ADD	C17	32768-I-4J-5IJ	524	0246
03643	0	62100	0	05667	STA	I13+27		524	0247
03644	0	62100	0	05673	STA	I13+31		524	0248
03645	0	62100	0	05676	STA	I13+34		524	0249
03646	0	62100	0	05700	STA	I13+36		524	0250
03647	0	40200	0	07604	SUB	C17	32767-I-4J-6IJ	524	0251
03650	0	40200	0	07535	SUB	P2		524	0252
03651	0	62100	0	05277	STA	IQ32		524	0253
03652	0	62100	0	05310	STA	IQ32+9		524	0254
03653	0	62100	0	05317	STA	IQ33+4		524	0255
03654	0	62100	0	05324	STA	IQ34+3		524	0256
03655	0	62100	0	05350	STA	IC38		524	0257
03656	0	62100	0	06344	STA	I27+17		524	0258
03657	0	62100	0	06365	STA	I28+6		524	0259
03660	0	62100	0	06404	STA	I29+6		524	0260
03661	0	62100	0	06042	STA	I19+14		524	0261
03662	0	62100	0	06100	STA	I21+18		524	0262
03663	0	62100	0	06103	STA	I21+21		524	0263
03664	0	62100	0	06130	STA	I22+2		524	0264
03665	0	62100	0	06132	STA	I22+4		524	0265
03666	0	40000	0	00144	ADD	100	32767-4J-6IJ	524	0266
03667	0	62100	0	06660	STA	SUBB+8		524	0267
03670	0	62100	0	07555	STA	T14		524	0268
03671	0	40200	0	07604	SUB	C17	32766-4J-6IJ	524	0269
03672	0	73400	4	00000	PAX	0,4		524	0270
03673	-0	63400	4	05350	SXD	IC38,4		524	0271
03674	-0	63400	4	06344	SXD	I27+17,4		524	0272
03675	-0	63400	4	06365	SXD	I28+6,4		524	0273
03676	-0	63400	4	06404	SXD	I29+6,4		524	0274
03677	0	40000	0	00144	ADD	100	32766+I-4J-6IJ	524	0275
03700	0	73400	4	00000	PAX	0,4		524	0276
03701	-0	63400	4	06660	SXD	SUBB+8,4		524	0277
03702	-0	63400	4	07555	SXD	T14,4		524	0278
03703	0	40200	0	00144	SUB	100	32766-I-4J-6IJ	524	0279

03704	0	40200	0	00144	SUB 100		524	0280
03705	0	73400	4	00000	PAX 0,4		524	0281
03706	-0	63400	4	06760	SXD SUBB+72,4		524	0282
03707	0	40200	0	00145	SUB 101	32766-I-5J-6IJ	524	0283
03710	0	73400	4	00000	PAX 0,4		524	0284
03711	-0	63400	4	06766	SXD SUBB+78,4		524	0285
03712	0	40000	0	07604	ADD C17	32767-I-5J-6IJ	524	0286
03713	0	62100	0	05325	STA IQ34+4		524	0287
03714	0	62100	0	05335	STA IC35+6		524	0288
03715	0	62100	0	06760	STA SUBB+72		524	0289
03716	0	62100	0	06036	STA I19+10		524	0290
03717	0	62100	0	06104	STA I21+22		524	0291
03720	0	62100	0	06134	STA I22+6		524	0292
03721	0	62100	0	06166	STA I23+13		524	0293
03722	0	40200	0	00145	SUB 101	32767-I-6J-6IJ	524	0294
03723	0	62100	0	04560	STA IC0+1		524	0295
03724	0	62100	0	04621	STA IC7		524	0296
03725	0	62100	0	04654	STA IC16		524	0297
03726	0	62100	0	04770	STA IC26+6		524	0298
03727	0	62100	0	05017	STA IC27+4		524	0299
03730	0	62100	0	05066	STA IC28+2		524	0300
03731	0	62100	0	05140	STA IC29+2		524	0301
03732	0	62100	0	05150	STA IC29+10		524	0302
03733	0	62100	0	05215	STA IC30+1		524	0303
03734	0	62100	0	06766	STA SUBB+78		524	0304
03735	0	62100	0	05511	STA I3+20		524	0305
03736	0	62100	0	05572	STA I12+4		524	0306
03737	0	62100	0	05574	STA I12+6		524	0307
03740	0	62100	0	06216	STA I24+3		524	0308
03741	0	40000	0	07604	ADD C17	32768-I-6J-6IJ	524	0309
03742	0	62100	0	05075	STA IC28+9		524	0310
03743	0	62100	0	05647	STA I13+11		524	0311
03744	0	40200	0	07606	SUB C19	32766-I-6J-6IJ	524	0312
03745	0	62100	0	05142	STA IC29+4		524	0313
03746	0	62100	0	05717	STA I14+9		524	0314
03747	0	62100	0	06105	STA I21+23		524	0315
03750	0	40000	0	07604	ADD C17	32767-I-6J-7IJ	524	0316
03751	0	40200	0	07535	SUB P2		524	0317
03752	0	62100	0	05540	STA I6		524	0318
03753	0	62100	0	05545	STA I6+5		524	0319

03754	0	62100	0	05551	STA I7		524	0320
03755	0	62100	0	05556	STA I7+5		524	0321
03756	0	02000	0	10014	TRA GOOF		524	0322
03757	0	40200	0	07535	SUB P2	32767-I-6J-8IJ	524	0323
03760	0	62100	0	04563	STA IC0+4		524	0324
03761	0	62100	0	04710	STA IC24		524	0325
03762	0	62100	0	05226	STA IC30+10		524	0326
03763	0	62100	0	05304	STA IQ32+5		524	0327
03764	0	62100	0	05313	STA IQ33		524	0328
03765	0	62100	0	05775	STA I15+16		524	0329
03766	0	62100	0	06057	STA I21+1		524	0330
03767	0	62100	0	06073	STA I21+13		524	0331
03770	0	40200	0	07604	SUB C17	32766-I-7J-8-IJ	524	0332
03771	0	40200	0	00145	SUB I01		524	0333
03772	0	62100	0	06500	STA SUB+6		524	0334
03773	0	62100	0	06505	STA SUB+11		524	0335
03774	0	73400	4	00000	PAX 0,4		524	0336
03775	-0	63400	4	06507	SXD SUB+13,4		524	0337
03776	0	40200	0	00144	SUB I00	32766-2I-7J-8IJ	524	0338
03777	0	62100	0	06507	STA SUB+13		524	0339
04000	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	0340
04001	0	07557	0	07556	PROB,0,PAGE		524	0341
04002	0	07400	4	07046	TSX F1,4	PRINT I TO W	524	0342
04003	0	00163	0	00144	100,0,115		524	0343
04004	0	53400	2	07617	LXA C28,2		524	0344
04005	0	53400	4	07600	LXA C13,4		524	0345
04006	0	50000	4	00170	CLA 120,4	MOVE K, RHO AND H TO	524	0346
04007	0	60100	2	07672	STO COMMON+28,2	PRINT TEMPORARIES	524	0347
04010	0	50000	4	00174	CLA 124,4		524	0348
04011	0	60100	2	07673	STO COMMON+29,2		524	0349
04012	0	50000	4	00200	CLA 128,4		524	0350
04013	0	60100	2	07674	STO COMMON+30,2		524	0351
04014	0	50000	4	00204	CLA 132,4		524	0352
04015	0	60100	2	07675	STO COMMON+31,2		524	0353
04016	0	50000	4	00210	CLA 136,4		524	0354
04017	0	60100	2	07676	STO COMMON+32,2		524	0355
04020	0	50000	4	00214	CLA 140,4		524	0356
04021	0	60100	2	07677	STO COMMON+33,2		524	0357
04022	0	50000	4	00220	CLA 144,4		524	0358
04023	0	60100	2	07700	STO COMMON+34,2		524	0359

S1

04024	2	00007	2	04025		TIX S2,2,7		524	0360
04025	2	00001	4	04006	S2	TIX S1,4,1		524	0361
04026	0	07400	4	07142		TSX F2,4	PRINT K(F) TO H	524	0362
04027	0	07671	0	07636		COMMON,0,COMMON+27		524	0363
04030	0	53400	2	07620		LXA C29,2		524	0364
04031	0	53400	4	07605		LXA C18,4		524	0365
04032	0	50000	4	00223		CLA 147,4	MOVE TT AND DELTA TT	524	0366
04033	0	60100	2	07655		STO COMMON+15,2	TO PRINT TEMPORARIES	524	0367
04034	0	50000	4	00226		CLA 150,4		524	0368
04035	0	60100	2	07656		STO COMMON+16,2		524	0369
04036	0	50000	4	00231		CLA 153,4		524	0370
04037	0	60100	2	07657		STO COMMON+17,2		524	0371
04040	0	50000	4	00234		CLA 156,4		524	0372
04041	0	60100	2	07660		STO COMMON+18,2		524	0373
04042	0	50000	4	00237		CLA 159,4		524	0374
04043	0	60100	2	07661		STO COMMON+19,2		524	0375
04044	2	00005	2	04045		TIX S3,2,5		524	0376
04045	2	00001	4	04032	S3	TIX S2+5,4,1		524	0377
04046	0	07400	4	07171		TSX F3,4	PRINT TT(F) TO DELTA TT(B)	524	0378
04047	0	07654	0	07636		COMMON,0,COMMON+14		524	0379
04050	0	50000	0	00162		CLA 114	IS THIS EXP VERSION	524	0380
04051	0	10000	0	04054		TZE S4+2	YES--GO TO S4+2	524	0381
04052	0	07400	4	07210	S4	TSX F4,4	NO--PRINT N(TAU)	524	0382
04053	0	00000	0	00237		159,0,0		524	0383
04054	0	07400	4	07220		TSX F5,4	PRINT Q(0)	524	0384
04055	0	77777	0	77777		32767,0,32767		524	0385
04056	0	50000	0	07614		CLA C25	T1=ROW+T2+27	524	0386
04057	0	40000	0	07562		ADD ROW		524	0387
04060	0	40000	0	07541		ADD T2		524	0388
04061	0	60100	0	07540		STO T1		524	0389
04062	0	40200	0	07615		SUB C26	IS THERE ROOM TO PRINT MU	524	0390
04063	-0	12000	0	04107		TMI S7	YES	524	0391
04064	0	10000	0	04107		TZE S7	YES	524	0392
04065	0	76000	0	00165		SWT 5	NO--IS OUTPUT ON TAPE	524	0393
04066	0	02000	0	04071		TRA S4+15		524	0394
04067	0	76600	0	00361		WPR	NO--RESTORE PRINTER	524	0395
04070	0	76000	0	00361		SPR 1		524	0396
04071	0	50000	0	07557		CLA PAGE	PAGE=PAGE+1	524	0397
04072	0	40000	0	07604		ADD C17		524	0398
04073	0	60100	0	07557		STO PAGE		524	0399

04074	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	0400
04075	0	07557	0	07556	PROB,0,PAGE		524	0401
04076	0	07400	4	07224	TSX F6,4	PRINT MU	524	0402
04077	0	77776	0	00000	S6 0,0,32766	PRINT ZETA	524	0403
04100	0	07400	4	07234	TSX F7,4		524	0404
04101	0	00000	0	00000	0,0,0		524	0405
04102	0	76000	0	00140	CLEAR SLF		524	0406
04103	0	53400	4	07626	LXA C35,4		524	0407
04104	0	60000	4	03263	STZ 1715,4		524	0408
04105	2	00001	4	04104	TIX CLEAR+2,4,1		524	0409
04106	0	02000	0	10017	TRA GOOF+3		524	0410
04107	0	07400	4	07224	S7 TSX F6,4	PRINT MU	524	0411
04110	0	77776	0	00000	0,0,32766		524	0412
04111	0	50000	0	07540	CLA T1		524	0413
04112	0	40000	0	07563	ADD ROWP		524	0414
04113	0	40000	0	07606	ADD C19		524	0415
04114	0	40200	0	07615	SUB C26	IS THERE ROOM TO PRINT ZETA	524	0416
04115	-0	12000	0	04100	TMI S6+1	YES	524	0417
04116	0	10000	0	04100	TZE S6+1	YES	524	0418
04117	0	76000	0	00165	SWT 5	NO--IS OUTPUT ON TAPE	524	0419
04120	0	02000	0	04123	TRA S7+12	YES	524	0420
04121	0	76600	0	00361	WPR	NO--RESTORE PRINTER	524	0421
04122	0	76000	0	00361	SPR 1		524	0422
04123	0	50000	0	07557	CLA PAGE	PAGE=PAGE+1	524	0423
04124	0	40000	0	07604	ADD C17		524	0424
04125	0	60100	0	07557	STO PAGE		524	0425
04126	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	0426
04127	0	07557	0	07556	PROB,0,PAGE		524	0427
04130	0	02000	0	04100	TRA S6+1		524	0428
						COMPUTE INTERMEDIARY QUANTITIES	524	0429
04131	0	50000	0	00144	IQ CLA 100	FLOAT I	524	0430
04132	-0	50100	0	07565	ORA C0		524	0431
04133	0	30000	0	07565	FAD C0		524	0432
04134	0	60100	0	07534	STO P1		524	0433
04135	0	30200	0	07574	FSB C9	DELTA R(F)	524	0434
04136	0	60100	0	07540	STO T1		524	0435
04137	0	50000	0	00146	CLA 102		524	0436
04140	0	24000	0	07540	FDH T1		524	0437
04141	-0	60000	0	03150	STQ 1640		524	0438
04142	0	26000	0	03150	FMP 1640	(DELTA R(F))(DELTA R(F))/(DELTA TAU)	524	0439

04143	0	24000	0	00151	FDH 105		524	0440
04144	-0	60000	0	03153	STQ 1643		524	0441
04145	0	50000	0	00147	CLA 103	DELTA R(B)	524	0442
04146	0	30200	0	00146	FSB 102		524	0443
04147	0	24000	0	07573	FDH C8		524	0444
04150	-0	60000	0	03151	STQ 1641		524	0445
04151	0	26000	0	03151	FMP 1641	(DELTA R(B))(DELTA R(B))/(DELTA TAU)	524	0446
04152	0	24000	0	00151	FDH 105		524	0447
04153	-0	60000	0	03154	STQ 1644		524	0448
04154	0	50000	0	00150	CLA 104	DELTA R(S)	524	0449
04155	0	30200	0	00147	FSB 103		524	0450
04156	0	24000	0	07576	FDH C11		524	0451
04157	-0	60000	0	03152	STQ 1642		524	0452
04160	0	26000	0	03152	FMP 1642	(DELTA R(S))(DELTA R(S))/(DELTA TAU)	524	0453
04161	0	24000	0	00151	FDH 105		524	0454
04162	-0	60000	0	03155	STQ 1645		524	0455
04163	0	50000	0	03151	CLA 1641	(DELTA R(B))/(DELTA R(F))	524	0456
04164	0	24000	0	03150	FDH 1640		524	0457
04165	-0	60000	0	03156	STQ 1646		524	0458
04166	0	50000	0	00147	CLA 103	(DELTA R(B))/(R(0)-DELTA R(B))	524	0459
04167	0	30200	0	03151	FSB 1641		524	0460
04170	0	60100	0	07540	STO T1		524	0461
04171	0	50000	0	03151	CLA 1641		524	0462
04172	0	24000	0	07540	FDH T1		524	0463
04173	-0	60000	0	03157	STQ 1647		524	0464
04174	0	50000	0	00163	CLA 115	IS COOLANT STAGNANT	524	0465
04175	0	10000	0	04215	TZE IQA	YES--GO TO IQA	524	0466
04176	0	56000	0	07571	LDQ C4	NO--8R(0)(DELTA R(B))/(4R(0)-DELTA R(B))	524	0467
04177	0	26000	0	00147	FMP 103		524	0468
04200	0	30200	0	03151	FSB 1641		524	0469
04201	0	60100	0	07540	STO T1		524	0470
04202	0	56000	0	00147	LDQ 103		524	0471
04203	0	26000	0	03151	FMP 1641		524	0472
04204	0	76500	0	00043	LRS 35		524	0473
04205	0	26000	0	07603	FMP C16		524	0474
04206	0	24000	0	07540	FDH T1		524	0475
04207	-0	60000	0	03160	STQ 1648		524	0476
04210	0	56000	0	00147	LDQ 103	R(0)(DELTA R(S))/R(S)	524	0477
04211	0	26000	0	03152	FMP 1642		524	0478
04212	0	24000	0	00150	FDH 104		524	0479

04213	-0	60000	0	03161	STQ 1649		524	0480
04214	0	02000	0	04264	TRA IQB		524	0481
04215	0	50000	0	00150	CLA 104	A(IS)	524	0482
04216	0	24000	0	00147	FDH 103		524	0483
04217	-0	75400	0	00000	PXD 0,0		524	0484
04220	0	76300	0	00043	LLS 35		524	0485
04221	0	07400	4	03062	TSX LN,4		524	0486
04222	0	02000	0	03140	TRA LNE		524	0487
04223	0	60100	0	07540	STO T1		524	0488
04224	0	50000	0	00150	CLA 104		524	0489
04225	0	30200	0	00147	FSB 103		524	0490
04226	0	76500	0	00043	LRS 35		524	0491
04227	0	26000	0	00152	FMP 106		524	0492
04230	0	24000	0	07540	FDH T1		524	0493
04231	-0	60000	0	03161	STQ 1649		524	0494
04232	0	56000	0	07571	LDQ C4	16A(IS)(DELTA R(B))/	524	0495
04233	0	26000	0	00147	FMP 103	(DELTA Z)(DELTA R(S))(4R(0)-DELTA R(B))	524	0496
04234	0	30200	0	03151	FSB 1641		524	0497
04235	0	76500	0	00043	LRS 35		524	0498
04236	0	26000	0	03152	FMP 1642		524	0499
04237	0	76500	0	00043	LRS 35		524	0500
04240	0	26000	0	00152	FMP 106		524	0501
04241	0	60100	0	07540	STO T1		524	0502
04242	0	56000	0	03161	LDQ 1649		524	0503
04243	0	26000	0	03151	FMP 1641		524	0504
04244	0	76500	0	00043	LRS 35		524	0505
04245	0	26000	0	07602	FMP C15		524	0506
04246	0	24000	0	07540	FDH T1		524	0507
04247	-0	60000	0	03160	STQ 1648		524	0508
04250	0	50000	0	00210	CLA 136	DO WE WANT CONSTANT	524	0509
04251	0	40200	0	07616	SUB C27	COOLANT TEMPERATURE	524	0510
04252	0	10000	0	04263	TZE IQB-1	NO--COMPUTE NS(STAGNANT)	524	0511
04253	0	56000	0	00152	LDQ 106		524	0512
04254	0	26000	0	00150	FMP 104		524	0513
04255	0	60100	0	07540	STO T1		524	0514
04256	0	56000	0	03161	LDQ 1649		524	0515
04257	0	26000	0	07567	FMP C2		524	0516
04260	0	24000	0	07540	FDH T1		524	0517
04261	-0	60000	0	03256	STQ 1710		524	0518
04262	0	02000	0	04264	TRA IQB		524	0519

04263	0	60000	0	03256	STZ 1710		524	0520
04264	0	53400	4	07600	IQB LXA C13,4	REG.C=4	524	0521
04265	0	53400	1	07601	LXA C14,1	REG.A=16	524	0522
04266	0	50000	4	00204	CLA 132,4	COMPUTE MF	524	0523
04267	0	24000	4	00170	FDH 120,4		524	0524
04270	0	26000	0	03153	FMP 1643		524	0525
04271	0	60100	4	03166	STO 1654,4		524	0526
04272	0	50000	4	00210	CLA 136,4	COMPUTE MB	524	0527
04273	0	24000	4	00174	FDH 124,4		524	0528
04274	0	26000	0	03154	FMP 1644		524	0529
04275	0	60100	4	03172	STO 1658,4		524	0530
04276	0	50000	4	00214	CLA 140,4	DO WE WANT CONSTANT	524	0531
04277	0	40200	0	07616	SUB C27	COOLANT TEMPERATURE	524	0532
04300	0	10000	0	04305	TZE IQG-1	YES--GO TO IQG-1	524	0533
04301	0	50000	4	00214	CLA 140,4	NO--COMPUTE MS	524	0534
04302	0	24000	4	00200	FDH 128,4		524	0535
04303	0	26000	0	03155	FMP 1645		524	0536
04304	0	60100	4	03176	STO 1662,4		524	0537
04305	0	53400	2	07600	LXA C13,2	REG.B=4	524	0538
04306	0	50000	0	00163	IQG CLA 115	IS COOLANT STAGNANT	524	0539
04307	0	10000	0	04315	TZE IQD	YES--GO TO IQD	524	0540
04310	0	50000	2	00220	CLA 144,2	NO--COMPUTE NB(FLOWING)	524	0541
04311	0	24000	4	00174	FDH 124,4		524	0542
04312	0	26000	0	03160	FMP 1648		524	0543
04313	0	60100	1	03216	STO 1678,1		524	0544
04314	0	02000	0	04321	TRA IQE		524	0545
04315	0	50000	2	00200	IQD CLA 128,2	COMPUTE NB(STAGNANT)	524	0546
04316	0	24000	4	00174	FDH 124,4		524	0547
04317	0	26000	0	03160	FMP 1648		524	0548
04320	0	60100	1	03216	STO 1678,1		524	0549
04321	0	50000	4	00170	IQE CLA 120,4	COMPUTE KF	524	0550
04322	0	24000	2	00174	FDH 124,2		524	0551
04323	-0	60000	0	07540	STQ T1		524	0552
04324	0	26000	0	03156	FMP 1646		524	0553
04325	0	30000	0	07566	FAD C1		524	0554
04326	0	60100	0	07541	STO T2		524	0555
04327	0	50000	0	07566	CLA C1		524	0556
04330	0	24000	0	07541	FDH T2		524	0557
04331	-0	60000	1	03236	STQ 1694,1		524	0558
04332	0	56000	0	07540	LDQ T1	COMPUTE LF	524	0559

04333	0	26000	0	03157	FMP 1647		524	0560
04334	0	76500	0	00043	LRS 35		524	0561
04335	0	26000	1	03236	FMP 1694,1		524	0562
04336	0	60100	1	03256	STO 1710,1		524	0563
04337	2	00001	1	04340	TIX IQF,1,1	REG.A=REG.A-1	524	0564
04340	2	00001	2	04306	TIX IQG,2,1	REG.B=REG.B-1	524	0565
04341	0	50000	0	00163	CLA 115	IS COOLANT STAGNANT	524	0566
04342	0	10000	0	04354	TZE IQH	YES--GO TO IQH	524	0567
04343	0	50000	4	00214	CLA 140,4	NO--DO WE WANT CONSTANT	524	0568
04344	0	40200	0	07616	SUB C27	COOLANT TEMPERATURE	524	0569
04345	0	10000	0	04353	TZE IQH-1	YES--GO TO IQH-1	524	0570
04346	0	50000	4	00220	CLA 144,4	NO--COMPUTE NS(FLOWING)	524	0571
04347	0	24000	4	00200	FDH 128,4		524	0572
04350	0	26000	0	03161	FMP 1649		524	0573
04351	0	60100	4	03262	STO 1714,4		524	0574
04352	0	02000	0	04354	TRA IQH		524	0575
04353	0	60000	4	03262	STZ 1714,4		524	0576
04354	2	00001	4	04266	TIX IQB+2,4,1	REG.C=REG.C-1	524	0577
						COMPUTE AND PRINT INITIAL TEMPERATURES	524	0578
04355	0	50000	0	00160	IT CLA 112	IS PSI(J,0) CONSTANT	524	0579
04356	-0	10000	0	04366	TNZ IT1	NO--GO TO IT1	524	0580
04357	0	50000	0	00145	CLA 101	YES--SET PSI(J,0)=PSI(1,0)	524	0581
04360	0	40200	0	07604	SUB C17		524	0582
04361	0	10000	0	04366	TZE IT1		524	0583
04362	0	73400	4	00000	PAX 0,4		524	0584
04363	0	50000	0	00000	CLA 0		524	0585
04364	0	60100	4	00000	STO 0,4		524	0586
04365	2	00001	4	04364	TIX IT+7,4,1		524	0587
04366	0	50000	0	00161	IT1 CLA 113	MUST T(I,J,0) BE COMPUTED	524	0588
04367	0	10000	0	04373	TZE IT1+5	YES--GO TO IT1+5	524	0589
04370	0	40200	0	07606	SUB C19	NO--IS IT ALL INPUT	524	0590
04371	0	10000	0	04537	TZE IT7	YES--GO TO IT7	524	0591
04372	0	02000	0	04531	TRA IT6+2	NO--GO TO IT6+2	524	0592
04373	0	56000	0	00170	LDQ 120	YES--T2=Q(0)R(B)R(B)/2K(B)	524	0593
04374	0	26000	0	07567	FMP C2		524	0594
04375	0	60100	0	07540	STO T1		524	0595
04376	0	56000	0	00146	LDQ 102		524	0596
04377	0	26000	0	00146	FMP 102		524	0597
04400	0	24000	0	07540	FDH T1		524	0598
04401	0	26000	0	77777	FMP 32767		524	0599

04402	0	60100	0	07541	STO T2		524	0600
04403	0	56000	0	00147	LDQ 103	$T1=K(B)/HR(O)+K(B)/2K(F)+LN(R(O)/R(B))$	524	0601
04404	0	26000	0	00214	FMP 140		524	0602
04405	0	60100	0	07540	STO T1		524	0603
04406	0	50000	0	00170	CLA 120		524	0604
04407	0	24000	0	07540	FDH T1		524	0605
04410	-0	60000	0	07540	STQ T1		524	0606
04411	0	56000	0	00164	LDQ 116		524	0607
04412	0	26000	0	07567	FMP C2		524	0608
04413	0	60100	0	07542	STO T3		524	0609
04414	0	50000	0	00170	CLA 120		524	0610
04415	0	24000	0	07542	FDH T3		524	0611
04416	-0	75400	0	00000	PXD 0,0		524	0612
04417	0	76300	0	00043	LLS 35		524	0613
04420	0	30000	0	07540	FAD T1		524	0614
04421	0	60100	0	07540	STO T1		524	0615
04422	0	50000	0	00147	CLA 103		524	0616
04423	0	24000	0	00146	FDH 102		524	0617
04424	-0	75400	0	00000	PXD 0,0		524	0618
04425	0	76300	0	00043	LLS 35		524	0619
04426	0	07400	4	03062	TSX LN,4		524	0620
04427	0	02000	0	03140	TRA LNE		524	0621
04430	0	30000	0	07540	FAD T1		524	0622
04431	0	60100	0	07540	STO T1	$T3=K(B)/2K(F)R(B)R(B)$	524	0623
04432	0	56000	0	00164	LDQ 116		524	0624
04433	0	26000	0	07567	FMP C2		524	0625
04434	0	76500	0	00043	LRS 35		524	0626
04435	0	26000	0	00146	FMP 102		524	0627
04436	0	76500	0	00043	LRS 35		524	0628
04437	0	26000	0	00146	FMP 102		524	0629
04440	0	60100	0	07542	STO T3		524	0630
04441	0	50000	0	00170	CLA 120		524	0631
04442	0	24000	0	07542	FDH T3		524	0632
04443	-0	60000	0	07542	STQ T3	$T5=K(B)/HR(O)$	524	0633
04444	0	56000	0	00147	LDQ 103		524	0634
04445	0	26000	0	00214	FMP 140		524	0635
04446	0	60100	0	07544	STO T5		524	0636
04447	0	50000	0	00170	CLA 120		524	0637
04450	0	24000	0	07544	FDH T5		524	0638
04451	-0	60000	0	07544	STQ T5		524	0639

04452	0	53400	1	07535	LXA P2,1	REG.A=IJ	524	0640
04453	0	53400	2	00145	LXA 101,2	REG.B=J	524	0641
04454	0	50000	0	00144	IT2 CLA 100		524	0642
04455	0	40200	0	07606	SUB C19		524	0643
04456	0	73400	4	00000	PAX 0,4	REG.C=I-2	524	0644
04457	0	56000	2	00000	LDQ 0,2	T6=ZETA(J)T2	524	0645
04460	0	26000	0	07541	FMP T2		524	0646
04461	0	60100	0	07545	STO T6		524	0647
04462	0	60000	0	07543	STZ T4	T4=0	524	0648
04463	0	56000	0	07543	IT3 LDQ T4	COMPUTE T(I,J,0) FOR I LESS THAN I-1	524	0649
04464	0	26000	0	07543	FMP T4		524	0650
04465	0	76500	0	00043	LRS 35		524	0651
04466	0	26000	0	07542	FMP T3		524	0652
04467	0	76000	0	00002	CHS		524	0653
04470	0	30000	0	07540	FAD T1		524	0654
04471	0	76500	0	00043	LRS 35		524	0655
04472	0	26000	0	07545	FMP T6		524	0656
04473	0	30000	2	00000	FAD 0,2		524	0657
04474	0	60100	1	00000	STO 0,1		524	0658
04475	0	50000	0	07543	CLA T4	T4=T4 + DELTA R(F)	524	0659
04476	0	30000	0	03150	FAD 1640		524	0660
04477	0	60100	0	07543	STO T4		524	0661
04500	2	00001	1	04501	IT4 TIX IT4,1,1	REG.A=REG.A-1	524	0662
04501	2	00001	4	04463	TIX IT3,4,1	REG.C=REG.C-1	524	0663
04502	0	56000	0	03151	LDQ 1641	COMPUTE T(I,J,0) FOR I=I-1	524	0664
04503	0	26000	0	07576	FMP C11		524	0665
04504	0	30000	0	00146	FAD 102		524	0666
04505	0	60100	0	07543	STO T4		524	0667
04506	0	50000	0	00147	CLA 103		524	0668
04507	0	24000	0	07543	FDH T4		524	0669
04510	-0	75400	0	00000	PXD 0,0		524	0670
04511	0	76300	0	00043	LLS 35		524	0671
04512	0	07400	4	03062	TSX LN,4		524	0672
04513	0	02000	0	03140	TRA LNE		524	0673
04514	0	30000	0	07544	FAD T5		524	0674
04515	0	76500	0	00043	LRS 35		524	0675
04516	0	26000	0	07545	FMP T6		524	0676
04517	0	30000	2	00000	FAD 0,2		524	0677
04520	0	60100	1	00000	STO 0,1		524	0678
04521	2	00001	1	04522	IT5 TIX IT5,1,1	REG.A=REG.A-1	524	0679

04522	0	56000	0	07545	IT5	LDQ T6	COMPUTE T(I,J,0) FOR I=I	524	0680
04523	0	26000	0	07544		FMP T5		524	0681
04524	0	30000	2	00000		FAD 0,2		524	0682
04525	0	60100	1	00000		STO 0,1		524	0683
04526	2	00001	1	04527		TIX IT6,1,1	REG.A=REG.A-1	524	0684
04527	2	00001	2	04454	IT6	TIX IT2,2,1	REG.B=REG.B-1	524	0685
04530	0	02000	0	04537		TRA IT7	SET T(I,J,0)=T(1,1,0)	524	0686
04531	0	50000	0	07535		CLA P2		524	0687
04532	0	40200	0	07604		SUB C17		524	0688
04533	0	73400	4	00000		PAX 0,4		524	0689
04534	0	50000	0	00000		CLA 0		524	0690
04535	0	60100	4	00000		STO 0,4		524	0691
04536	2	00001	4	04535		TIX IT6+6,4,1		524	0692
04537	0	60000	0	07536	IT7	STZ P3	TAU=0	524	0693
04540	0	60000	0	07537		STZ P4	ITERATION NO.=0	524	0694
04541	0	50000	0	07557		CLA PAGE	PAGE=PAGE+1	524	0695
04542	0	40000	0	07604		ADD C17		524	0696
04543	0	60100	0	07557		STO PAGE		524	0697
04544	0	76000	0	00165		SWT 5	IS OUTPUT ON TAPE	524	0698
04545	0	02000	0	04550		TRA IT7+9	YES--GO TO IT7+9	524	0699
04546	0	76600	0	00361		WPR	NO--RESTORE PRINTER	524	0700
04547	0	76000	0	00361		SPR 1		524	0701
04550	0	07400	4	07020		TSX F0,4	PRINT TITLE	524	0702
04551	0	07557	0	07556		PROB,0,PAGE		524	0703
04552	0	50000	0	07631		CLA C39	LINE=6	524	0704
04553	0	60100	0	07561		STO LINE		524	0705
04554	0	07400	4	07247		TSX F9,4	PRINT INITIAL TEMPERATURE TITLE	524	0706
04555	0	07537	0	07536		P3,0,P4		524	0707
04556	0	07400	4	06472		TSX SUB,4	EXIT TO TEMPERATURE PRINT SUBROUTINE	524	0708
							COMPUTE INITIAL PHASES	524	0709
04557	0	53400	4	07535	IC0	LXA P2,4		524	0710
04560	0	60000	4	00000		STZ 0,4		524	0711
04561	2	00001	4	04560		TIX IC0+1,4,1		524	0712
04562	0	53400	4	00145		LXA 101,4		524	0713
04563	0	60000	4	00000		STZ 0,4		524	0714
04564	2	00001	4	04563		TIX IC0+4,4,1		524	0715
04565	0	53400	1	00145	IC	LXA 101,1	REG.A=J	524	0716
04566	0	53400	4	07535		LXA P2,4	REG.C=IJ	524	0717
04567	0	50000	0	00144	IC1	CLA 100		524	0718
04570	0	40200	0	07606		SUB C19		524	0719

04571	0	73400	2	00000		PAX 0,2					
04572	0	50000	4	00000	IC9	CLA 0,4		REG.B=I-2		524	0720
04573	0	30200	0	00220		FSB 144		COMPARE T(I,J) WITH TT(AB,F)		524	0721
04574	0	10000	0	04605		TZE IC3		=, GO TO IC3		524	0722
04575	0	12000	0	04601		TPL IC2		GREATER, GO TO IC2		524	0723
04576	0	50000	0	07600		CLA C13		LESS, DEC. OF ACC.=4, GO TO IC7		524	0724
04577	0	76700	0	00022		ALS 18				524	0725
04600	0	02000	0	04621		TRA IC7				524	0726
04601	0	30000	0	00220	IC2	FAD 144		COMPARE T(I,J) WITH TT(BC,F)		524	0727
04602	0	30200	0	00221		FSB 145		=, GO TO IC5		524	0728
04603	0	10000	0	04614		TZE IC5		GREATER, GO TO IC4		524	0729
04604	0	12000	0	04610		TPL IC4		LESS, DEC. OF ACC.=3, GO TO IC7		524	0730
04605	0	50000	0	07605	IC3	CLA C18				524	0731
04606	0	76700	0	00022		ALS 18		COMPARE T(I,J) WITH TT(CD,F)		524	0732
04607	0	02000	0	04621		TRA IC7		=, GO TO IC6		524	0733
04610	0	30000	0	00221	IC4	FAD 145		GREATER, GO TO IC6		524	0734
04611	0	30200	0	00222		FSB 146		LESS, DEC. OF ACC.=2, GO TO IC7		524	0735
04612	0	10000	0	04617		TZE IC6				524	0736
04613	0	12000	0	04617		TPL IC6		=, GO TO IC6		524	0737
04614	0	50000	0	07606	IC5	CLA C19		GREATER, GO TO IC6		524	0738
04615	0	76700	0	00022		ALS 18		LESS, DEC. OF ACC.=2, GO TO IC7		524	0739
04616	0	02000	0	04621		TRA IC7				524	0740
04617	0	50000	0	07604	IC6	CLA C17		DEC. OF ACC.=1		524	0741
04620	0	76700	0	00022		ALS 18				524	0742
04621	0	62200	4	00000	IC7	STD 0,4		DEC. OF PHASE CHANGE ARRAY=DEC. OF ACC.		524	0743
04622	2	00001	4	04623		TIX IC8,4,1		REG.C=REG.C-1		524	0744
04623	2	00001	2	04572	IC8	TIX IC9,2,1		REG.B=REG.B-1		524	0745
04624	0	53400	2	07606		LXA C19,2		REC.B=2		524	0746
04625	0	50000	4	00000	IC10	CLA 0,4		COMPARE T(I,J) WITH TT(AB,B)		524	0747
04626	0	30200	0	00223		FSB 147				524	0748
04627	0	10000	0	04640		TZE IC12		=, GO TO IC12		524	0749
04630	0	12000	0	04634		TPL IC11		GREATER, GO TO IC11		524	0750
04631	0	50000	0	07600		CLA C13		LESS, DEC. OF ACC.=4, GO TO IC16		524	0751
04632	0	76700	0	00022		ALS 18				524	0752
04633	0	02000	0	04654		TRA IC16				524	0753
04634	0	30000	0	00223	IC11	FAD 147		COMPARE T(I,J) WITH TT(BC,B)		524	0754
04635	0	30200	0	00224		FSB 148		=, GO TO IC14		524	0755
04636	0	10000	0	04647		TZE IC14		GREATER, GO TO IC13		524	0756
04637	0	12000	0	04643		TPL IC13		LESS, DEC. OF ACC.=3, GO TO IC16		524	0757
04640	0	50000	0	07605	IC12	CLA C18				524	0758
											524 0759

04641	0	76700	0	00022	ALS 18		524	0760
04642	0	02000	0	04654	TRA IC16		524	0761
04643	0	30000	0	00224	IC13 FAD 148	COMPARE T(I,J) WITH TT(CD,B)	524	0762
04644	0	30200	0	00225	FSB 149		524	0763
04645	0	10000	0	04652	TZE IC15	=, GO TO IC15	524	0764
04646	0	12000	0	04652	TPL IC15	GREATER, GO TO IC15	524	0765
04647	0	50000	0	07606	IC14 CLA C19	LESS, DEC. OF ACC.=2, GO TO IC16	524	0766
04650	0	76700	0	00022	ALS 18		524	0767
04651	0	02000	0	04654	TRA IC16		524	0768
04652	0	50000	0	07604	IC15 CLA C17	DEC. OF ACC.=1	524	0769
04653	0	76700	0	00022	ALS 18		524	0770
04654	0	62200	4	00000	IC16 STD 0,4	DEC. OF PHASE CHANGE ARRAY=DEC. OF ACC.	524	0771
04655	2	00001	4	04656	TIX IC17,4,1	REG.C=REG.C-1	524	0772
04656	2	00001	2	04625	IC17 TIX IC10,2,1	REG.B=REG.B-1	524	0773
04657	2	00001	1	04567	TIX IC1,1,1	REG.A=REG.A-1	524	0774
04660	0	53400	4	00145	LXA 101,4	REG.C=J	524	0775
04661	0	50000	4	00000	IC18 CLA 0,4	COMPARE PSI(J) WITH TT(AB,S)	524	0776
04662	0	30200	0	00226	FSB 150		524	0777
04663	0	10000	0	04674	TZE IC20	=, GO TO IC20	524	0778
04664	0	12000	0	04670	TPL IC19	GREATER, GO TO IC19	524	0779
04665	0	50000	0	07600	CLA C13	LESS, DEC. OF ACC.=4, GO TO IC24	524	0780
04666	0	76700	0	00022	ALS 18		524	0781
04667	0	02000	0	04710	TRA IC24		524	0782
04670	0	30000	0	00226	IC19 FAD 150	COMPARE PSI(J) WITH TT(BC,S)	524	0783
04671	0	30200	0	00227	FSB 151		524	0784
04672	0	10000	0	04703	TZE IC22	=, GO TO IC22	524	0785
04673	0	12000	0	04677	TPL IC21	GREATER, GO TO IC21	524	0786
04674	0	50000	0	07605	IC20 CLA C18	LESS, DEC. OF ACC.=3, GO TO IC24	524	0787
04675	0	76700	0	00022	ALS 18		524	0788
04676	0	02000	0	04710	TRA IC24		524	0789
04677	0	30000	0	00227	IC21 FAD 151	COMPARE PSI(J) WITH TT(CD,S)	524	0790
04700	0	30200	0	00230	FSB 152		524	0791
04701	0	10000	0	04706	TZE IC23	=, GO TO IC23	524	0792
04702	0	12000	0	04706	TPL IC23	GREATER, GO TO IC23	524	0793
04703	0	50000	0	07606	IC22 CLA C19	LESS, DEC. OF ACC.=2, GO TO IC24	524	0794
04704	0	76700	0	00022	ALS 18		524	0795
04705	0	02000	0	04710	TRA IC24		524	0796
04706	0	50000	0	07604	IC23 CLA C17	DEC. OF ACC.=1	524	0797
04707	0	76700	0	00022	ALS 18		524	0798
04710	0	62200	4	00000	IC24 STD 0,4	DEC. OF PHASE CHANGE ARRAY=DEC. OF ACC.	524	0799

04711	2	00001	4	04661	TIX IC18,4,1	REG.C=REG.C-1	524	0800
04712	0	50000	0	07634	CLA C42		524	0801
04713	0	62100	0	05342	STA IC36		524	0802
04714	0	50000	0	00151	CLA 105		524	0803
04715	0	60100	0	07647	STO COMMON+9		524	0804
04716	0	50000	0	00155	CLA 109		524	0805
04717	0	60100	0	07651	STO COMMON+11		524	0806
04720	0	50000	0	00156	CLA 110		524	0807
04721	0	60100	0	07650	STO COMMON+10		524	0808
04722	-0	63400	4	07636	SXD COMMON,4		524	0809
04723	0	02000	0	04754	TRA ADJ1+24		524	0810
04724	0	50000	0	00151	ADJ1 CLA 105		524	0811
04725	0	24000	0	07567	FDH C2		524	0812
04726	-0	60000	0	00151	STQ 105		524	0813
04727	-0	60000	0	07647	STQ COMMON+9		524	0814
04730	0	56000	0	00155	LDQ 109		524	0815
04731	0	20000	0	07606	MPY C19		524	0816
04732	-0	60000	0	00155	STQ 109		524	0817
04733	-0	60000	0	07651	STQ COMMON+11		524	0818
04734	0	53400	1	07605	LXA C18,1		524	0819
04735	0	56000	1	03156	LDQ 1646,1		524	0820
04736	0	26000	0	07567	FMP C2		524	0821
04737	0	60100	1	03156	STO 1646,1		524	0822
04740	2	00001	1	04735	TIX *-3,1,1		524	0823
04741	0	53400	1	07623	LXA C32,1		524	0824
04742	0	56000	1	03176	LDQ 1662,1		524	0825
04743	0	26000	0	07567	FMP C2		524	0826
04744	0	60100	1	03176	STO 1662,1		524	0827
04745	2	00001	1	04742	TIX *-3,1,1		524	0828
04746	0	50000	0	00162	CLA 114		524	0829
04747	0	10000	0	04753	TZE *+4		524	0830
04750	0	56000	0	00156	LDQ 110		524	0831
04751	0	26000	0	07567	FMP C2		524	0832
04752	0	60100	0	00156	STO 110		524	0833
04753	0	60100	0	07650	STO COMMON+10		524	0834
04754	0	07400	4	04757	TSX IC25,4		524	0835
04755	-0	53400	4	07636	LXD COMMON,4		524	0836
04756	0	02000	0	05343	TRA IC37		524	0837
04757	-0	63400	1	07637	IC25 SXD COMMON+1,1		524	0838
04760	-0	63400	2	07640	SXD COMMON+2,2		524	0839

04761	-0	63400	4	07641	SXD COMMON+3,4			524	0840
04762	0	53400	4	07535	IC26 LXA P2,4	COMPUTE, TEST AND PRINT INITIAL COEFFICIENTS		524	0841
04763	0	53400	2	00145	LXA 101,2	REG.C=IJ		524	0842
04764	0	53400	1	07604	LXA C17,1	REG.B=J		524	0843
04765	-0	63400	1	07642	SXD COMMON+4,1			524	0844
04766	0	53400	1	00144	LXA 100,1	REG.A=I		524	0845
04767	-0	63400	2	07643	SXD COMMON+5,2			524	0846
04770	0	50000	4	00000	CLA 0,4			524	0847
04771	-0	73400	2	00000	PDX 0,2			524	0848
04772	0	60000	4	00000	STZ 0,4	COMPUTE B(1,J)		524	0849
04773	0	50000	0	07571	CLA C4	COMPUTE D(1,J)		524	0850
04774	0	24000	2	03166	FDH 1654,2			524	0851
04775	-0	60000	4	00000	STQ 0,4			524	0852
04776	-0	60000	0	07644	STQ COMMON+6	COMPUTE C(1,J)		524	0853
04777	0	50200	0	07644	CLS COMMON+6			524	0854
05000	0	30000	0	07566	FAD C1			524	0855
05001	0	60100	4	00000	STO 0,4			524	0856
05002	0	56000	0	77777	LDQ 32767	COMPUTE F(1,J)		524	0857
05003	0	26000	0	00151	FMP 105			524	0858
05004	0	24000	2	00204	FDH 132,2			524	0859
05005	-0	53400	2	07643	LXD COMMON+5,2			524	0860
05006	0	26000	1	77777	FMP 32767,1			524	0861
05007	0	76500	0	00043	LRS 35			524	0862
05010	0	26000	2	00000	FMP 0,2			524	0863
05011	0	60100	4	00000	STO 0,4			524	0864
05012	2	00001	1	05013	TIX IC27,1,1	REG.A=REG.A-1		524	0865
05013	2	00001	4	05014	IC27 TIX IC27+1,4,1	REG.C=REG.C-1		524	0866
05014	-0	63400	1	07644	SXD COMMON+6,1			524	0867
05015	-0	53400	1	07642	LXD COMMON+4,1			524	0868
05016	1	00001	1	05017	TXI IC27+4,1,1			524	0869
05017	0	50000	4	00000	CLA 0,4			524	0870
05020	-0	73400	2	00000	PDX 0,2			524	0871
05021	-0	75400	1	00000	PXD 0,1	FLOAT INCREASING I		524	0872
05022	0	77100	0	00022	ARS 18			524	0873
05023	-0	50100	0	07565	ORA C0			524	0874
05024	0	30000	0	07565	FAD C0			524	0875
05025	0	30200	0	07566	FSB C1			524	0876
05026	0	60100	0	07646	STO COMMON+8	COMPUTE B(I,J), I=2, I-3		524	0877
05027	0	56000	0	07646	LDQ COMMON+8			524	0878
								524	0879

05030	0	26000	2	03166	FMP 1654,2		524	0880
05031	0	60100	0	07645	STO COMMON+7		524	0881
05032	0	50000	0	07646	CLA COMMON+8		524	0882
05033	0	30200	0	07576	FSB C11		524	0883
05034	0	24000	0	07645	FDH COMMON+7		524	0884
05035	-0	60000	4	00000	STQ 0,4		524	0885
05036	0	50000	0	07646	CLA COMMON+8	COMPUTE D(I,J),I=2, I-3	524	0886
05037	0	30000	0	07576	FAD C11		524	0887
05040	0	24000	0	07645	FDH COMMON+7		524	0888
05041	-0	60000	4	00000	STQ 0,4		524	0889
05042	0	50000	0	07567	CLA C2	COMPUTE C(I,J),I=2,....I-3	524	0890
05043	0	24000	2	03166	FDH 1654,2		524	0891
05044	-0	60000	0	07646	STQ COMMON+8		524	0892
05045	0	50000	0	07566	CLA C1		524	0893
05046	0	30200	0	07646	FSB COMMON+8		524	0894
05047	0	60100	4	00000	STO 0,4		524	0895
05050	0	56000	0	77777	LDQ 32767	COMPUTE F(I,J),I=2,....I-3	524	0896
05051	0	26000	0	00151	FMP 105		524	0897
05052	0	24000	2	00204	FDH 132,2		524	0898
05053	-0	53400	2	07643	LXD COMMON+5,2		524	0899
05054	-0	63400	1	07642	SXD COMMON+4,1		524	0900
05055	-0	53400	1	07644	LXD COMMON+6,1		524	0901
05056	0	26000	1	77777	FMP 32767,1		524	0902
05057	0	76500	0	00043	LRS 35		524	0903
05060	0	26000	2	00000	FMP 0,2		524	0904
05061	0	60100	4	00000	STO 0,4		524	0905
05062	3	00004	1	05012	TXH IC27-1,1,4	IS I GREATER THAN I-3--NO, GO TO IC27-1	524	0906
05063	2	00001	1	05064	TIX IC28,1,1	YES--REG.A=REG.A-1	524	0907
05064	2	00001	4	05065	TIX IC28+1,4,1	REG.C=REG.C-1	524	0908
05065	-0	63400	1	07644	SXD COMMON+6,1		524	0909
05066	0	50000	4	00000	CLA 0,4		524	0910
05067	-0	73400	2	00000	PDX 0,2		524	0911
05070	0	77100	0	00022	ARS 18		524	0912
05071	0	40200	0	07604	SUB C17		524	0913
05072	0	76500	0	00043	LRS 35		524	0914
05073	0	20000	0	07600	MPY C13		524	0915
05074	0	76300	0	00065	LLS 53		524	0916
05075	0	40000	4	00000	ADD 0,4		524	0917
05076	-0	73400	1	00000	PDX 0,1		524	0918
05077	0	50000	0	07534	CLA P1	COMPUTE B(I-2,J)	524	0919

05100	0	30200	0	07570	FSB C3		524	0920
05101	0	76500	0	00043	LRS 35		524	0921
05102	0	26000	2	03166	FMP 1654,2		524	0922
05103	0	60100	0	07645	STO COMMON+7		524	0923
05104	0	50000	0	07534	CLA P1		524	0924
05105	0	30200	0	07575	FSB C10		524	0925
05106	0	24000	0	07645	FDH COMMON+7		524	0926
05107	-0	60000	4	00000	STQ 0,4		524	0927
05110	0	50000	0	07534	CLA P1	COMPUTE D(I-2,J)	524	0928
05111	0	30200	0	07574	FSB C9		524	0929
05112	0	76500	0	00043	LRS 35		524	0930
05113	0	26000	0	07567	FMP C2		524	0931
05114	0	76500	0	00043	LRS 35		524	0932
05115	0	26000	1	03236	FMP 1694,1		524	0933
05116	0	24000	0	07645	FDH COMMON+7		524	0934
05117	-0	60000	4	00000	STQ 0,4		524	0935
05120	0	50000	0	07566	CLA C1	COMPUTE C(I-2,J)	524	0936
05121	0	30200	4	00000	FSB 0,4		524	0937
05122	0	30200	4	00000	FSB 0,4		524	0938
05123	0	60100	4	00000	STO 0,4		524	0939
05124	0	56000	0	77777	LDQ 32767	COMPUTE F(I-2,J)	524	0940
05125	0	26000	0	00151	FMP 105		524	0941
05126	0	24000	2	00204	FDH 132,2		524	0942
05127	-0	53400	1	07644	LXD COMMON+6,1		524	0943
05130	-0	53400	2	07643	LXD COMMON+5,2		524	0944
05131	0	26000	1	77777	FMP 32767,1		524	0945
05132	0	76500	0	00043	LRS 35		524	0946
05133	0	26000	2	00000	FMP 0,2		524	0947
05134	0	60100	4	00000	STO 0,4		524	0948
05135	2	00001	4	05136	TIX IC29,4,1	REG.C=REG.C-1	524	0949
05136	2	00001	1	05137	TIX IC29+1,1,1	REG.A=REG.A-1	524	0950
05137	-0	63400	1	07644	SXD COMMON+6,1		524	0951
05140	0	50000	4	00000	CLA 0,4		524	0952
05141	-0	73400	2	00000	PDX 0,2		524	0953
05142	0	50000	4	00000	CLA 0,4		524	0954
05143	0	77100	0	00022	ARS 18		524	0955
05144	0	40200	0	07604	SUB C17		524	0956
05145	0	76500	0	00043	LRS 35		524	0957
05146	0	20000	0	07600	MPY C13		524	0958
05147	0	76300	0	00065	LLS 53		524	0959

05150	0	40000	4	00000	ADD 0,4		524	0960
05151	-0	73400	1	00000	PDX 0,1		524	0961
05152	0	50000	0	07534	CLA P1	COMPUTE B(I-1,J)	524	0962
05153	0	30200	0	07574	FSB C9		524	0963
05154	0	60100	0	07645	STO COMMON+7		524	0964
05155	0	56000	0	07567	LDQ C2		524	0965
05156	0	26000	1	03256	FMP 1710,1		524	0966
05157	0	24000	2	03172	FDH 1658,2		524	0967
05160	0	26000	0	07645	FMP COMMON+7		524	0968
05161	0	60100	4	00000	STO 0,4		524	0969
05162	0	50000	0	00147	CLA 103	COMPUTE D(I-1,J)	524	0970
05163	0	30200	0	03151	FSB 1641		524	0971
05164	0	76500	0	00043	LRS 35		524	0972
05165	0	26000	2	03172	FMP 1658,2		524	0973
05166	0	60100	0	07645	STO COMMON+7		524	0974
05167	0	50000	0	03151	CLA 1641		524	0975
05170	0	24000	0	07567	FDH C2		524	0976
05171	-0	60000	0	07646	STQ COMMON+8		524	0977
05172	0	50000	0	00147	CLA 103		524	0978
05173	0	30200	0	07646	FSB COMMON+8		524	0979
05174	0	24000	0	07645	FDH COMMON+7		524	0980
05175	-0	60000	4	00000	STQ 0,4		524	0981
05176	0	50000	0	07566	CLA C1	COMPUTE C(I-1,J)	524	0982
05177	0	30200	4	00000	FSB 0,4		524	0983
05200	0	30200	4	00000	FSB 0,4		524	0984
05201	0	60100	4	00000	STO 0,4		524	0985
05202	0	56000	0	77777	LDQ 32767	COMPUTE F(I-1,J)	524	0986
05203	0	26000	0	00151	FMP 105		524	0987
05204	0	24000	2	00210	FDH 136,2		524	0988
05205	-0	53400	1	07644	LXD COMMON+6,1		524	0989
05206	-0	53400	2	07643	LXD COMMON+5,2		524	0990
05207	0	26000	1	77777	FMP 32767,1		524	0991
05210	0	76500	0	00043	LRS 35		524	0992
05211	0	26000	2	00000	FMP 0,2		524	0993
05212	0	60100	4	00000	STO 0,4		524	0994
05213	2	00001	4	05214	TIX IC30,4,1	REG.C=REG.C-1	524	0995
05214	2	00001	1	05215	TIX IC30+1,1,1	REG.A=REG.A-1	524	0996
05215	0	50000	4	00000	CLA 0,4		524	0997
05216	-0	73400	2	00000	PDX 0,2		524	0998
05217	-0	63400	1	07644	SXD COMMON+6,1		524	0999

05220	-0	53400	1	07643	LXD COMMON+5,1		524	1000
05221	0	77100	0	00022	ARS 18		524	1001
05222	0	40200	0	07604	SUB C17		524	1002
05223	0	76500	0	00043	LRS 35		524	1003
05224	0	20000	0	07600	MPY C13		524	1004
05225	0	76300	0	00065	LLS 53		524	1005
05226	0	40000	1	00000	ADD 0,1		524	1006
05227	-0	73400	1	00000	PDX 0,1		524	1007
05230	0	50000	1	03216	CLA 1678,1	COMPUTE E(I,J)	524	1008
05231	0	24000	2	03172	FDH 1658,2		524	1009
05232	-0	53400	1	07643	LXD COMMON+5,1		524	1010
05233	-0	60000	1	00000	STQ 0,1		524	1011
05234	0	56000	0	00147	LDQ 103	COMPUTE B(I,J)	524	1012
05235	0	26000	0	07571	FMP C4		524	1013
05236	0	30200	0	03151	FSB 1641		524	1014
05237	0	76500	0	00043	LRS 35		524	1015
05240	0	26000	2	03172	FMP 1658,2		524	1016
05241	0	60100	0	07645	STO COMMON+7		524	1017
05242	0	56000	0	00147	LDQ 103		524	1018
05243	0	26000	0	07567	FMP C2		524	1019
05244	0	30200	0	03151	FSB 1641		524	1020
05245	0	24000	0	07645	FDH COMMON+7		524	1021
05246	0	26000	0	07571	FMP C4		524	1022
05247	0	60100	4	00000	STO 0,4		524	1023
05250	0	50000	0	07566	CLA C1	COMPUTE C(I,J)	524	1024
05251	0	30200	4	00000	FSB 0,4		524	1025
05252	0	30200	1	00000	FSB 0,1		524	1026
05253	0	60100	4	00000	STO 0,4		524	1027
05254	0	60000	4	00000	STZ 0,4	COMPUTE D(I,J)	524	1028
05255	0	56000	0	77777	LDQ 32767	COMPUTE F(I,J)	524	1029
05256	0	26000	0	00151	FMP 105		524	1030
05257	0	24000	2	00210	FDH 136,2		524	1031
05260	-0	53400	2	07644	LXD COMMON+6,2		524	1032
05261	0	26000	2	77777	FMP 32767,2		524	1033
05262	0	76500	0	00043	LRS 35		524	1034
05263	0	26000	1	00000	FMP 0,1		524	1035
05264	0	60100	4	00000	STO 0,4		524	1036
05265	-0	53400	2	07643	LXD COMMON+5,2		524	1037
05266	2	00001	4	05267	TIX IC31,4,1	REG.C=REG.C-1	524	1038
05267	2	00001	2	04764	TIX IC26+2,2,1	REG.B=REG.B-1	524	1039

05270	0	56000	0	00151	LDQ	105	COMPUTE H	524	1040
05271	0	26000	0	00153	FMP	107		524	1041
05272	0	24000	0	00152	FDH	106		524	1042
05273	-0	60000	0	03262	STQ	1714		524	1043
05274	0	53400	1	00145	LXA	101,1	REG.A=J	524	1044
05275	0	50000	0	03256	CLA	1710	DO WE WANT CONSTANT	524	1045
05276	-0	10000	0	05302	TNZ	IQ32+3	COOLANT TEMPERATURE--NO, GO TO IQ32+3	524	1046
05277	0	60000	1	00000	STZ	0,1	YES--G(J)=0	524	1047
05300	2	00001	1	05277	TIX	IQ32,1,1	REG.A=REG.A-1	524	1048
05301	0	02000	0	05321	TRA	IQ34		524	1049
05302	0	50000	0	00163	CLA	115	IS COOLANT FLOWING	524	1050
05303	0	10000	0	05313	TZE	IQ33	NO--GO TO IQ33	524	1051
05304	0	50000	1	00000	CLA	0,1	YES--COMPUTE G(FLOWING)	524	1052
05305	-0	73400	2	00000	PDX	0,2		524	1053
05306	0	50000	2	03262	CLA	1714,2		524	1054
05307	0	24000	2	03176	FDH	1662,2		524	1055
05310	-0	60000	1	00000	STQ	0,1		524	1056
05311	2	00001	1	05304	TIX	IQ32+5,1,1	REG.A=REG.A-1	524	1057
05312	0	02000	0	05321	TRA	IQ34		524	1058
05313	0	50000	1	00000	CLA	0,1	COMPUTE G(STAGNANT)	524	1059
05314	-0	73400	2	00000	PDX	0,2		524	1060
05315	0	50000	0	03256	CLA	1710		524	1061
05316	0	24000	2	03176	FDH	1662,2		524	1062
05317	-0	60000	1	00000	STQ	0,1		524	1063
05320	2	00001	1	05313	TIX	IQ33,1,1	REG.A=REG.A-1	524	1064
05321	0	53400	2	00145	LXA	101,2	REG.B=J	524	1065
05322	0	50000	0	07566	CLA	C1	COMPUTE I-H-G(J)	524	1066
05323	0	30200	0	03262	FSB	1714		524	1067
05324	0	30200	2	00000	FSB	0,2		524	1068
05325	0	60100	2	00000	STO	0,2		524	1069
05326	2	00001	2	05322	TIX	IQ34+1,2,1	REG.B=REG.B-1	524	1070
05327	0	53400	4	07535	LXA	P2,4	REG.C=IJ	524	1071
05330	0	53400	2	00145	LXA	101,2	REG.B=J	524	1072
05331	0	50000	4	00000	CLA	0,4	IS C(I,J) NEGATIVE	524	1073
05332	0	10000	0	05334	TZE	IC35+5		524	1074
05333	-0	12000	0	05342	TMI	IC36	YES	524	1075
05334	2	00001	4	05331	TIX	IC35+2,4,1	NO--REG.C=REG.C-1	524	1076
05335	0	50000	2	00000	CLA	0,2	IS I-G(J)-H NEGATIVE	524	1077
05336	0	10000	0	05340	TZE	IC35+9		524	1078
05337	-0	12000	0	05342	TMI	IC36	YES	524	1079

05340	2	00001	2	05335	TIK IC35+6,2,1	NO--REG.B=REG.B-1	524	1080
05341	0	02000	0	05353	TRA IC39		524	1081
05342	0	02000	0	04724	IC36 TRA ADJ1		524	1082
05343	0	50000	0	07561	IC37 CLA LINE	LINE=LINE+3	524	1083
05344	0	40000	0	07605	ADD C18		524	1084
05345	0	60100	0	07561	STO LINE		524	1085
05346	0	07400	4	06570	TSX SUBBP,4	EXIT TO ROW OVERFLOW TEST	524	1086
05347	0	07400	4	07270	TSX F12,4	PRINT TITLE AND FIRST ROW OF B	524	1087
05350	0	00000	0	00000	IC38 0,0,0		524	1088
05351	0	07400	4	06650	TSX SUBB,4	EXIT TO COEFFICIENT PRINT SUBROUTINE	524	1089
05352	0	02000	0	05376	TRA I		524	1090
05353	0	50000	0	07561	IC39 CLA LINE	WILL LINE OVERFLOW PAGE	524	1091
05354	0	02000	0	10044	TRA GOOF+24		524	1092
05355	-0	12000	0	05370	TMI IC39+13	NO	524	1093
05356	0	10000	0	05370	TZE IC39+13	NO	524	1094
05357	0	76000	0	00165	SWT 5	YES--IS OUTPUT ON TAPE	524	1095
05360	0	02000	0	05363	TRA IC39+8	NO	524	1096
05361	0	76600	0	00361	WPR	YES--RESTORE PRINTER	524	1097
05362	0	76000	0	00361	SPR 1		524	1098
05363	0	50000	0	07557	CLA PAGE	PAGE=PAGE+1	524	1099
05364	0	40000	0	07604	ADD C17		524	1100
05365	0	02000	0	10023	TRA GOOF+7		524	1101
05366	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	1102
05367	0	07557	0	07556	PROB,0,PAGE		524	1103
05370	0	07400	4	07376	TSX F21,4	PRINT DELTA TAU,BETA,N	524	1104
05371	0	07651	0	07647	COMMON+9,0,COMMON+11		524	1105
05372	0	02000	0	10027	TRA GOOF+11		524	1106
05373	-0	53400	2	07640	LXD COMMON+2,2		524	1107
05374	-0	53400	4	07641	LXD COMMON+3,4		524	1108
05375	0	02000	4	00001	TRA 1,4	RETURN	524	1109
05376	0	50000	0	00162	I CLA 114	ITERATIONS	524	1110
05377	0	10000	0	05423	TZE I+21	IS THIS EXP VERSION	524	1111
05400	0	60100	0	07541	STO T2	YES--GO TO I+21	524	1112
05401	0	50000	0	07604	CLA C17	NO--NT COUNTER=NT	524	1113
05402	0	60100	0	07542	STO T3	BETA COUNTER=1	524	1114
05403	0	50000	0	00156	CLA 110		524	1115
05404	0	60100	0	07553	STO T12	FIX BETA	524	1116
05405	-0	30000	0	07565	UFA C0		524	1117
05406	-0	32000	0	07633	ANA C41		524	1118
							524	1119

05407	0	60100	0	00156	STO 110		524	1120
05410	0	50000	0	00240	CLA 160	DELTA N(TAU)	524	1121
05411	0	30200	0	00237	FSB 159		524	1122
05412	0	24000	0	07553	FDH T12		524	1123
05413	-0	60000	0	07552	STQ T11		524	1124
05414	0	50000	0	07552	CLA T11	CURRENT N(TAU)	524	1125
05415	0	24000	0	07567	FDH C2		524	1126
05416	-0	75400	0	00000	PXD 0,0		524	1127
05417	0	76300	0	00043	LLS 35		524	1128
05420	0	30000	0	00237	FAD 159		524	1129
05421	0	60100	0	07540	STO T1		524	1130
05422	0	02000	0	05435	TRA I1-7	GO TO I1-7	524	1131
05423	0	60000	0	07541	STZ T2	NT COUNTER=0	524	1132
05424	0	50000	0	00151	CLA 105	CURRENT N(TAU)	524	1133
05425	0	24000	0	00156	FDH 110		524	1134
05426	-0	75400	0	00000	PXD 0,0		524	1135
05427	0	76300	0	00043	LLS 35		524	1136
05430	0	07400	4	07672	TSX EXP,4		524	1137
05431	0	02000	0	10011	TRA EXPE		524	1138
05432	0	30000	0	07566	FAD C1		524	1139
05433	0	24000	0	07567	FDH C2		524	1140
05434	-0	60000	0	07540	STQ T1		524	1141
05435	0	50000	0	07604	CLA C17	ITERATION NO.=1	524	1142
05436	0	60100	0	07537	STO P4		524	1143
05437	0	60100	0	07543	STO T4	N COUNTER=1	524	1144
05440	0	60000	0	07536	STZ P3	TAU=0	524	1145
05441	0	56000	0	00151	LDQ 105	.5 DELTA TAU	524	1146
05442	0	26000	0	07576	FMP C11		524	1147
05443	0	60100	0	07554	STO T13		524	1148
05444	0	50000	0	07536	CLA P3	TAU+DELTA TAU	524	1149
05445	0	30000	0	00151	FAD 105		524	1150
05446	0	60100	0	07536	STO P3		524	1151
05447	0	53400	1	07535	LXA P2,1	REG.A=IXJ	524	1152
05450	0	53400	4	00145	LXA 101,4	REG.C=J	524	1153
05451	0	53400	2	00144	LXA 100,2	REG.B=I	524	1154
05452	0	56000	1	00000	LDQ 0,1	T6=F(I,J)N(TAU)	524	1155
05453	0	26000	0	07540	FMP T1		524	1156
05454	0	60100	0	07545	STO T6		524	1157
05455	-0	75400	2	00000	PXD 0,2		524	1158
05456	0	77100	0	00022	ARS 18		524	1159

05457	0	40200	0	07604	SUB C17	IS I=I	524	1160
05460	-0	10000	0	05465	TNZ I3	NO--GO TO I3	524	1161
05461	0	56000	4	00000	LDQ 0,4	YES--T6=T6+E(J)PSI(J)	524	1162
05462	0	26000	4	00000	FMP 0,4		524	1163
05463	0	30000	0	07545	FAD T6		524	1164
05464	0	60100	0	07545	STO T6		524	1165
05465	-0	76000	0	00142	I3 SLT 2	IS SL2 ON	524	1166
05466	0	02000	0	05475	TRA I3+8	NO--GO TO I3+8	524	1167
05467	0	56000	0	07547	LDQ T8	YES--T6=T6+T(I-1,J)OLD B	524	1168
05470	0	26000	1	00000	FMP 0,1		524	1169
05471	0	30000	0	07545	FAD T6		524	1170
05472	0	60100	0	07545	STO T6		524	1171
05473	0	56000	0	07551	LDQ T10	(OLD C)	524	1172
05474	0	02000	0	05502	TRA I3+13	GO TO I3+13	524	1173
05475	0	56000	1	00000	LDQ 0,1	T6=T6+B(I,J)T(I-1,J)	524	1174
05476	0	26000	1	00000	FMP 0,1		524	1175
05477	0	30000	0	07545	FAD T6		524	1176
05500	0	60100	0	07545	STO T6		524	1177
05501	0	56000	1	00000	LDQ 0,1	T6=T6+C(I,J)T(I,J)	524	1178
05502	0	26000	1	00000	FMP 0,1		524	1179
05503	0	30000	0	07545	FAD T6		524	1180
05504	0	60100	0	07545	STO T6		524	1181
05505	0	56000	1	00000	LDQ 0,1	T6=T6+D(I,J)T(I+1,J)	524	1182
05506	0	26000	1	00000	FMP 0,1		524	1183
05507	0	30000	0	07545	FAD T6		524	1184
05510	0	60100	0	07545	STO T6		524	1185
05511	0	50000	1	00000	CLA 0,1		524	1186
05512	-0	63400	4	07546	SXD T7,4	SAVE REG.C	524	1187
05513	-0	73400	4	00000	PDX 0,4	REG.C=PHASE(I,J)	524	1188
05514	2	00001	4	05516	TIX I3+25,4,1	IS PHASE(I,J)=4	524	1189
05515	0	02000	0	05530	TRA I4	YES--GO TO I4	524	1190
05516	-0	75400	2	00000	PXD 0,2	NO--REG.C=REG.C-1	524	1191
05517	0	77100	0	00022	ARS 18	IS I=I	524	1192
05520	0	40200	0	07604	SUB C17		524	1193
05521	0	10000	0	05533	TZE I5	YES--GO TO I5	524	1194
05522	0	40200	0	07604	SUB C17	NO--IS I=I-1	524	1195
05523	0	10000	0	05533	TZE I5	YES--GO TO I5	524	1196
05524	0	50000	0	07545	CLA T6	NO	524	1197
05525	0	30200	4	00223	FSB 147,4	IS T6 GREATER THAN OR=TT(F)	524	1198
05526	0	10000	0	05540	TZE I6	YES--GO TO I6	524	1199

05527	0	12000	0	05540		TPL I6	YES--GO TO I6	524	1200
05530	0	50000	0	07545	I4	CLA T6	NO	524	1201
05531	0	60100	1	00000		STO 0,1	T(I,J)(TAU+DELTAU)=T6	524	1202
05532	0	02000	0	06024		TRA I19	GO TO I19	524	1203
05533	0	50000	0	07545	I5	CLA T6	IS T6 GREATER THAN OR=TT(B)	524	1204
05534	0	30200	4	00226		FSB 150,4		524	1205
05535	0	10000	0	05551		TZE I7	YES--GO TO I7	524	1206
05536	0	12000	0	05551		TPL I7	YES--GO TO I7	524	1207
05537	0	02000	0	05530		TRA I4	NO--GO TO I4	524	1208
05540	0	30000	1	00000	I6	FAD 0,1	IS T6-TT(F)+T PRIME(I,J) GREATER	524	1209
05541	0	30200	4	00234		FSB 156,4	THAN OR=DELTT(F)	524	1210
05542	0	10000	0	05562		TZE I8	YES--GO TO I8	524	1211
05543	0	12000	0	05562		TPL I8	YES--GO TO I8	524	1212
05544	0	30000	4	00234		FAD 156,4	NO--T PRIME(I,J)=T6-TT(F)+T PRIME(I,J)	524	1213
05545	0	60100	1	00000		STO 0,1		524	1214
05546	0	50000	4	00223		CLA 147,4	T(I,J)(TAU+DELTAU)=TT(F)	524	1215
05547	0	60100	1	00000		STO 0,1		524	1216
05550	0	02000	0	06024		TRA I19		524	1217
05551	0	30000	1	00000	I7	FAD 0,1	IS T6-TT(B)+T PRIME(I,J) GREATER	524	1218
05552	0	30200	4	00237		FSB 159,4	THAN OR=DELTT(B)	524	1219
05553	0	10000	0	05566		TZE I9	YES--GO TO I9	524	1220
05554	0	12000	0	05566		TPL I9	YES--GO TO I9	524	1221
05555	0	30000	4	00237		FAD 159,4	NO--T PRIME(I,J)=T6-TT(B)+T PRIME(I,J)	524	1222
05556	0	60100	1	00000		STO 0,1		524	1223
05557	0	50000	4	00226		CLA 150,4	T(I,J)(TAU+DELTAU)=TT(B)	524	1224
05560	0	60100	1	00000		STO 0,1		524	1225
05561	0	02000	0	06024		TRA I19		524	1226
05562	0	30000	4	00223	I8	FAD 147,4	T(I,J)(TAU+DELTAU)=T6+T PRIME(I,J)-DELTT(F)	524	1227
05563	0	60100	1	00000		STO 0,1		524	1228
05564	0	60000	1	00000		STZ 0,1	T PRIME(I,J)=0	524	1229
05565	0	02000	0	05571		TRA I12+3	GO TO I12	524	1230
05566	0	30000	4	00226	I9	FAD 150,4	T(I,J)(TAU+DELTAU)=T6+T PRIME(I,J)-DELTT(B)	524	1231
05567	0	60100	1	00000		STO 0,1		524	1232
05570	0	02000	0	05564		TRA I8+2	GO TO I8+2	524	1233
05571	-0	75400	0	00000		PXD 0,0		524	1234
05572	0	62100	1	00000		STA 0,1	ADDRESS OF PC ARRAY=0	524	1235
05573	-0	75400	4	00000		PXD 0,4		524	1236
05574	0	62200	1	00000		STD 0,1	DEC. OF PC ARRAY=NEW PHASE	524	1237
05575	-0	75400	2	00000		PXD 0,2		524	1238
05576	0	77100	0	00022		ARS 18		524	1239

05577	0	40200	0	00144	SUB	100	IS I=1	524	1240
05600	0	10000	0	06011	TZE	I16	YES--GO TO I16	524	1241
05601	0	40000	0	00144	ADD	100	NO	524	1242
05602	0	40200	0	07604	SUB	C17	IS I=I	524	1243
05603	0	10000	0	05755	TZE	I15	YES--GO TO I15	524	1244
05604	0	40200	0	07604	SUB	C17	NO--IS I=I-1	524	1245
05605	0	10000	0	05706	TZE	I14	YES--GO TO I14	524	1246
05606	0	40200	0	07604	SUB	C17	NO--IS I=I-2	524	1247
05607	0	10000	0	05634	TZE	I13	YES--GO TO I13	524	1248
							NEW COEFFICIENTS FOR I BETWEEN 1 AND I-2	524	1249
05610	0	56000	1	00000	LDQ	0,1	FIX B(I,J)	524	1250
05611	0	26000	4	03165	FMP	1653,4		524	1251
05612	0	24000	4	03166	FDH	1654,4		524	1252
05613	-0	60000	1	00000	STQ	0,1		524	1253
05614	0	50000	0	07567	CLA	C2	FIX C(I,J)	524	1254
05615	0	24000	4	03166	FDH	1654,4		524	1255
05616	-0	75400	0	00000	PXD	0,0		524	1256
05617	0	76300	0	00043	LLS	35		524	1257
05620	0	76000	0	00002	CHS			524	1258
05621	0	30000	0	07566	FAD	C1		524	1259
05622	0	60100	1	00000	STO	0,1		524	1260
05623	0	56000	1	00000	LDQ	0,1	FIX D(I,J)	524	1261
05624	0	26000	4	03165	FMP	1653,4		524	1262
05625	0	24000	4	03166	FDH	1654,4		524	1263
05626	-0	60000	1	00000	STQ	0,1		524	1264
05627	0	56000	1	00000	LDQ	0,1	FIX F(I,J)	524	1265
05630	0	26000	4	00203	FMP	131,4		524	1266
05631	0	24000	4	00204	FDH	132,4		524	1267
05632	-0	60000	1	00000	STQ	0,1		524	1268
05633	0	02000	0	06024	TRA	I19	GO TO I19	524	1269
							NEW COEFFICIENTS FOR I=I-2	524	1270
05634	0	56000	1	00000	I13 LDQ	0,1	FIX B(I-2,J)	524	1271
05635	0	26000	4	03165	FMP	1653,4		524	1272
05636	0	24000	4	03166	FDH	1654,4		524	1273
05637	-0	60000	1	00000	STQ	0,1		524	1274
05640	-0	63400	2	07550	SXD	T9,2	SAVE REG.B	524	1275
05641	-0	75400	4	00000	PXD	0,4	REG.B=(F-1)4+B	524	1276
05642	0	77100	0	00022	ARS	18		524	1277
05643	0	40200	0	07604	SUB	C17		524	1278
05644	0	76500	0	00043	LRS	35		524	1279

05645	0	20000	0	07600	MPY C13		524	1280
05646	0	76300	0	00065	LLS 53		524	1281
05647	0	40000	1	00000	ADD 0,1		524	1282
05650	-0	73400	2	00000	PDX 0,2		524	1283
05651	0	56000	1	00000	LDQ 0,1	FIX D(I-2,J)	524	1284
05652	0	26000	4	03165	FMP 1653,4		524	1285
05653	0	24000	4	03166	FDH 1654,4		524	1286
05654	0	26000	2	03236	FMP 1694,2		524	1287
05655	0	24000	2	03232	FDH 1690,2		524	1288
05656	-0	60000	1	00000	STQ 0,1		524	1289
05657	0	50000	0	07566	CLA C1		524	1290
05660	0	30200	1	00000	FSB 0,1	FIX C(I-2,J)	524	1291
05661	0	30200	1	00000	FSB 0,1		524	1292
05662	0	60100	1	00000	STO 0,1		524	1293
05663	0	56000	1	00000	LDQ 0,1	FIX F(I-2,J)	524	1294
05664	0	26000	4	00203	FMP 131,4		524	1295
05665	0	24000	4	00204	FDH 132,4		524	1296
05666	-0	60000	1	00000	STQ 0,1		524	1297
05667	0	50000	1	00000	CLA 0,1	SAVE B(I-1)	524	1298
05670	0	60100	0	07547	STO T8		524	1299
05671	0	50000	1	00000	CLA 0,1	SAVE C(I-1)	524	1300
05672	0	60100	0	07551	STO T10		524	1301
05673	0	56000	1	00000	LDQ 0,1	FIX B(I-1)	524	1302
05674	0	26000	2	03256	FMP 1710,2		524	1303
05675	0	24000	2	03252	FDH 1706,2		524	1304
05676	-0	60000	1	00000	STQ 0,1		524	1305
05677	0	50000	0	07566	CLA C1	FIX C(I-1)	524	1306
05700	0	30200	1	00000	FSB 0,1		524	1307
05701	0	30200	1	00000	FSB 0,1		524	1308
05702	0	60100	1	00000	STO 0,1		524	1309
05703	0	76000	0	00142	SLN 2	TURN ON SL2	524	1310
05704	-0	53400	2	07550	LXD T9,2	RESTORE REG.B	524	1311
05705	0	02000	0	06024	TRA I19	GO TO I19	524	1312
						NEW COEFFICIENTS FOR I=I-1	524	1313
05706	0	56000	1	00000	LDQ 0,1	FIX F(I-1,J)	524	1314
05707	0	26000	4	00207	FMP 135,4		524	1315
05710	0	24000	4	00210	FDH 136,4		524	1316
05711	-0	60000	1	00000	STQ 0,1		524	1317
05712	0	56000	1	00000	LDQ 0,1	FIX D(I-1,J)	524	1318
05713	0	26000	4	03171	FMP 1657,4		524	1319

05714	0	24000	4	03172	FDH 1658,4		524	1320
05715	-0	60000	1	00000	STQ 0,1		524	1321
05716	-0	63400	2	07550	SXD T9,2	SAVE REG.B	524	1322
05717	0	50000	1	00000	CLA 0,1		524	1323
05720	0	77100	0	00022	ARS 18		524	1324
05721	0	40200	0	07604	SUB C17		524	1325
05722	0	76500	0	00043	LRS 35		524	1326
05723	0	20000	0	07600	MPY C13		524	1327
05724	-0	77300	0	00022	RQL 18		524	1328
05725	-0	60000	0	07545	STQ T6		524	1329
05726	-0	75400	4	00000	PXD 0,4	REG.B=(F-1)4+B	524	1330
05727	0	40000	0	07545	ADD T6		524	1331
05730	-0	73400	2	00000	PDX 0,2		524	1332
05731	0	56000	1	00000	LDQ 0,1	FIX D(I-2,J)	524	1333
05732	0	26000	2	03236	FMP 1694,2		524	1334
05733	0	24000	2	03235	FDH 1693,2		524	1335
05734	-0	60000	1	00000	STQ 0,1		524	1336
05735	0	56000	1	00000	LDQ 0,1	FIX B(I-1,J)	524	1337
05736	0	26000	2	03256	FMP 1710,2		524	1338
05737	0	24000	2	03255	FDH 1709,2		524	1339
05740	0	26000	4	03171	FMP 1657,4		524	1340
05741	0	24000	4	03172	FDH 1658,4		524	1341
05742	-0	60000	1	00000	STQ 0,1		524	1342
05743	0	50000	0	07566	CLA C1	FIX C(I-1,J)	524	1343
05744	0	30200	1	00000	FSB 0,1		524	1344
05745	0	30200	1	00000	FSB 0,1		524	1345
05746	0	60100	1	00000	STO 0,1		524	1346
05747	0	50000	0	07566	CLA C1	FIX C(I-2,J)	524	1347
05750	0	30200	1	00000	FSB 0,1		524	1348
05751	0	30200	1	00000	FSB 0,1		524	1349
05752	0	60100	1	00000	STO 0,1		524	1350
05753	-0	53400	2	07550	LXD T9,2	RESTORE REG.B	524	1351
05754	0	02000	0	06024	TRA I19	GO TO I19	524	1352
						NEW COEFFICIENTS FOR I=I	524	1353
05755	0	56000	1	00000	LDQ 0,1	FIX F(I,J)	524	1354
05756	0	26000	4	00207	FMP 135,4		524	1355
05757	0	24000	4	00210	FDH 136,4		524	1356
05760	-0	60000	1	00000	STQ 0,1		524	1357
05761	0	56000	1	00000	LDQ 0,1	FIX B(I,J)	524	1358
05762	0	26000	4	03171	FMP 1657,4		524	1359

I15

05763	0	24000	4	03172	FDH 1658,4		524	1360
05764	-0	60000	1	00000	STQ 0,1		524	1361
05765	-0	63400	2	07550	SXD T9,2	SAVE REG.B	524	1362
05766	-0	75400	4	00000	PXD 0,4		524	1363
05767	0	77100	0	00022	ARS 18		524	1364
05770	0	40200	0	07604	SUB C17		524	1365
05771	0	76500	0	00043	LRS 35		524	1366
05772	0	20000	0	07600	MPY C13		524	1367
05773	0	76300	0	00065	LLS 53		524	1368
05774	-0	53400	2	07546	LXD T7,2	REG.B=J	524	1369
05775	0	40000	2	00000	ADD 0,2		524	1370
05776	-0	73400	2	00000	PDX 0,2	REG.B=(B-1)4+S	524	1371
05777	0	50000	2	03216	CLA 1678,2	FIX E(J)	524	1372
06000	0	24000	4	03172	FDH 1658,4		524	1373
06001	-0	53400	4	07546	LXD T7,4	RESTORE J TO REG.C	524	1374
06002	-0	60000	4	00000	STQ 0,4		524	1375
06003	0	50000	0	07566	CLA C1	FIX C(I,J)	524	1376
06004	0	30200	1	00000	FSB 0,1		524	1377
06005	0	30200	4	00000	FSB 0,4		524	1378
06006	0	60100	1	00000	STO 0,1		524	1379
06007	-0	53400	2	07550	LXD T9,2	RESTORE REG.B	524	1380
06010	0	02000	0	06024	TRA I19	GO TO I19	524	1381
						NEW COEFFICIENTS FOR I=1	524	1382
06011	0	50000	0	07571	CLA C4	FIX D(1,J)	524	1383
06012	0	24000	4	03166	FDH 1654,4		524	1384
06013	-0	60000	1	00000	STQ 0,1		524	1385
06014	0	50000	0	07566	CLA C1	FIX C(1,J)	524	1386
06015	0	30200	1	00000	FSB 0,1		524	1387
06016	0	60100	1	00000	STO 0,1		524	1388
06017	0	56000	1	00000	LDQ 0,1	FIX F(1,J)	524	1389
06020	0	26000	4	00203	FMP 131,4		524	1390
06021	0	24000	4	00204	FDH 132,4		524	1391
06022	-0	60000	1	00000	STQ 0,1		524	1392
06023	0	02000	0	06024	TRA I19	GO TO I19	524	1393
						COMPUTE PSI(J,TAU+DELTAU)	524	1394
06024	-0	53400	4	07546	LXD T7,4	RESTORE J TO REG.C	524	1395
06025	2	00001	1	06026	TIX I19+2,1,1	REG.A=REG.A-1	524	1396
06026	2	00001	2	05452	TIX I2,2,1	ROW DONE--NO--REG.B=REG.B-1--GO TO I2	524	1397
06027	-0	75400	4	00000	PXD 0,4	YES--IS J=1	524	1398
06030	0	77100	0	00022	ARS 18		524	1399

06031	0	40200	0	00145	SUB 101		524	1400
06032	0	10000	0	06053	TZE I20	YES--GO TO I20	524	1401
06033	0	56000	0	03262	LDQ 1714	NO--T6=PSI(J-1)H	524	1402
06034	0	26000	4	00000	FMP 0,4		524	1403
06035	0	60100	0	07545	STO T6		524	1404
06036	0	56000	4	00000	LDQ 0,4	T6=T6+PSI(J)(1-G-H)	524	1405
06037	0	26000	4	00000	FMP 0,4		524	1406
06040	0	30000	0	07545	FAD T6		524	1407
06041	0	60100	0	07545	STO T6		524	1408
06042	0	56000	4	00000	LDQ 0,4		524	1409
06043	3	00001	4	06046	TXH *+3,4,1	IS J=J	524	1410
06044	0	26000	1	00000	FMP 0,1	YES	524	1411
06045	0	02000	0	06047	TRA *+2		524	1412
06046	0	26000	1	00000	FMP 0,1	NO	524	1413
06047	0	30000	0	07545	FAD T6		524	1414
06050	0	60100	0	07545	STO T6		524	1415
06051	0	60100	4	00000	STO 0,4		524	1416
06052	0	02000	0	06056	TRA I21		524	1417
06053	0	56000	0	03262	LDQ 1714	GET PSI(0,TAU)H	524	1418
06054	0	26000	0	00154	FMP 108		524	1419
06055	0	02000	0	06035	TRA I19+9	GO TO I19+9	524	1420
06056	-0	63400	2	07550	SXD T9,2	SAVE REG.B	524	1421
06057	0	50000	4	00000	CLA 0,4		524	1422
06060	-0	73400	2	00000	PDX 0,2	REG.B=PHASE(PSI(J))	524	1423
06061	2	00001	2	06066	TIK I21+8,2,1	REG.B=REG.B-1	524	1424
06062	0	02000	0	06151	TRA I23	IS PSI(J) GREATER THAN OR=MAX PSI	524	1425
06063	2	00001	2	06153	TIK I23+2,2,1		524	1426
06064	0	02000	0	06151	TRA I23	YES--GO TO I23	524	1427
06065	0	10000	0	06151	TZE I23	YES--GO TO I23	524	1428
06066	0	50000	0	07545	CLA T6	NO--IS PSI(J) GREATER THAN OR=TT(S)	524	1429
06067	0	30200	2	00231	FSB 153,2		524	1430
06070	0	10000	0	06072	TZE I21+12	YES--GO TO I21+12	524	1431
06071	-0	12000	0	06153	TMI I23+2	NO--GO TO I23+2	524	1432
06072	-0	75400	2	00000	PXD 0,2	YES--STORE NEW PHASE PARAMETER	524	1433
06073	0	62200	4	00000	STD 0,4		524	1434
06074	0	50000	0	00163	CLA 115	IS W=0	524	1435
06075	0	10000	0	06126	TZE I22	YES--GO TO I22	524	1436
06076	0	50000	2	03262	CLA 1714,2	NO--FIX G FOR W NOT=0	524	1437
06077	0	24000	2	03176	FDH 1662,2		524	1438
06100	-0	60000	4	00000	STQ 0,4		524	1439

06101	0	50000	0	07566	CLA C1	FIX 1-G-H	524	1440
06102	0	30200	0	03262	FSB 1714		524	1441
06103	0	30200	4	00000	FSB 0,4		524	1442
06104	0	60100	4	00000	STO 0,4		524	1443
06105	0	50000	1	00000	CLA 0,1	FIX E(J)	524	1444
06106	-0	63400	1	07546	SXD T7,1	SAVE REG.A	524	1445
06107	0	77100	0	00022	ARS 18		524	1446
06110	0	40200	0	07604	SUB C17		524	1447
06111	0	76500	0	00043	LRS 35		524	1448
06112	0	20000	0	07600	MPY C13		524	1449
06113	-0	77300	0	00022	RQL 18		524	1450
06114	-0	60000	0	07545	STQ T6		524	1451
06115	-0	75400	2	00000	PXD 0,2		524	1452
06116	0	40000	0	07545	ADD T6		524	1453
06117	-0	73400	1	00000	PDX 0,1	REG.A=(B-1)4+S	524	1454
06120	0	50000	4	00000	CLA 0,4		524	1455
06121	0	24000	1	03215	FDH 1677,1		524	1456
06122	0	26000	1	03216	FMP 1678,1		524	1457
06123	0	60100	4	00000	STO 0,4		524	1458
06124	-0	53400	1	07546	LXD T7,1		524	1459
06125	0	02000	0	06063	TRA I21+5	GO TO I21+5	524	1460
06126	0	50000	0	03256	CLA 1710	FIX G(J)	524	1461
06127	0	24000	2	03176	FDH 1662,2		524	1462
06130	-0	60000	4	00000	STQ 0,4		524	1463
06131	0	50000	0	07566	CLA C1	FIX 1-G-H	524	1464
06132	0	30200	4	00000	FSB 0,4		524	1465
06133	0	30200	0	03262	FSB 1714		524	1466
06134	0	60100	4	00000	STO 0,4		524	1467
06135	0	02000	0	06105	TRA I21+23	GO TO I21+23	524	1468
06136	0	50000	0	07566	CLA C1	FIX C(I,J)	524	1469
06137	0	30200	1	00000	FSB 0,1		524	1470
06140	0	30200	4	00000	FSB 0,4		524	1471
06141	0	60100	1	00000	STO 0,1		524	1472
06142	0	02000	0	05451	TRA I1+5		524	1473
06143	0	50000	0	07566	CLA C1	FIX C(I,J)	524	1474
06144	0	30200	1	00000	FSB 0,1		524	1475
06145	0	30200	4	00000	FSB 0,4		524	1476
06146	0	60100	1	00000	STO 0,1		524	1477
06147	0	53400	2	07535	LXA P2,2	REG. B=IXJ	524	1478
06150	0	02000	0	06156	TRA I23+5	GO TO I23+5	524	1479

I22

06151	0	50000	0	00230	I23	CLA 152	PSI(J,TAU+DELTAU)=TT(S,3)	524	1480
06152	0	60100	4	00000		STO 0,4		524	1481
06153	-0	53400	2	07550		LXD T9,2	RESTORE REG.B	524	1482
06154	2	00001	4	06136		TIX I22+8,4,1	IS J=J---NO---REG.C=REG.C-1---GO TO I22+8	524	1483
06155	0	02000	0	06143		TRA I22+13	YES---GO TO I22+13	524	1484
06156	0	50000	2	00000		CLA 0,2	MOVE T(TAU+DELTAU)	524	1485
06157	0	60100	2	00000		STO 0,2		524	1486
06160	2	00001	2	06156		TIX I23+5,2,1		524	1487
06161	0	53400	2	00145		LXA 101,2	REG.B=J	524	1488
06162	0	50000	2	00000		CLA 0,2	MOVE PSI(TAU+DELTAU)	524	1489
06163	0	60100	2	00000		STO 0,2		524	1490
06164	2	00001	2	06162		TIX I23+9,2,1		524	1491
06165	0	53400	4	00145		LXA 101,4	REG.C=J	524	1492
06166	0	50000	4	00000		CLA 0,4	IS 1-G-H NEGATIVE	524	1493
06167	0	10000	0	06171		TZE I23+16		524	1494
06170	-0	12000	0	06415		TMI I30	YES---GO TO I30	524	1495
06171	2	00001	4	06166		TIX I23+13,4,1		524	1496
06172	0	53400	4	07535		LXA P2,4	NO---REG.C=IXJ	524	1497
06173	0	50000	4	00000		CLA 0,4	IS C(I,J) NEGATIVE	524	1498
06174	0	10000	0	06176		TZE I23+21		524	1499
06175	-0	12000	0	06415		TMI I30	YES---GO TO I30	524	1500
06176	2	00001	4	06173		TIX I23+18,4,1		524	1501
06177	0	50000	0	07536		CLA P3	NO---IS TAU=FINAL TAU	524	1502
06200	0	30000	0	07554		FAD T13		524	1503
06201	0	30200	0	00157		FSB 111		524	1504
06202	0	10000	0	06376		TZE I29	YES---GO TO I29	524	1505
06203	0	12000	0	06376		TPL I29		524	1506
06204	0	50000	0	07541		CLA T2	NO---IS N(TAU) COUNTER=1	524	1507
06205	0	40200	0	07604		SUB C17		524	1508
06206	0	10000	0	06357		TZE I28	YES---GO TO I28	524	1509
06207	-0	76000	0	00143		SLT 3	NO---IS SL3 ON (HAS A ROW ALREADY MELTED)	524	1510
06210	0	02000	0	06213		TRA I24	NO---GO TO I24	524	1511
06211	0	76000	0	00143		SLN 3	YES---TURN ON SL3 AGAIN	524	1512
06212	0	02000	0	06225		TRA I24+10	GO TO I24+10	524	1513
06213	0	53400	2	07535	I24	LXA P2,2	REG.B=IXJ	524	1514
06214	0	53400	4	00144		LXA 100,4	REG.C=I	524	1515
06215	0	50000	0	07607		CLA C20		524	1516
06216	-0	32000	2	00000		ANA 0,2	HAS A ROW MELTED	524	1517
06217	-0	10000	0	06223		TNZ I24+8		524	1518
06220	2	00001	2	06221		TIX I24+6,2,1		524	1519

06221	2	00001	4	06215	TIX I24+2,4,1		524	1520
06222	0	02000	0	06323	TRA I27	YES--GO TO I27	524	1521
06223	-0	63400	4	06224	SXD I24+9,4		524	1522
06224	2	00000	2	06214	TIX I24+1,2,0		524	1523
06225	0	50000	0	07543	CLA T4	NO--IS IT TIME FOR PERIODIC PRINT	524	1524
06226	0	40200	0	00155	SUB I09		524	1525
06227	0	10000	0	06315	TZE I26	YES--GO TO I26	524	1526
06230	0	50000	0	07543	CLA T4	NO--INCREASE N COUNTER BY 1	524	1527
06231	0	40000	0	07604	ADD C17		524	1528
06232	0	60100	0	07543	STO T4		524	1529
06233	0	50000	0	00162	CLA I14	IS THIS EXP VERSION	524	1530
06234	0	10000	0	06247	TZE I24+28	YES - GO TO I24+28	524	1531
06235	0	50000	0	07542	CLA T3	IS T3=BETA	524	1532
06236	0	40200	0	00156	SUB I10		524	1533
06237	0	10000	0	06274	TZE I25	YES--GO TO I25	524	1534
06240	0	50000	0	07540	CLA T1	NO--INCREASE N(IAU)	524	1535
06241	0	30000	0	07552	FAD T11		524	1536
06242	0	60100	0	07540	STO T1		524	1537
06243	0	50000	0	07542	CLA T3	INCREASE BETA COUNTER BY 1	524	1538
06244	0	40000	0	07604	ADD C17		524	1539
06245	0	60100	0	07542	STO T3		524	1540
06246	0	02000	0	06270	TRA I25-4		524	1541
06247	0	50000	0	07536	CLA P3	NEXT CURRENT N(IAU)	524	1542
06250	0	24000	0	00156	FDH I10		524	1543
06251	-0	75400	0	00000	PXD 0,0		524	1544
06252	0	76300	0	00043	LLS 35		524	1545
06253	0	07400	4	07672	TSX EXP,4		524	1546
06254	0	02000	0	10011	TRA EXPE		524	1547
06255	0	60100	0	07544	STO T5		524	1548
06256	0	50000	0	07536	CLA P3		524	1549
06257	0	30000	0	00151	FAD I05		524	1550
06260	0	24000	0	00156	FDH I10		524	1551
06261	-0	75400	0	00000	PXD 0,0		524	1552
06262	0	76300	0	00043	LLS 35		524	1553
06263	0	07400	4	07672	TSX EXP,4		524	1554
06264	0	02000	0	10011	TRA EXPE		524	1555
06265	0	30000	0	07544	FAD T5		524	1556
06266	0	24000	0	07567	FDH C2		524	1557
06267	-0	60000	0	07540	STQ T1		524	1558
06270	0	50000	0	07537	CLA P4	INCREASE ITERATION NO. BY 1	524	1559

06271	0	40000	0	07604	ADD C17		524	1560
06272	0	60100	0	07537	STO P4		524	1561
06273	0	02000	0	10041	TRA GOOF+21		524	1562
06274	0	50000	0	07604	I25 CLA C17	BETA COUNTER=1	524	1563
06275	0	60100	0	07542	STO T3	NEW DELTA N(TAU)	524	1564
06276	0	53400	2	07541	LXA T2,2		524	1565
06277	0	50000	2	00000	CLA 0,2		524	1566
06300	0	30200	2	00000	FSB 0,2		524	1567
06301	0	24000	0	07553	FDH T12		524	1568
06302	-0	60000	0	07552	STQ T11		524	1569
06303	0	50000	0	07552	CLA T11	NEW N(TAU)	524	1570
06304	0	24000	0	07567	FDH C2		524	1571
06305	-0	75400	0	00000	PXD 0,0		524	1572
06306	0	76300	0	00043	LLS 35		524	1573
06307	0	30000	2	00000	FAD 0,2		524	1574
06310	0	60100	0	07540	STO T1		524	1575
06311	0	50000	0	07541	CLA T2	DECREASE NT COUNTER BY 1	524	1576
06312	0	40200	0	07604	SUB C17		524	1577
06313	0	60100	0	07541	STO T2		524	1578
06314	0	02000	0	06270	TRA I25-4	GO TO I25-4	524	1579
						ROUTINE PRINT	524	1580
						HAS A ROW JUST MELTED	524	1581
06315	-0	76000	0	00144	I26 SLT 4		524	1582
06316	0	02000	0	06320	TRA I26+3		524	1583
06317	0	02000	0	06321	TRA I26+4	YES--GO TO I26+4	524	1584
06320	0	07400	4	06536	TSX SUBBB,4	NO--EXIT TO SUBBB FOR TEMP. PRINT	524	1585
06321	0	60000	0	07543	STZ T4	N COUNTER=0	524	1586
06322	0	02000	0	06230	TRA I24+13	GO TO I24+13	524	1587
						ONE ROW HAS MELTED	524	1588
06323	0	76000	0	00143	I27 SLN 3	LIGHT SL 3	524	1589
06324	0	76000	0	00144	SLN 4	LIGHT SL 4	524	1590
06325	0	07400	4	06536	TSX SUBBB,4	EXIT TO SUBBB FOR TEMP. PRINT	524	1591
06326	0	76000	0	00162	SWT 2	SHOULD WE TERMINATE PROBLEM	524	1592
06327	0	02000	0	06337	TRA I27+12	YES--GO TO I27+12	524	1593
06330	0	50000	0	07561	CLA LINE	NO--LINE=LINE+2	524	1594
06331	0	40000	0	07606	ADD C19		524	1595
06332	0	60100	0	07561	STO LINE		524	1596
06333	0	07400	4	07001	TSX SUBX,4	EXIT TO REMARK SPACE TEST	524	1597
06334	0	07400	4	07421	TSX F23,4	PRINT ONE ROW HAS MELTED	524	1598
06335	0	07536	0	07536	P3,0,P3		524	1599
06336	0	02000	0	06225	TRA I24+10	GO TO I24+10		

06337	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1600
06340	0	40000	0	07606	ADD C19		524	1601
06341	0	60100	0	07561	STO LINE		524	1602
06342	0	07400	4	06570	TSX SUBBP,4		524	1603
06343	0	07400	4	07430	TSX F24,4	PRINT TITLE AND FIRST ROW OF B	524	1604
06344	0	00000	0	00000	0,0,0		524	1605
06345	0	07400	4	06650	TSX SUBB,4	EXIT TO PRINT REMAINING COEFFICIENTS	524	1606
06346	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1607
06347	0	40000	0	07606	ADD C19		524	1608
06350	0	60100	0	07561	STO LINE		524	1609
06351	0	07400	4	07001	TSX SUBX,4	EXIT TO REMARK SPACE ROUTINE	524	1610
06352	0	50000	0	07536	CLA P3		524	1611
06353	0	60100	0	07557	STO PAGE		524	1612
06354	0	07400	4	07444	TSX F25,4	PRINT ONE ROW HAS MELTED	524	1613
06355	0	07557	0	07556	PROB,0,PAGE		524	1614
06356	0	02000	0	03304	TRA END		524	1615
						N(TAU) USED UP	524	1616
06357	0	07400	4	06536	128 TSX SUBBB,4	EXIT TO SUBBB FOR TEMP. PRINT	524	1617
06360	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1618
06361	0	40000	0	07606	ADD C19		524	1619
06362	0	60100	0	07561	STO LINE		524	1620
06363	0	07400	4	06570	TSX SUBBP,4	EXIT TO ROW OVERFLOW TEST	524	1621
06364	0	07400	4	07430	TSX F24,4	PRINT TITLE AND FIRST ROW B	524	1622
06365	0	00000	0	00000	0,0,0		524	1623
06366	0	07400	4	06650	TSX SUBB,4	EXIT TO PRINT REMAINING COEFFICIENTS	524	1624
06367	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1625
06370	0	40000	0	07606	ADD C19		524	1626
06371	0	60100	0	07561	STO LINE		524	1627
06372	0	07400	4	07001	TSX SUBX,4	EXIT TO REMARK SPACE TEST	524	1628
06373	0	07400	4	07460	TSX F26,4		524	1629
06374	0	07556	0	07556	PROB,0,PROB		524	1630
06375	0	02000	0	03304	TRA END		524	1631
						TAU=FINAL TAU	524	1632
06376	0	07400	4	06536	129 TSX SUBBB,4	EXIT TO SUBBB FOR TEMP. PRINT	524	1633
06377	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1634
06400	0	40000	0	07606	ADD C19		524	1635
06401	0	60100	0	07561	STO LINE		524	1636
06402	0	07400	4	06570	TSX SUBBP,4		524	1637
06403	0	07400	4	07430	TSX F24,4	PRINT TITLE AND FIRST ROW OF B	524	1638
06404	0	00000	0	00000	0,0,0		524	1639

06405	0	07400	4	06650	TSX SUBB,4	EXIT TO PRINT REMAINING COEFFICIENTS	524	1640
06406	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1641
06407	0	40000	0	07606	ADD C19		524	1642
06410	0	60100	0	07561	STO LINE		524	1643
06411	0	07400	4	07001	TSX SUBX,4	EXIT TO REMARK SPACE TEST	524	1644
06412	0	07400	4	07471	TSX F27,4	PRINT TAU=FINAL TAU	524	1645
06413	0	07556	0	07556	PROB,0,PROB		524	1646
06414	0	02000	0	03304	TRA END		524	1647
							524	1648
							524	1649
06415	0	50000	0	07635	I30 CLA C43	NEGATIVE COEFFICIENT COMPUTED	524	1650
06416	0	62100	0	05342	STA IC36		524	1651
06417	-0	63400	4	07636	SXD COMMON,4		524	1652
06420	0	50000	0	00151	ADJ2 CLA 105		524	1653
06421	0	24000	0	07567	FDH C2		524	1654
06422	-0	60000	0	00151	STQ 105		524	1655
06423	-0	60000	0	07647	STQ COMMON+9		524	1656
06424	0	56000	0	00155	LDQ 109		524	1657
06425	0	20000	0	07606	MPY C19		524	1658
06426	-0	60000	0	00155	STQ 109		524	1659
06427	-0	60000	0	07651	STQ COMMON+11		524	1660
06430	0	53400	1	07605	LXA C18,1		524	1661
06431	0	56000	1	03156	LDQ 1646,1		524	1662
06432	0	26000	0	07567	FMP C2		524	1663
06433	0	60100	1	03156	STO 1646,1		524	1664
06434	2	00001	1	06431	TIJ *-3,1,1		524	1665
06435	0	53400	1	07623	LXA C32,1		524	1666
06436	0	56000	1	03176	LDQ 1662,1		524	1667
06437	0	26000	0	07567	FMP C2		524	1668
06440	0	60100	1	03176	STO 1662,1		524	1669
06441	2	00001	1	06436	TIJ *-3,1,1		524	1670
06442	0	56000	0	07543	LDQ T4		524	1671
06443	0	20000	0	07606	MPY C19		524	1672
06444	-0	60000	0	07543	STQ T4		524	1673
06445	0	50000	0	00162	CLA 114		524	1674
06446	0	10000	0	06460	TZE *+10		524	1675
06447	0	56000	0	07542	LDQ T3		524	1676
06450	0	20000	0	07606	MPY C19		524	1677
06451	-0	60000	0	07542	STQ T3		524	1678
06452	0	56000	0	00156	LDQ 110		524	1679
06453	0	20000	0	07606	MPY C19		524	1679

06454 -0 60000 0 00156	STQ 110	524 1680
06455 0 56000 0 07553	LDQ T12	524 1681
06456 0 26000 0 07567	FMP C2	524 1682
06457 0 60100 0 07553	STO T12	524 1683
06460 0 60100 0 07650	STO COMMON+10	524 1684
06461 0 50000 0 07552	CLA T11	524 1685
06462 0 24000 0 07567	FDH C2	524 1686
06463 -0 60000 0 07552	STQ T11	524 1687
06464 0 50000 0 07554	CLA T13	524 1688
06465 0 24000 0 07567	FDH C2	524 1689
06466 -0 60000 0 07554	STQ T13	524 1690
06467 0 07400 4 04757	TSX IC25,4	524 1691
06470 -0 53400 4 07636	LXD COMMON,4	524 1692
06471 0 02000 0 06177	TRA I23+22	524 1693
SUB--THE TEMPERATURE PRINT SUBROUTINE		
06472 -0 63400 4 06520 SUB	SXD SUB+22,4	524 1694
06473 0 53400 1 00145	LXA 101,1	524 1695
06474 0 53400 2 07535	LXA P2,2	524 1696
06475 -0 63400 1 07535	SXD P2,1	524 1697
06476 0 53400 1 00144	LXA 100,1	524 1698
06477 0 50000 2 00000	CLA 0,2	524 1699
06500 0 60100 1 00000	STO 0,1	524 1700
06501 2 00001 2 06502	TIX SUB+8,2,1	524 1701
06502 2 00001 1 06477	TIX SUB+5,1,1	524 1702
06503 -0 53400 1 07535	LXD P2,1	524 1703
06504 0 50000 1 00000	CLA 0,1	524 1704
06505 0 60100 0 00000	STO 0	524 1705
06506 0 07400 4 07264	TSX F10,4	524 1706
06507 0 00000 0 00000	0,0,0	524 1707
06510 0 50000 0 07561	CLA LINE	524 1708
06511 0 40000 0 07564	ADD ROWQ	524 1709
06512 0 60100 0 07561	STO LINE	524 1710
06513 0 40000 0 07564	ADD ROWQ	524 1711
06514 0 40200 0 07615	SUB C26	524 1712
06515 -0 12000 0 06532	TMI SUB+32	524 1713
06516 0 10000 0 06532	TZE SUB+32	524 1714
06517 0 76000 0 00165	SWT 5	524 1715
06520 -3 00000 0 06523	TXL SUB+25,0,0	524 1716
06521 0 76600 0 00361	WPR	524 1717
06522 0 76000 0 00361	SPR 1	524 1718
		524 1719

06523	0	50000	0	07557	CLA PAGE	PAGE=PAGE+1	524	1720
06524	0	40000	0	07604	ADD C17		524	1721
06525	0	60100	0	07557	STO PAGE		524	1722
06526	0	50000	0	07604	CLA C17	LINE=1	524	1723
06527	0	60100	0	07561	STO LINE		524	1724
06530	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	1725
06531	0	07557	0	07556	PROB,0,PAGE		524	1726
06532	2	00001	1	06475	TIX SUB+3,1,1	REG.A=REG.A-1	524	1727
06533	-0	63400	0	07535	SXD P2,0		524	1728
06534	-0	53400	4	06520	LXD SUB+22,4	RETURN REG.C	524	1729
06535	0	02000	4	00001	TRA 1,4	EXIT	524	1730
						SUBBB--PREPARATION FOR, AND USE OF SUB	524	1731
06536	-0	63400	4	06546	SUBBB SXD SUBBB+8,4	SAVE REG.C	524	1732
06537	0	50000	0	07561	CLA LINE	IS THERE ROOM FOR A TITLE AND A ROW	524	1733
06540	0	40000	0	07564	ADD ROWQ		524	1734
06541	0	40000	0	07606	ADD C19		524	1735
06542	0	40200	0	07615	SUB C26		524	1736
06543	-0	12000	0	06560	TMI SUBBB+18	YES--GO TO SUBBB+18	524	1737
06544	0	10000	0	06560	TZE SUBBB+18	YES--GO TO SUBBB+18	524	1738
06545	0	76000	0	00165	SWT 5	NO--IS OUTPUT ON TAPE	524	1739
06546	-3	00000	0	06551	TXL SUBBB+11,0,0	YES--GO TO SUBBB+11	524	1740
06547	0	76600	0	00361	WPR	NO--RESTORE PRINTER	524	1741
06550	0	76000	0	00361	SPR 1		524	1742
06551	0	50000	0	07557	CLA PAGE	PAGE=PAGE+1	524	1743
06552	0	40000	0	07604	ADD C17		524	1744
06553	0	60100	0	07557	STO PAGE		524	1745
06554	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	1746
06555	0	07557	0	07556	PROB,0,PAGE		524	1747
06556	0	50000	0	07604	CLA C17	LINE=1	524	1748
06557	0	60100	0	07561	STO LINE		524	1749
06560	0	07400	4	07407	TSX F22,4	PRINT ROUTINE TEMPERATURE TITLE	524	1750
06561	0	07537	0	07536	P3,0,P4		524	1751
06562	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1752
06563	0	40000	0	07606	ADD C19		524	1753
06564	0	60100	0	07561	STO LINE		524	1754
06565	0	07400	4	06472	TSX SUB,4	EXIT TO TEMPERATURE PRINT SUBROUTINE	524	1755
06566	-0	53400	4	06546	LXD SUBBB+8,4	RETURN REG.C	524	1756
06567	0	02000	4	00001	TRA 1,4	EXIT	524	1757
						SUBBP--ROW OVERFLOW TEST SUBROUTINE	524	1758
06570	-0	63400	4	06577	SUBBP SXD SUBBP+7,4	SAVE REG.C	524	1759

06571	0	50000	0	07561	CLA LINE	WILL ROW OVERFLOW	524	1760
06572	0	40000	0	07562	ADD ROW		524	1761
06573	0	40200	0	07615	SUB C26		524	1762
06574	-0	12000	0	06613	TMI SUBBP+19	NO--GO TO SUBBP+19	524	1763
06575	0	10000	0	06613	TZE SUBBP+19	NO--GO TO SUBBP+19	524	1764
06576	0	76000	0	00165	SWT 5	YES--IS OUTPUT ON TAPE	524	1765
06577	-3	00000	0	06602	TXL SUBBP+10,0,0	YES--GO TO SUBBP+10	524	1766
06600	0	76600	0	00361	WPR	NO--RESTORE PRINTER	524	1767
06601	0	76000	0	00361	SPR 1		524	1768
06602	0	50000	0	07557	CLA PAGE	PAGE=PAGE+1	524	1769
06603	0	40000	0	07604	ADD C17		524	1770
06604	0	60100	0	07557	STO PAGE		524	1771
06605	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	1772
06606	0	07557	0	07556	PROB,0,PAGE		524	1773
06607	0	50000	0	07605	CLA C18	LINE=ROW+3	524	1774
06610	0	40000	0	07562	ADD ROW		524	1775
06611	0	60100	0	07561	STO LINE		524	1776
06612	0	02000	0	06616	TRA SUBBP+22		524	1777
06613	0	50000	0	07561	CLA LINE	LINE=LINE+ROW	524	1778
06614	0	40000	0	07562	ADD ROW		524	1779
06615	0	60100	0	07561	STO LINE		524	1780
06616	-0	53400	4	06577	LXD SUBBP+7,4	RETURN REG,4	524	1781
06617	0	02000	4	00001	TRA 1,4	EXIT	524	1782
06620	-0	63400	4	06627	SUBBQ SXD SUBBQ+7,4	SUBBQ--COLUMN OVERFLOW TEST SUBROUTINE	524	1783
06621	0	50000	0	07561	CLA LINE	SAVE REG,C	524	1784
06622	0	40000	0	07563	ADD ROWP	WILL COLUMN OVERFLOW	524	1785
06623	0	40200	0	07615	SUB C26		524	1786
06624	-0	12000	0	06643	TMI SUBBQ+19	NO--GO TO SUBBQ+19	524	1787
06625	0	10000	0	06643	TZE SUBBQ+19	NO--GO TO SUBBQ+19	524	1788
06626	0	76000	0	00165	SWT 5	YES--IS OUTPUT ON TAPE	524	1789
06627	-3	00000	0	06632	TXL SUBBQ+10,0,0	YES--GO TO SUBBQ+10	524	1790
06630	0	76600	0	00361	WPR	NO--RESTORE PRINTER	524	1791
06631	0	76000	0	00361	SPR 1		524	1792
06632	0	50000	0	07557	CLA PAGE	PAGE=PAGE+1	524	1793
06633	0	40000	0	07604	ADD C17		524	1794
06634	0	60100	0	07557	STO PAGE		524	1795
06635	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	1796
06636	0	07557	0	07556	PROB,0,PAGE		524	1797
06637	0	50000	0	07605	CLA C18	LINE=ROWP+3	524	1798
06640	0	40000	0	07563	ADD ROWP		524	1799
							524	1800

06641	0	60100	0	07561	STO	LINE		524	1801
06642	0	02000	0	06646	TRA	SUBBQ+22		524	1802
06643	0	50000	0	07561	CLA	LINE	LINE=LINE+ROWP	524	1803
06644	0	40000	0	07563	ADD	ROWP		524	1804
06645	0	60100	0	07561	STO	LINE		524	1805
06646	-0	53400	4	06627	LXD	SUBBQ+7,4	RETURN REG.C	524	1806
06647	0	02000	4	00001	TRA	1,4	EXIT	524	1807
							SUBB--COEFFICIENT PRINT SUBROUTINE	524	1808
06650	-0	63400	4	06752	SUBB	SXD SUBB+66,4	SAVE REG.C	524	1809
06651	0	53400	1	07600	LXA	C13,1	REG.A=4	524	1810
06652	0	50000	0	00145	CLA	101	REG.B=J-1	524	1811
06653	0	40200	0	07604	SUB	C17		524	1812
06654	0	73400	2	00000	PAX	0,2		524	1813
06655	-3	00000	2	06670	TXL	SUBB+16,2,0	IF J=1, GO TO SUBB+16	524	1814
06656	0	07400	4	06570	TSX	SUBBP,4	EXIT TO ROW OVERFLOW TEST	524	1815
06657	0	07400	4	07305	TSX	F13,4	PRINT REMAINING B,C,D,F	524	1816
06660	0	00000	0	00000		0,0,0		524	1817
06661	0	50000	0	06660	CLA	SUBB+8	INCREASE PRINT ADDRESSES BY I	524	1818
06662	0	40000	0	00144	ADD	100		524	1819
06663	0	76500	0	00022	LRS	18		524	1820
06664	0	40000	0	00144	ADD	100		524	1821
06665	0	76300	0	00022	LLS	18		524	1822
06666	0	60100	0	06660	STO	SUBB+8		524	1823
06667	2	00001	2	06656	TIX	SUBB+6,2,1	REG.B=REG.B-1	524	1824
06670	-3	00003	1	06706	TXL	SUBB+30,1,3		524	1825
06671	0	50000	0	06660	CLA	SUBB+8	INCREASE PRINT ADDRESSES BY I	524	1826
06672	0	40000	0	00144	ADD	100		524	1827
06673	0	76500	0	00022	LRS	18		524	1828
06674	0	40000	0	00144	ADD	100		524	1829
06675	0	76300	0	00022	LLS	18		524	1830
06676	0	60100	0	06660	STO	SUBB+8		524	1831
06677	0	50000	0	07561	CLA	LINE	LINE=LINE+1	524	1832
06700	0	40000	0	07604	ADD	C17		524	1833
06701	0	60100	0	07561	STO	LINE		524	1834
06702	0	07400	4	06570	TSX	SUBBP,4	EXIT TO ROW OVERFLOW TEST	524	1835
06703	0	07400	4	07312	TSX	F14,4	PRINT TITLE AND FIRST ROW OF C	524	1836
06704	0	00000	0	00000		0,0,0		524	1837
06705	2	00001	1	06652	TIX	SUBB+2,1,1	REG.A=REG.A-I	524	1838
06706	-3	00002	1	06724	TXL	SUBB+44,1,2		524	1839
06707	0	50000	0	06660	CLA	SUBB+8	INCREASE PRINT ADDRESSES BY I	524	1840

06710	0	40000	0	00144	ADD 100		524	1841
06711	0	76500	0	00022	LRS 18		524	1842
06712	0	40000	0	00144	ADD 100		524	1843
06713	0	76300	0	00022	LLS 18		524	1844
06714	0	60100	0	06660	STO SUBB+8		524	1845
06715	0	50000	0	07561	CLA LINE	LINE=LINE+1	524	1846
06716	0	40000	0	07604	ADD C17		524	1847
06717	0	60100	0	07561	STO LINE		524	1848
06720	0	07400	4	06570	TSX SUBBP,4	EXIT TO ROW OVERFLOW TEST	524	1849
06721	0	07400	4	07322	TSX F15,4	PRINT TITLE AND FIRST ROW OF D	524	1850
06722	0	00000	0	00000	0,0,0		524	1851
06723	2	00001	1	06652	TIX SUBB+2,1,1	REG.A=REG.A-1	524	1852
06724	-3	00001	1	06753	TXL SUBB+67,1,1		524	1853
06725	0	50000	0	06660	CLA SUBB+8	INCREASE PRINT ADDRESSES BY I+J	524	1854
06726	0	40000	0	00144	ADD 100		524	1855
06727	0	40000	0	00145	ADD 101		524	1856
06730	0	76500	0	00022	LRS 18		524	1857
06731	0	40000	0	00144	ADD 100		524	1858
06732	0	40000	0	00145	ADD 101		524	1859
06733	0	76300	0	00022	LLS 18		524	1860
06734	0	60100	0	06660	STO SUBB+8		524	1861
06735	0	50000	0	07561	CLA LINE	LINE=LINE+1	524	1862
06736	0	40000	0	07604	ADD C17		524	1863
06737	0	60100	0	07561	STO LINE		524	1864
06740	0	07400	4	06620	TSX SUBBQ,4	EXIT TO COLUMN OVERFLOW TEST	524	1865
06741	0	07400	4	07332	TSX F16,4	PRINT E	524	1866
06742	0	00000	0	00000	0,0,0		524	1867
06743	2	00001	1	06744	TIX SUBB+60,1,1	REG.A=REG.A-1	524	1868
06744	0	50000	0	07561	CLA LINE	LINE=LINE+1	524	1869
06745	0	40000	0	07604	ADD C17		524	1870
06746	0	60100	0	07561	STO LINE		524	1871
06747	0	07400	4	06570	TSX SUBBP,4	EXIT TO ROW OVERFLOW TEST	524	1872
06750	0	07400	4	07342	TSX F17,4	PRINT TITLE AND FIRST ROW OF F	524	1873
06751	0	00000	0	00000	0,0,0		524	1874
06752	-3	00000	0	06652	TXL SUBB+2,0,0	GO TO SUBB+2	524	1875
06753	0	50000	0	07561	CLA LINE	LINE=LINE+1	524	1876
06754	0	40000	0	07604	ADD C17		524	1877
06755	0	60100	0	07561	STO LINE		524	1878
06756	0	07400	4	06620	TSX SUBBQ,4	EXIT TO COLUMN OVERFLOW TEST	524	1879
06757	0	07400	4	07352	TSX F18,4	PRINT G	524	1880

06760	0	00000	0	00000	0,0,0		524	1881
06761	0	50000	0	07561	CLA LINE	LINE=LINE+1	524	1882
06762	0	40000	0	07604	ADD C17		524	1883
06763	0	60100	0	07561	STO LINE		524	1884
06764	0	07400	4	06620	TSX SUBBQ,4	EXIT TO COLUMN OVERFLOW TEST	524	1885
06765	0	07400	4	07362	TSX F19,4	PRINT 1-G-H	524	1886
06766	0	00000	0	00000	0,0,0		524	1887
06767	0	50000	0	07561	CLA LINE	LINE=LINE+2	524	1888
06770	0	40000	0	07606	ADD C19		524	1889
06771	0	60100	0	07561	STO LINE		524	1890
06772	0	07400	4	07001	TSX SUBX,4	EXIT TO REMARK SPACE TEST	524	1891
06773	0	07400	4	07372	TSX F20,4	PRINT H	524	1892
06774	0	03262	0	03262	1714,0,1714		524	1893
06775	-0	53400	4	06752	LXD SUBB+66,4	RETURN REG.C	524	1894
06776	0	50000	0	07555	CLA T14		524	1895
06777	0	60100	0	06660	STO SUBB+8		524	1896
07000	0	02000	4	00001	TRA 1,4		524	1897
07001	-0	63400	4	07007	SUBX SXD SUBX+6,4	FINAL REMARK SPACE TEST SUBROUTINE	524	1898
07002	0	50000	0	07561	CLA LINE	SAVE REG.C	524	1899
07003	0	40200	0	07615	SUB C26	IS THERE ROOM FOR PRINTING	524	1900
07004	-0	12000	0	07016	TMI SUBX+13	YES	524	1901
07005	0	10000	0	07016	TZE SUBX+13	YES	524	1902
07006	0	76000	0	00165	SWT 5	NO--IS OUTPUT ON TAPE	524	1903
07007	-3	00000	0	07012	TXL SUBX+9,0,0	NO	524	1904
07010	0	76600	0	00361	WPR	YES--RESTORE PRINTER	524	1905
07011	0	76000	0	00361	SPR 1		524	1906
07012	0	02000	0	10034	TRA GOOF+16		524	1907
07013	0	60100	0	07561	STO LINE		524	1908
07014	0	07400	4	07020	TSX F0,4	PRINT TITLE	524	1909
07015	0	07557	0	07556	PROB,0,PAGE		524	1910
07016	-0	53400	4	07007	LXD SUBX+6,4	RETURN REG.C	524	1911
07017	0	02000	4	00001	TRA 1,4	EXIT	524	1912
						OUTPUT FORMATS	524	1913
07020	0	02000	0	01725	F0 TRA OUT1		524	1914
07021	021130605125				BCD 29H RE-147	CYCLOPS	524	1915
07022	400104076060					PROBLEM NO.F9.5,79H	524	1916
07023	237023434647							
07024	626060475146							
07025	224325446045							

07026 463326113305
 07027 730711306060
 07030 606060606060
 07031 606060606060
 07032 606060606060
 07033 606060606060
 07034 606060606060
 07035 606060606060
 07036 606060606060
 07037 606060606060
 07040 606060606060
 07041 606060606060
 07042 606060606060
 07043 606060606060
 07044 472127256031
 07045 036060606060
 07046 0 02000 0 01725 F1
 07047 616106306031
 07050 454764636161
 07051 010430606027
 07052 254525512143
 07053 602421632161
 07054 053060606031
 07055 133103730103
 07056 306060606060
 07057 606060606060
 07060 411331037301
 07061 003060606060
 07062 605174223413
 07063 260103330573
 07064 010330606060
 07065 606060606051
 07066 740034132610
 07067 330573010330
 07070 606060606060
 07071 606051746234
 07072 132601053305
 07073 610103306060
 07074 602425436321
 07075 606321641326

BCD

PAGE 1524 1917

BCD 13

524 1918

TRA OUT1

524 1919

BCD //6H INPUT//14H GENERAL DATA/5H I=13,13H

J=13,1524 1920

BCD 0H

R(B)=F13.5,13H

R(O)=F8.5,13H

R(S)=F15.5524 1921

BCD /13H

DELTA TAU=F11.8,15H

DELTA Z= F8.5,10H

V=E524 1922

07076	010133107301						
07077	053060606060						
07100	602425436321						
07101	607113606026						
07102	103305730100						
07103	306060606060						
07104	606060651325						
07105	010133057301	BCD	11.5,19H	PSI(0,TAU)=F9.3//20H	PROBLEM PARAMETERS/5H	524	1923
07106	113060606060						
07107	606060604762						
07110	317400736321						
07111	643413261133						
07112	036161020030						
07113	606047514622						
07114	432544604721						
07115	512144256325						
07116	516261053060						
07117	606045133103	BCD	N=I3,7H	BETA=0PE11.4,13H	FINAL TAU=F8.4,10H	P=I1524	1924
07120	730730606022						
07121	256321130047						
07122	250101330473						
07123	010330606060						
07124	263145214360						
07125	632164132610						
07126	330473010030						
07127	606060606060						
07130	606047133101						
07131	731130606060	BCD	9,9H	T=I1,11H	NT=I3,13H	W=I1	524 1925
07132	606060606313						
07133	310173010130						
07134	606060606060						
07135	606045631331						
07136	037301033060						
07137	606060606060						
07140	606060606613						
07141	310160606060						
07142	0 02000 0 01725	F2	TRA OUT1				524 1926
07143	610201306060		BCD /21H	MATERIAL PROPERTIES/87H	K(F)	K(B)	524 1927
07144	442163255131						
07145	214360475146						

07146	472551633125						
07147	626110073060						
07150	606060606042						
07151	742634606060						
07152	606060606060						
07153	427422346060						
07154	606060606060						
07155	604274623460	BCD	K(S)	RHO*(F)	RHO*(B)	RHO*(S)	H/(1H524 1928
07156	606060606060						
07157	605130465423						
07160	742634606060						
07161	606051304654						
07162	237422346060						
07163	606060513046						
07164	542374623460						
07165	606060606060						
07166	603061740130						
07167	600147072501	BCD	2.1P7E13.5)				524 1929
07170	033305346060						
07171	0 02000 0 01725	F3	TRA OUT1				524 1930
07172	610606306060		BCD /66H	TT(F)	TT(B)	TT(S)	DELTA TT(F) D524 1931
07173	606060606363						
07174	742634606060						
07175	606060606063						
07176	637422346060						
07177	606060606060						
07200	636374623460						
07201	606060602425						
07202	436321606363						
07203	742634606024						
07204	254363216063		BCD 4ELTA TT(B)/(1H 5F13.3)				524 1932
07205	637422346174						
07206	013060052601						
07207	033303346060						
07210	0 02000 0 01725	F4	TRA OUT1				524 1933
07211	610203306060		BCD 7/23H	N(TAU)	(READ ACROSS)/(1H 1P8E13.5)		524 1934
07212	457463216434						
07213	606074512521						
07214	246021235146						
07215	626234617401						

07216	306001471025			
07217	010333053460			
07220	0 02000 0 01725	F5	TRA OUT1	524 1935
07221	610730606050		BCD 3/7H Q(0)=1PE12.5	524 1936
07222	740034130147			
07223	250102330560			
07224	0 02000 0 01725	F6	TRA OUT1	524 1937
07225	610200306060		BCD 7/20H MU (READ ACROSS)/(1H 10F10.6)	524 1938
07226	446460606074			
07227	512521246021			
07230	235146626234			
07231	617401306001			
07232	002601003306			
07233	346060606060			
07234	0 02000 0 01725	F7	TRA OUT1	524 1939
07235	610200306060		BCD 7/20H ZETA (READ ACROSS)/(1H 10F10.6)	524 1940
07236	712563216074			
07237	512521246021			
07240	235146626234			
07241	617401306001			
07242	002601003306			
07243	346060606060			
07244	0 02000 0 01725	F8	TRA OUT1	524 1941
07245	740147112501		BCD 2(1P9E13.5)	524 1942
07246	033305346060			
07247	0 02000 0 01725	F9	TRA OUT1	524 1943
07250	616107306046		BCD //7H OUTPUT//22H TEMPERATURES AT TAU=F9.5,20H	ITERATIO524 1944
07251	646347646361			
07252	610202306060			
07253	632544472551			
07254	216364512562			
07255	602163606321			
07256	641326113305			
07257	730200306060			
07260	606060603163			
07261	255121633146			
07262	456045463360		BCD 2N NO. I6	524 1945
07263	310660606060			
07264	0 02000 0 01725	F10	TRA OUT1	524 1946
07265	013060261133		BCD 31H F9.3,11F10.3	524 1947

07266	037301012601						
07267	003303606060						
07270	0 02000 0 01725	F12	TRA OUT1				524 1948
07271	616102023060		BCD //22H	INITIAL COEFFICIENTS/9H	B	10E11.4/(9H	1524 1949
07272	603145316331						
07273	214360234625						
07274	262631233125						
07275	456362611130						
07276	606060226060						
07277	606060010025						
07300	010133046174						
07301	113060606060						
07302	606060606001						
07303	002501013304		BCD 20E11.4)				524 1950
07304	346060606060						
07305	0 02000 0 01725	F13	TRA OUT1				524 1951
07306	113060606060		BCD 49H	10E11.4			524 1952
07307	606060606001						
07310	002501013304						
07311	606060606060						
07312	0 02000 0 01725	F14	TRA OUT1				524 1953
07313	611130606060		BCD 7/9H	C	10E11.4/(9H	10E11.4)	524 1954
07314	236060606060						
07315	010025010133						
07316	046174113060						
07317	606060606060						
07320	606001002501						
07321	013304346060						
07322	0 02000 0 01725	F15	TRA OUT1				524 1955
07323	611130606060		BCD 7/9H	D	10E11.4/(9H	10E11.4)	524 1956
07324	246060606060						
07325	010025010133						
07326	046174113060						
07327	606060606060						
07330	606001002501						
07331	013304346060						
07332	0 02000 0 01725	F16	TRA OUT1				524 1957
07333	611130606060		BCD 7/9H	E	10E11.4/(9H	10E11.4)	524 1958
07334	256060606060						
07335	010025010133						

07336	046174113060						
07337	606060606060						
07340	606001002501						
07341	013304346060						
07342	0 02000 0 01725	F17	TRA OUT1				524 1959
07343	611130606060		BCD 7/9H	F	10E11.4/(9H	10E11.4)	524 1960
07344	266060606060						
07345	010025010133						
07346	046174113060						
07347	606060606060						
07350	606001002501						
07351	013304346060						
07352	0 02000 0 01725	F18	TRA OUT1				524 1961
07353	611130606060		BCD 7/9H	G	10E11.4/(9H	10E11.4)	524 1962
07354	276060606060						
07355	010025010133						
07356	046174113060						
07357	606060606060						
07360	606001002501						
07361	013304346060						
07362	0 02000 0 01725	F19	TRA OUT1				524 1963
07363	611130606060		BCD 7/9H	1-G-H	10E11.4/(9H	10E11.4)	524 1964
07364	014027403060						
07365	010025010133						
07366	046174113060						
07367	606060606060						
07370	606001002501						
07371	013304346060						
07372	0 02000 0 01725	F20	TRA OUT1				524 1965
07373	611130606060		BCD 3/9H	H	E11.4		524 1966
07374	306060606060						
07375	250101330460						
07376	0 02000 0 01725	F21	TRA OUT1				524 1967
07377	610102306060		BCD 8/12H	DELTA TAU=F11.8,8H	BETA=E11.4,5H	N=I4	524 1968
07400	242543632160						
07401	632164132601						
07402	013310731030						
07403	606060222563						
07404	211325010133						
07405	047305306060						

07406	604513310460						
07407	0 02000 0 01725	F22	TRA OUT1				524 1969
07410	610202306060		BCD 9/22H	TEMPERATURES AT TAU=F9.5,17H	ITERATION NO. 16		524 1970
07411	632544472551						
07412	216364512562						
07413	602163606321						
07414	641326113305						
07415	730107306060						
07416	603163255121						
07417	633146456045						
07420	463360310660						
07421	0 02000 0 01725	F23	TRA OUT1				524 1971
07422	610207306060		BCD 6/27H	ONE ROW HAS MELTED. TAU=F9.5			524 1972
07423	464525605146						
07424	666030216260						
07425	442543632524						
07426	336060632164						
07427	132611330560						
07430	0 02000 0 01725	F24	TRA OUT1				524 1973
07431	610200306060		BCD /20H	FINAL COEFFICIENTS/9H B	10E11.4/(9H		10E1524 1974
07432	263145214360						
07433	234625262631						
07434	233125456362						
07435	611130606060						
07436	226060606060						
07437	010025010133						
07440	046174113060						
07441	606060606060						
07442	606001002501						
07443	013304346060		BCD 11.4)				524 1975
07444	0 02000 0 01725	F25	TRA OUT1				524 1976
07445	610401306060		BCD /41H	ONE ROW HAS MELTED. END OF PROBLEM NO.F9.5,7H. TAU=F524			1977
07446	464525605146						
07447	666030216260						
07450	442543632524						
07451	336060254524						
07452	604626604751						
07453	462243254460						
07454	454633261133						
07455	057307303360						

07456	606321641326			
07457	113305606060		BCD 19.5	524 1978
07460	0 02000 0 01725	F26	TRA OUT1	524 1979
07461	610307306060		BCD 8/37H N(TAU) USED UP. END OF PROBLEM NO.F9.5	524 1980
07462	457463216434			
07463	606462252460			
07464	644733606025			
07465	452460462660			
07466	475146224325			
07467	446045463326			
07470	113305606060			
07471	0 02000 0 01725	F27	TRA OUT1	524 1981
07472	610306306060		BCD 8/36H TAU=FINAL TAU. END OF PROBLEM NO.F9.5	524 1982
07473	632164132631			
07474	452143606321			
07475	643360602545			
07476	246046266047			
07477	514622432544			
07500	604546332611			
07501	330560606060			
07502	0 02000 0 01725	F28	TRA OUT1	524 1983
07503	610701306060		BCD /71H LOG. OF A NO. LESS THAN OR EQUAL TO ZERO DESIRED.	END 524 1984
07504	434627336046			
07505	266021604546			
07506	336043256262			
07507	606330214560			
07510	465160255064			
07511	214360634660			
07512	712551466024			
07513	256231512524			
07514	336060254524			
07515	604626604751		BCD 4 OF PROBLEM NO.F9.5	524 1985
07516	462243254460			
07517	454633261133			
07520	056060606060			
07521	0 02000 0 01725	F29	TRA OUT1	524 1986
07522	610407306060		BCD /47H EXPONENTIAL OUT OF RANGE. END OF PROBLEM NO.F9.5	524 1987
07523	256747464525			
07524	456331214360			
07525	466463604626			

07526	605121452725					
07527	336060254524					
07530	604626604751					
07531	462243254460					
07532	454633261133					
07533	056060606060					
07534	+000000000000	P1	DEC 0	FLOATING I		524 1988
07535	+000000000000	P2	DEC 0	IXJ		524 1989
07536	+000000000000	P3	DEC 0	TAU		524 1990
07537	+000000000000	P4	DEC 0	ITERATION NO.		524 1991
07540	+000000000000	T1	DEC 0	CURRENT N(TAU)		524 1992
07541	+000000000000	T2	DEC 0	NT COUNTER		524 1993
07542	+000000000000	T3	DEC 0	BETA COUNTER		524 1994
07543	+000000000000	T4	DEC 0	N COUNTER		524 1995
07544	+000000000000	T5	DEC 0	TEMPORARY		524 1996
07545	+000000000000	T6	DEC 0	TEMPORARY		524 1997
07546	+000000000000	T7	DEC 0	SAVE REG.C		524 1998
07547	+000000000000	T8	DEC 0	OLD B(I-1,J)		524 1999
07550	+000000000000	T9	DEC 0	SAVE REG.B		524 2000
07551	+000000000000	T10	DEC 0	OLD C(I-1,J)		524 2001
07552	+000000000000	T11	DEC 0	CURRENT DELTA N(TAU)		524 2002
07553	+000000000000	T12	DEC 0	FLOATING BETA		524 2003
07554	+000000000000	T13	DEC 0	.5 DELTA TAU		524 2004
07555	+000000000000	T14	DEC 0	32767-4J-6IJ,0,32766+I-4J-6IJ		524 2005
07556	+000000000000	PROB	DEC 0	PROB. NO.		524 2006
07557	+000000000000	PAGE	DEC 0	PAGE NO.		524 2007
07560	+000000000000	ZERO	DEC 0	ZERO		524 2008
07561	+000000000000	LINE	DEC 0	LINE NO.		524 2009
07562	+000000000000	ROW	DEC 0	(I+9)/10		524 2010
07563	+000000000000	ROWP	DEC 0	(J+9)/10		524 2011
07564	+000000000000	ROWQ	DEC 0	(I+12)/10		524 2012
				PROGRAM CONSTANTS		524 2013
07565	+233000000000	C0	OCT 233000000000			524 2014
07566	+201400000000	C1	DEC 1.			524 2015
07567	+202400000000	C2	DEC 2.			524 2016
07570	+202600000000	C3	DEC 3.			524 2017
07571	+203400000000	C4	DEC 4.			524 2018
07572	+000000000240	C5	DEC 160			524 2019
07573	+201600000000	C8	DEC 1.5			524 2020
07574	+202500000000	C9	DEC 2.5			524 2021

07575 +2027000000000	C10	DEC 3.5	524	2022
07576 +2004000000000	C11	DEC .5	524	2023
07577 +000000077777	C12	DEC 32767	524	2024
07600 +0000000000004	C13	DEC 4	524	2025
07601 +0000000000020	C14	DEC 16	524	2026
07602 +2054000000000	C15	DEC 16.	524	2027
07603 +2044000000000	C16	DEC 8.	524	2028
07604 +0000000000001	C17	DEC 1	524	2029
07605 +0000000000003	C18	DEC 3	524	2030
07606 +0000000000002	C19	DEC 2	524	2031
07607 0 42006 0 00000	C20	HPR 0,0,6	524	2032
07610 +0000000000011	C21	DEC 9	524	2033
07611 +0000000000012	C22	DEC 10	524	2034
07612 +0000000000007	C23	DEC 7	524	2035
07613 +0000000000010	C24	DEC 8	524	2036
07614 +0000000000035	C25	DEC 29	524	2037
07615 +0000000000073	C26	DEC 59	524	2038
07616 +370601137164	C27	DEC 1E36	524	2039
07617 +0000000000034	C28	DEC 28	524	2040
07620 +0000000000017	C29	DEC 15	524	2041
07621 +0000000000236	C30	DEC 158	524	2042
07622 +000000570000	C31	OCT 000000570000	524	2043
07623 +0000000000014	C32	DEC 12	524	2044
07624 +0000000000005	C33	DEC 5	524	2045
07625 +0000200000000	C34	OCT 000020000000	524	2046
07626 +0000000000113	C35	DEC 75	524	2047
07627 +0000000000067	C37	DEC 55	524	2048
07630 +0000000000074	C38	DEC 60	524	2049
07631 +0000000000006	C39	DEC 6	524	2050
07632 0 02000 0 01755	C40	TRA BLK5+2	524	2051
07633 +0007777777777	C41	OCT 000777777777	524	2052
07634 0 02000 0 04724	C42	TRA ADJ1	524	2053
07635 0 02000 0 06420	C43	TRA ADJ2	524	2054
07636 COMMON	BSS	28	524	2055
			524	2056
07672 0 60100 0 07641	EXP	STO COMMON+3	EXP	0001
07673 -0 32000 0 10001		ANA EXP+71	EXP	0002
07674 0 30000 0 07641		FAD COMMON+3	EXP	0003
07675 0 60100 0 07636		STO COMMON	EXP	0004
07676 -0 63400 2 07637		SXD COMMON+1,2	EXP	0005

GE EXP SUBROUTINE

NORMALIZED X IN ACC
STORE X
SAVE INDEX 2

07677 -0 63400 1 07640	SXD COMMON+2,1	SAVE INDEX 1	EXP 0006
	TEST X EQ TO OR GR THAN 1		EXP 0007
07700 0 56000 0 10002	LDQ EXP+72	1-2 -27 INTO QR	EXP 0008
07701 0 76300 0 00000	LLS 0	MAKE X +	EXP 0009
07702 0 04000 0 07764	TLQ EXP+58	JUMP IF ABS X NOT LESS THAN 1	EXP 0010
07703 0 53400 1 10001	LXA EXP+71,1	0 INTO INDEX 1	EXP 0011
	FIND NO TERMS FOR SERIES		EXP 0012
07704 0 60100 0 07641	STO COMMON+3	STORE ABS X	EXP 0013
07705 0 56000 0 10003	LDQ EXP+73	6.188 INTO QR	EXP 0014
07706 0 26000 0 07641	FMP COMMON+3	6.188 ABS X	EXP 0015
07707 0 30000 0 10004	FAD EXP+74	6.188 ABS X + 5.35	EXP 0016
07710 -0 30000 0 10005	UFA EXP+75	ACC + 0X2 4	EXP 0017
07711 0 76700 0 00010	ALS 8		EXP 0018
07712 0 76500 0 00037	LRS 31		EXP 0019
07713 0 76000 0 00010	RND		EXP 0020
07714 0 73400 2 00000	PAX 0,2	NO TERMS INTO INDEX 2	EXP 0021
	INITIALIZATION FOR SERIES		EXP 0022
07715 0 50000 0 10006	CLA EXP+76		EXP 0023
07716 0 60100 0 07642	STO COMMON+4	1 INTO N	EXP 0024
07717 0 60100 0 07643	STO COMMON+5	1 INTO DEN	EXP 0025
07720 2 00001 2 07721	TIX EXP+23,2,1	NO. TERMS -1 INTO INDEX 2	EXP 0026
07721 0 50200 0 07641	CLS COMMON+3		EXP 0027
07722 0 60100 0 07641	STO COMMON+3	-ABS X	EXP 0028
07723 0 60100 0 07644	STO COMMON+6	-ABS X INTO NUM	EXP 0029
07724 0 30000 0 10006	FAD EXP+76	-ABS X +1	EXP 0030
07725 0 60100 0 07645	STO COMMON+7	ACC INTO EXPL	EXP 0031
	SERIES LOOP		EXP 0032
07726 0 50000 0 07642	CLA COMMON+4		EXP 0033
07727 0 30000 0 10006	FAD EXP+76		EXP 0034
07730 0 60100 0 07642	STO COMMON+4	N+1 INTO N	EXP 0035
07731 0 56000 0 07643	LDQ COMMON+5		EXP 0036
07732 0 26000 0 07642	FMP COMMON+4		EXP 0037
07733 0 60100 0 07643	STO COMMON+5	N TIMES DEN INTO DEN	EXP 0038
07734 0 56000 0 07641	LDQ COMMON+3		EXP 0039
07735 0 26000 0 07644	FMP COMMON+6		EXP 0040
07736 0 60100 0 07644	STO COMMON+6	-ABS X TIMES NUM INTO NUM	EXP 0041
07737 0 24000 0 07643	FDH COMMON+5	NUM/DEN	EXP 0042
07740 0 76000 0 00000	CLM		EXP 0043
07741 0 76300 0 00043	LLS 35		EXP 0044
07742 0 30000 0 07645	FAD COMMON+7	ACC + EXPL	EXP 0045

07743	0	60100	0	07645	STO COMMON+7	INTO EXPL	EXP 0046
07744	2	00001	2	07726	TIX EXP+28,2,1		EXP 0047
					RECIPROCATATE EXPL IF X +		EXP 0048
07745	0	50000	0	07636	CLA COMMON	X	EXP 0049
07746	-0	12000	0	07752	TMI EXP+48	JUMP IF X-	EXP 0050
07747	0	50000	0	10006	CLA EXP+76		EXP 0051
07750	0	24000	0	07645	FDH COMMON+7	1/EXPL	EXP 0052
07751	-0	60000	0	07645	STQ COMMON+7	INTO EXPL	EXP 0053
					TEST INDEX 1, OUT IF ZERO		EXP 0054
07752	2	00000	1	07757	TIX EXP+53,1,0	JUMP TO SQ. ANS. IF IND. 1 NOT EQ. 0	EXP 0055
07753	0	50000	0	07645	CLA COMMON+7	EXP X INTO ACC	EXP 0056
07754	-0	53400	2	07637	LXD COMMON+1,2	RESTORE IND 2	EXP 0057
07755	-0	53400	1	07640	LXD COMMON+2,1	RESTORE IND. 1	EXP 0058
07756	0	02000	4	00002	TRA 2,4	OUT	EXP 0059
					ABS X WAS GR THAN OR EQ TO 1, FIX ANS		EXP 0060
07757	0	56000	0	07645	LDQ COMMON+7	EXPL	EXP 0061
07760	0	26000	0	07645	FMP COMMON+7	EXPL 2	EXP 0062
07761	0	60100	0	07645	STO COMMON+7	INTO EXPL	EXP 0063
07762	2	00001	1	07757	TIX EXP+53,1,1		EXP 0064
07763	0	02000	0	07754	TRA EXP+50	TO RESTORE AND OUT	EXP 0065
					TEST X GR THAN 88		EXP 0066
07764	0	56000	0	10007	LDQ EXP+77	88 INTO QR	EXP 0067
07765	0	04000	0	07775	TLQ EXP+67	JUMP IF ABS X GR THAN 88	EXP 0068
07766	0	60100	0	07641	STO COMMON+3	STORE ABS X	EXP 0069
07767	-0	32000	0	10010	ANA EXP+78	LEAVE EXP -128 IN ACC	EXP 0070
07770	0	77100	0	00033	ARS 27		EXP 0071
07771	0	73400	1	00000	PAX 0,1	EXP-128 INTO IND1 FOR FIXING ANS	EXP 0072
07772	0	50000	0	07641	CLA COMMON+3		EXP 0073
07773	-0	32000	0	10002	ANA EXP+72	LEAVE NO WITH EXP OF 128 IN ACC	EXP 0074
07774	0	02000	0	07704	TRA EXP+10	TO FIND NO TERMS	EXP 0075
					ERROR, EXPL TOO BIG FOR WORD SIZE		EXP 0076
07775	-0	53400	2	07637	LXD COMMON+1,2	RESTORE REGISTERS	EXP 0077
07776	-0	53400	1	07640	LXD COMMON+2,1		EXP 0078
07777	0	50000	0	07641	CLA COMMON+3	X INTO ACC	EXP 0079
10000	0	02000	4	00001	TRA 1,4	OUT TO ERROR RETURN	EXP 0080
					CONSTANTS		EXP 0081
10001	-3770000000000				OCT -3770000000000	MASK FOR X NORMALIZING	EXP 0082
10002	+200777777777				OCT +200777777777	1-2-27, MASK FOR ABS X	EXP 0083
10003	+203614020305				OCT +203614020305	6.188	EXP 0084
10004	+203526314632				OCT +203526314632	5.35	EXP 0085

10005	+204000000000		OCT	+204000000000	OX2 4		EXP	0086
10006	+201400000000		OCT	+201400000000	1		EXP	0087
10007	+207540000000		OCT	+207540000000	88		EXP	0088
10010	-177000000000		OCT	-177000000000	MASK FOR EXPONENT		EXP	0089
10011	0 07400 4 07521	EXPE	TSX	F29,4			524	2057
10012	0 07556 0 07556			PROB,0,PROB			524	2058
10013	0 02000 0 03304		TRA	END			524	2059
	03062		ORG	1586			524	2060
03062	0 10000 4 00001	LN	TZE	1,4	GE LN SUBROUTINE		524	2061
03063	-0 12000 4 00001		TMI	1,4	TO ERROR RETURN		LN	00001
03064	0 60100 0 07637		STO	COMMON+1	TO ERROR RETURN		LN	00002
03065	-0 32000 0 03127		ANA	LN+37			LN	00003
03066	0 30000 0 07637		FAD	COMMON+1	NORMALIZED X IN ACC		LN	00004
03067	0 76500 0 00033		LRS	27			LN	00005
03070	0 76700 0 00023		ALS	19			LN	00006
03071	-0 60000 0 07637		STQ	COMMON+1	FRACTION INTO F		LN	00007
03072	0 40200 0 03124		SUB	LN+34	EXP-128 EQUALS E		LN	00008
03073	0 36100 0 03123		ACL	LN+33			LN	00009
03074	0 30000 0 03123		FAD	LN+33	FLOAT + NORMALIZE E		LN	00010
03075	0 76500 0 00043		LRS	35	E INTO QR		LN	00011
03076	0 26000 0 03125		FMP	LN+35			LN	00012
03077	0 60100 0 07636		STO	COMMON	E LN 2 INTO E		LN	00013
03100	0 50000 0 07637		CLA	COMMON+1			LN	00014
03101	0 77100 0 00010		ARS	8			LN	00015
03102	0 36100 0 03122		ACL	LN+32			LN	00016
03103	0 30200 0 03136		FSB	LN+44			LN	00017
03104	0 60100 0 07637		STO	COMMON+1	F-0.725 INTO F		LN	00018
03105	-0 63400 2 07641		SXD	COMMON+3,2	SAVE CONTENTS INDEX 2		LN	00019
03106	0 53400 2 03101		LXA	LN+15,2	8 INTO INDEX 2		LN	00020
03107	0 50000 0 03126		CLA	LN+36			LN	00021
03110	0 60100 0 07640		STO	COMMON+2	0.5 INTO N		LN	00022
03111	0 50000 0 07637		CLA	COMMON+1			LN	00023
03112	0 24000 0 07640		FDH	COMMON+2			LN	00024
03113	0 76000 0 00000		CLM				LN	00025
03114	0 76300 0 00043		LLS	35	F/N INTO ACC		LN	00026
03115	0 30000 2 03140		FAD	LN+46,2	CONTENTS ACC + TABLE VAL		LN	00027
03116	2 00001 2 03110		TIX	LN+22,2,1			LN	00028
03117	0 30000 0 07636		FAD	COMMON	LN X IN ACC		LN	00029
03120	-0 53400 2 07641		LXD	COMMON+3,2	RESTORE CONTENTS INDEX 2		LN	00030
								00031

03121	0 02000 4 00002	TRA 2,4	EXIT	LN 00032
03122	+2000000000000	OCT +2000000000000	0 X 2 0	LN 00033
03123	+2100000000000	OCT +2100000000000	0 X 2 8	LN 00034
03124	+0004000000000	OCT +0004000000000	128 FOR E	LN 00035
03125	+200542710277	OCT +200542710277	LN 2	LN 00036
03126	+2004000000000	OCT +2004000000000	0.5	LN 00037
03127	-3770000000000	OCT -3770000000000	MASK FOR NORMALIZING	LN 00038
03130	+203504631463	OCT +203504631463	5.075	LN 00039
03131	+200525252525	OCT +200525252525	2/3	LN 00040
03132	+2027200000000	OCT +2027200000000	3.625	LN 00041
03133	+2014000000000	OCT +2014000000000	1	LN 00042
03134	+202426314632	OCT +202426314632	2.175	LN 00043
03135	+2024000000000	OCT +2024000000000	2	LN 00044
03136	+200563146315	OCT +200563146315	0.725	LN 00045
03137	-177511232337	OCT -177511232337	LN 0.725	LN 00046
03140	0 07400 4 07502	LNE TSX F28,4	PRINT UNDEFINED LOG. DESIRED	524 2062
03141	0 07556 0 07556	PROB,0,PROB		524 2063
03142	0 02000 0 03304	TRA END		524 2064
	10014	ORG 4108		524 2065
10014	0 62100 0 05564	GOOF STA I8+2		524 2066
10015	0 62100 0 10020	STA GOOF+4		524 2067
10016	0 02000 0 03757	TRA S1-23		524 2068
10017	0 53400 4 07535	LXA P2,4	CLEAR T PRIME (I,J)	524 2069
10020	0 60000 4 00000	STZ 0,4		524 2070
10021	2 00001 4 10020	TIX *-1,4,1		524 2071
10022	0 02000 0 04131	TRA IQ		524 2072
10023	0 60100 0 07557	STO PAGE		524 2073
10024	0 50000 0 07604	CLA C17		524 2074
10025	0 60100 0 07561	STO LINE		524 2075
10026	0 02000 0 05366	TRA IC39+11		524 2076
10027	0 50000 0 07561	CLA LINE		524 2077
10030	0 40000 0 07606	ADD C19		524 2078
10031	0 60100 0 07561	STO LINE		524 2079
10032	-0 53400 1 07637	LXD COMMON+1,1		524 2080
10033	0 02000 0 05373	TRA IC39+16		524 2081
10034	0 50000 0 07557	CLA PAGE		524 2082
10035	0 40000 0 07604	ADD C17		524 2083
10036	0 60100 0 07557	STO PAGE		524 2084
10037	0 50000 0 07605	CLA C18		524 2085
10040	0 02000 0 07013	TRA SUBX+10		524 2086

10041 -0 76000 0 00144
10042 0 02000 0 05444
10043 0 02000 0 05444
10044 0 40000 0 07606
10045 0 40200 0 07615
10046 0 02000 0 05355
 05566
 03270

I12

SLT 4
TRA I1
TRA I1
ADD C19
SUB C26
TRA IC39+2
SYN I9
END BEGIN

524 2087
524 2088
524 2089
524 2090
524 2091
524 2092
524 2093
524 2094

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