NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Report 32-1416

Thermal Analysis System I: User's Manual

J. A. Hultberg

P. F. O'Brien

JET PROPULSION LABORATORY

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

March 1, 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Report 32-1416

Thermal Analysis System I: User's Manual

J. A. Hultberg
P. F. O'Brien

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

March 1, 1971

Prepared Under Contract No. NAS 7-100
National Aeronautics and Space Administration

Preface

The work described in this report was performed by the Engineering Mechanics Division of the Jet Propulsion Laboratory.

Contents

Tables

Figure

Abstract

A computer program (Thermal Analysis System I) was written to calculate steady-state temperatures for a radiation-conduction-coupled constant-property thermal model. A two-region spectral analysis is provided for the radiation portion of the computation. The "script $\mathcal{F}$" technique is used for infrared heat transfer and the radiosity technique is used for solar heat input. The program is designed for maximum ease of use from the user's standpoint. The rules for order and placement of user input data to the program are almost free-form. The output is formatted for ease of user understanding and diagnosis of errors. Some user control of output is provided.

Thermal Analysis System I: User's Manual

I. Introduction

Development of a temperature control system to maintain the various subsystems of a space vehicle within the proper temperature limits requires an understanding of the thermal properties of the components, the thermal coupling between the components themselves, and the coupling from the components to the surrounding environment. The Thermal Analysis System I (TAS I) is designed as an easy-to-use digital computer program for thermal design analysis. It fills the gap between "back of the envelope calculations" and computer codes that require complex user input and is useful in two ways: (1) it may be used when a problem does not justify, or time does not permit, an analysis requiring a complex computer program; or (2) it may serve as a stepping-stone to more complex thermal analysis programs. The thermal analyst who is accustomed to working with complex thermal analysis programs and their input formats probably would not save much time by using TAS I. It is intended mainly for use as a design tool by the temperature control engineer who performs thermal analysis for system design, and should be helpful for this purpose because the program coding is simplified and the input rules are easy to use and remember. The output is formatted for ease of user understanding and diagnosis of errors.

The program is written in FORTRAN IV and is operational on the IBM 7094, IBM 360.6, IBM 360/65, UNIVAC 1108 (EXEC 2), UNIVAC 1108 (EXEC 3), and CDC 6400. The code is written so that no changes are necessary in the FORTRAN statements when switching from one machine to another. The executive control cards must, of course, be changed from one computer installation to another, but this should offer no difficulty because conversions from the IBM 7094 to other machines have been easily accomplished by users without the aid of the author. Although some character recognition is used in the program, it is done in such a manner that the program remains word-length-independent. The TAS I physical program has been submitted to COSMIC,* the NASA agency for general distribution. A listing of the source program is given in the Appendix.

II. Analytic Procedures

The Thermal Analysis System I (TAS I) combines a thermal analysis program with subprograms to compute the infrared conductance, or $\mathcal{G}$, and the heat input due to solar heating.

The spectral analysis formulation is developed for two regions: (1) a solar region in which solar properties apply

*Computer Software Management and Information Center, Computer Center, University of Georgia, Athens, Georgia, 30601, telephone (404) 542-3265.

and (2) an infrared region in which the IR properties apply. This separation is possible because there are two widely different temperature levels being considered: the high solar temperature and the much lower spacecraft temperature. The energy in the solar region due to the IR radiation is negligible in comparison with the solar energy itself. This widely used assumption makes it possible to compute the heat inputs in the solar region separately from the IR heat transfer. Thus, the heat inputs in the solar region are not a function of the spacecraft temperature. The problem solution is therefore reduced to that of finding the spacecraft temperature distribution for a single wavelength region without the iteration procedures that would be necessary if multiple regions had to be considered.

III. Some Basic Relationships for Radiant Transfer in an Enclosure

Any real radiant-transfer system in an enclosure of arbitrary spatial distribution of boundary temperature, surface emissivity, and initial irradiation may be approximated or idealized by a finite set of discrete surfaces, each of which exhibits uniform temperature, radiant properties, and irradiation. The radiosity of discrete surface $A(1)$ in an enclosure represented by N discrete surfaces is given by the conservation relationship

$$L(1) = L(01) + \rho(1)\,[F(1,1)\,L(1) + F(1,2)\,L(2) + \cdots + F(1,N)\,L(N)] \tag{1}$$

where

$L(1)$ = radiosity or flux density streaming from $A(1)$ into the enclosure

$L(01)$ = flux density entering the system at $A(1)$ for thermal excitation equal to $EIR(1)\,\sigma T^4(1)$

$\rho(1) = 1 - EIR(1)$ or $1 - ESOL(1)$, the gray reflectance of $A(1)$ in some finite wavelength interval, dimensionless

$F(1,1), F(1,2)$ = the form factors that describe the direct flux transfer between the discrete surfaces, dimensionless

Relationships of the form of Eq. (1) may be written in the following matrix relationship for each discrete surface that defines the space:

$$\underbrace{\begin{bmatrix} [1-\rho(1)F(1,1)] & -\rho(1)F(1,2) & - \cdots & -\rho(1)F(1,N) \\ -\rho(2)F(2,1) & +[1-\rho(2)F(2,2)] & - \cdots & -\rho(2)F(2,N) \\ \vdots & & & \vdots \\ -\rho(N)F(N,1) & -\rho(N)F(N,2) & - \cdots & +[1-\rho(N)F(N,N)] \end{bmatrix}}_{\text{Transfer matrix}} \cdot \underbrace{\begin{bmatrix} L(1) \\ L(2) \\ \vdots \\ L(N) \end{bmatrix}}_{\text{Response vector}} = \underbrace{\begin{bmatrix} L(01) \\ L(02) \\ \vdots \\ L(0N) \end{bmatrix}}_{\text{Excitation vector}} \tag{2}$$

Equation (2) may be multiplied by the inverse of the transfer matrix to produce

$$\begin{bmatrix} L(1) \\ L(2) \\ \vdots \\ L(N) \end{bmatrix} = \begin{bmatrix} \frac{L(1,1)}{L(01)} & \frac{L(1,2)}{L(02)} & \cdots & \frac{L(1,N)}{L(0N)} \\ \frac{L(2,1)}{L(01)} & \frac{L(2,2)}{L(02)} & \cdots & \frac{L(2,N)}{L(0N)} \\ \vdots & \vdots & & \vdots \\ \frac{L(N,1)}{L(01)} & \frac{L(N,2)}{L(02)} & \cdots & \frac{L(N,N)}{L(0N)} \end{bmatrix} \circ \begin{bmatrix} L(01) \\ L(02) \\ \vdots \\ L(0N) \end{bmatrix} \quad (3)$$

Inverse of transfer matrix

The elements of the inverse transfer matrix represent transfer functions for unit excitation of the system at one surface only. For example, $[L(1,2)/L(02)]$ is the radiosity $L(1,2)$ of surface $A(1)$ that results from single excitation of the system at $A(2)$, relative to the excitation radiosity $L(02)$. For thermal excitation at $A(2)$, the transfer function is $[L(1,2)/EIR(2)\,\sigma T^4(2)]$. Note that each element of the inverse transfer matrix is a function of the entire array of form factors and radiant surface properties that define the space.

Several useful conservation and reciprocity relationships exist between the elements of the inverse transfer matrix or the transfer functions. In any enclosure defined by N discrete surfaces the total radiosity of surface $A(1)$ is

$$L(1) = L(1,1) + L(1,2) + \cdots + L(1,N) \quad (4)$$

In a uniform temperature enclosure or blackbody cavity, the total radiosity of surface $A(1)$ is

$$L(1) = \sigma T^4(1) \quad (5)$$

and

$$T(1) = T(2) = \cdots = T(N) = T \quad (6)$$

With the substitution of Eqs. (5) and (6) in Eq. (4),

$$\frac{L(1,1)}{\sigma T^4(1)} + \frac{L(1,2)}{\sigma T^4(2)} + \cdots + \frac{L(1,N)}{\sigma T^4(N)} = \frac{\sigma T^4}{\sigma T^4} = 1 \quad (7)$$

Now multiplying each term on the left side of Eq. (7) by the emissivity ratios results in

$$\frac{EIR(1)}{EIR(1)}\frac{L(1,1)}{\sigma T^4(1)} + \frac{EIR(2)}{EIR(2)}\frac{L(1,2)}{\sigma T^4(2)} + \cdots + \frac{EIR(N)}{EIR(N)}\frac{L(1,N)}{\sigma T^4(N)} \quad (8)$$

Note that the denominator of each term is simply the flux density generated at or initially streaming into the enclosure at each surface. In terms of the notation defined in Eq. (1),

$$EIR(1)\frac{L(1,1)}{L(01)} + EIR(2)\frac{L(1,2)}{L(02)} + \cdots + EIR(N)\frac{L(1,N)}{L(0N)} = 1 \quad (9)$$

If the conservation equation (9) applies in the case of a uniform temperature enclosure or uniform excitation vector, it must also apply for any excitation distribution because the transfer functions depend only on the geometry and radiant-property transfer matrix that is postulated to be independent of the excitation vector.

Consider now the net radiant-flux transfer from discrete area $A(1)$ expressed verbally as

$$Q(1, \mathrm{NET}) = \begin{bmatrix} \text{flux entering space at } A(1) \\ \text{after any self-absorption} \end{bmatrix} - \begin{bmatrix} \text{flux absorbed at } A(1) \\ \text{from all other surfaces} \end{bmatrix} \tag{10}$$

Equation (10) may also be expressed verbally as

$$\frac{Q(1, \mathrm{NET})}{A(1)} = \begin{bmatrix} \text{total flux density} \\ \text{streaming from } A(1) \end{bmatrix} - \begin{bmatrix} \text{total flux density incident at } A(1), \\ \text{including all multiple reflections} \end{bmatrix} \tag{10a}$$

Equation (10a) is expressed in terms of radiosity and irradiation as

$$\frac{Q(1, \mathrm{NET})}{A(1)} = L(1) - G(1 + 2 + 3 \cdots + N, 1) \tag{10b}$$

where

$G(1 + 2 + 3 + \cdots + N, 1)$ = the irradiation at $A(1)$ from discrete surfaces $A(1), A(2), \cdots, A(N)$

and

$$G(1 + 2 + 3 + \cdots + N, 1) = F(1,1)\,L(1) + F(1,2)\,L(2) + \cdots + F(1,N)\,L(N) \tag{10c}$$

Now substituting in Eq. (10b) for $L(2)$ the right-hand side of Eq. (1) and for $G(1 + 2 + 3 + \cdots + N, 1)$ the right-hand side of Eq. (10c) results in

$$\begin{aligned} \frac{Q(1, \mathrm{NET})}{A(1)} = {} & L(01) + \rho(1)\,F(1,1)\,L(1) + \rho(1)\,F(1,2)\,L(2) + \cdots + \rho(1)\,F(1,N)\,L(N) - F(1,1)\,L(1) \\ & - F(1,2)\,L(2) - \cdots - F(1,N)\,L(N) \end{aligned} \tag{10d}$$

Then combining terms in Eq. (10d) gives

$$\frac{Q(1, \mathrm{NET})}{A(1)} = L(01) - EIR(1)\,[F(1,1)\,L(1) + F(1,2)\,L(2) + \cdots + F(1,N)\,L(N)] \tag{10e}$$

Expressed verbally, Eq. (10e) reads as

$$\frac{Q(1, \mathrm{NET})}{A(1)} = \begin{bmatrix} \text{total flux density} \\ \text{generated at } A(1) \end{bmatrix} - \begin{bmatrix} \text{total flux density} \\ \text{absorbed at } A(1) \end{bmatrix} \tag{10f}$$

Verbal equations (10), (10a) and (10f) are all *identical* concepts.

Now Eq. (10e) may be expanded in terms of the transfer functions defined by the matrix equation (3) as follows:

$$
\begin{aligned}
\frac{Q(1,\mathrm{NET})}{A(1)} = L(01) - EIR(1)\Bigg[& F(1,1)\frac{L(1,1)}{L(01)}\cdot L(01) + F(1,2)\frac{L(2,1)}{L(01)}\cdot L(01) + \cdots + F(1,N)\frac{L(N,1)}{L(01)}\cdot L(01) \\
& + F(1,1)\frac{L(1,2)}{L(02)}\cdot L(02) + F(1,2)\frac{L(2,2)}{L(02)}\cdot L(02) + \cdots + F(1,N)\frac{L(N,2)}{L(02)}\cdot L(02) \\
& + F(1,1)\frac{L(1,3)}{L(03)}\cdot L(03) + F(1,2)\frac{L(2,3)}{L(03)}\cdot L(03) + \cdots + F(1,N)\frac{L(N,3)}{L(03)}\cdot L(03) \\
& + \cdots + F(1,1)\frac{L(1,N)}{L(0N)}\cdot L(0N) + F(1,2)\frac{L(2,N)}{L(0N)}\cdot L(0N) + \cdots + F(1,N)\frac{L(N,N)}{L(0N)}\cdot L(0N)\Bigg]
\end{aligned}
\qquad (10g)
$$

Combining terms with similar excitation yields

$$
\begin{aligned}
\frac{Q(1,\mathrm{NET})}{A(1)} = L(01) & - EIR(1)\,L(01)\left[F(1,1)\frac{L(1,1)}{L(01)} + F(1,2)\frac{L(2,1)}{L(01)} + \cdots + F(1,N)\frac{L(N,1)}{L(01)}\right] \\
& - EIR(1)\,L(02)\left[F(1,1)\frac{L(1,2)}{L(02)} + F(1,2)\frac{L(2,2)}{L(02)} + \cdots + F(1,N)\frac{L(N,2)}{L(02)}\right] \\
& - EIR(1)\,L(03)\left[F(1,1)\frac{L(1,3)}{L(03)} + F(1,2)\frac{L(2,3)}{L(03)} + \cdots + F(1,N)\frac{L(N,3)}{L(03)}\right] \\
& + \cdots + EIR(1)\,L(0N)\left[F(1,1)\frac{L(1,N)}{L(0N)} + F(1,2)\frac{L(2,N)}{L(0N)} + \cdots + F(1,N)\frac{L(N,N)}{L(0N)}\right]
\end{aligned}
\qquad (10h)
$$

For an enclosure with the excitation at $A(1)$, $A(2)$, $\cdots$, $A(N)$ only, Eq. (1) becomes

$$
\begin{aligned}
L(1,1) &= L(01) + \rho(1)\,[F(1,1)\,L(1,1) + F(1,2)\,L(2,1) + \cdots + F(1,N)\,L(N,1)] \\
L(1,2) &= \rho(1)\,[F(1,1)\,L(1,2) + F(1,2)\,L(2,2) + \cdots + F(1,N)\,L(N,2)] \\
&\ \vdots \\
L(1,N) &= \rho(1)\,[F(1,1)\,L(1,N) + F(1,2)\,L(2,N) + \cdots + F(1,N)\,L(N,N)]
\end{aligned}
\qquad (10i)
$$

Equations (10i) can be rearranged as

$$
\begin{aligned}
\frac{L(1,1) - L(01)}{\rho(1)\,L(01)} &= \left[F(1,1)\frac{L(1,1)}{L(01)} + F(1,2)\frac{L(2,1)}{L(01)} + \cdots + F(1,N)\frac{L(N,1)}{L(01)}\right] \\
\frac{L(1,2)}{\rho(1)\,L(02)} &= \left[F(1,1)\frac{L(1,2)}{L(02)} + F(1,2)\frac{L(2,2)}{L(02)} + \cdots + F(1,N)\frac{L(N,2)}{L(02)}\right] \\
&\ \vdots \\
\frac{L(1,N)}{\rho(1)\,L(0N)} &= \left[F(1,1)\frac{L(1,N)}{L(0N)} + F(1,2)\frac{L(2,N)}{L(0N)} + \cdots + F(1,N)\frac{L(N,N)}{L(0N)}\right]
\end{aligned}
\qquad (10j)
$$

Now substituting the left-hand parts of Eq. (10j) into (10h) results in

$$
\frac{Q(1,\mathrm{NET})}{A(1)} = L(01) - \frac{EIR(1)}{\rho(1)}\,L(01)\left[\frac{L(1,1)}{L(01)} - 1\right] - \frac{EIR(1)}{\rho(1)}\,L(02)\left[\frac{L(1,2)}{L(02)}\right] - \frac{EIR(1)}{\rho(1)}\,L(03)\left[\frac{L(1,3)}{L(03)}\right] \qquad (10k)
$$

The first two terms to the right of the equality sign of Eq. (10k) may be combined, and Eq. (10k) then reduces to Eq. (11).

Equation (10b) can be cast in yet another form by noting that the term in brackets on the right-hand side of Eq. (1) is the total irradiation of $A(1)$ from all regions that can be viewed from $A(1)$. That is, the irradiation term of Eq. (10c) may be substituted into Eq. (1) to give

$$L(1) = L(01) + \rho(1) G(1 + 2 + 3 + \cdots + N, 1) \tag{10l}$$

Now the irradiation in Eq. (10l) may be expressed in terms of the radiosities and the reflectance as

$$G(1 + 2 + 3 + \cdots + N, 1) = \frac{[L(1) - L(01)]}{\rho(1)} \tag{10m}$$

Substituting the right-hand side of Eq. (10m) into Eq. (10b) yields

$$\frac{Q(1, \mathrm{NET})}{A(1)} = L(1) - \left[\frac{L(1) - L(01)}{\rho(1)}\right] = \frac{L(01)}{\rho(1)} - \left[\frac{(1 - \rho(1))}{\rho(1)}\right] L(1) \tag{10n}$$

With the notation that $L(01) = EIR(1)\,\sigma T^4(1)$ and $(1 - \rho(1)) = EIR(1)$, Eq. (10n) takes the form of

$$\frac{Q(1, \mathrm{NET})}{A(1)} = \frac{L(01)}{\rho(1)} - \frac{EIR(1)}{\rho(1)} L(1) = \frac{EIR(1)}{\rho(1)} [\sigma T^4(1) - L(1)] \tag{10o}$$

Now substitute $L(1)$ in terms of the transfer functions of Eq. (3) and substitute in Eq. (10o) to give

$$\frac{Q(1, \mathrm{NET})}{A(1)} = \frac{L(01)}{\rho(1)} - \frac{EIR(1)}{\rho(1)} \left[\frac{L(1,1)}{L(01)} \cdot L(01) + \cdots + \frac{L(1,N)}{L(0N)} \cdot L(0N)\right] \tag{10p}$$

Combining terms in Eq. (10p) results in

$$\frac{Q(1, \mathrm{NET})}{A(1)} = \left[1 - EIR(1) \frac{L(1,1)}{L(01)}\right] \frac{L(01)}{\rho(1)} - EIR(1) \left[\frac{L(1,2)}{L(02)} \frac{L(02)}{\rho(1)} + \cdots + \frac{L(1,N)}{L(0N)} \frac{L(0N)}{\rho(1)}\right] \tag{10q}$$

Equation (10q) is identical to Eqs. (10k) and (11).

In terms of the quantities defined in Eq. (3), verbal equation (10) becomes

$$\frac{Q(1, \mathrm{NET})}{A(1)} = \left[1 - EIR(1) \frac{L(1,1)}{L(0)}\right] \frac{L(01)}{\rho(1)} - EIR(1) \left[\frac{L(1,2)}{L(02)} \frac{L(02)}{\rho(1)} + \frac{L(1,3)}{L(03)} \frac{L(03)}{\rho(1)} + \cdots + \frac{L(1,N)}{L(0N)} \frac{L(0N)}{\rho(1)}\right] \tag{11}$$

Equation (11) is divided by $A(1)$ so that the equation is in terms of flux density or Btu/hr-ft^2. The two terms on the right side of Eq. (11) correspond to the verbal equation (10). Note that each of the terms such as

$$\frac{L(1,2)}{L(02)} \frac{L(02)}{\rho(1)}$$

represents an irradiation at $A(1)$. That is, $L(1,2)/\rho(1)$ is the flux density of radiation onto $A(1)$ when $A(2)$ is the only source.

Equation (9) may be rearranged in the form

$$\left[1 - EIR\,(1)\frac{L\,(1,1)}{L\,(01)}\right] = EIR\,(2)\frac{L\,(1,2)}{L\,(02)} + \cdots + EIR\,(N)\frac{L\,(1,N)}{L\,(0N)} \tag{12}$$

Now substitute the left-hand side of Eq. (12) in Eq. (11) to obtain

$$\frac{Q\,(1,\mathrm{NET})}{A\,(1)} = \left[EIR\,(2)\frac{L\,(1,2)}{L\,(02)} + \cdots + EIR\,(N)\frac{L\,(1,N)}{L\,(0,N)}\right]\frac{L\,(01)}{\rho\,(1)} - EIR\,(1)\frac{L\,(1,2)}{L\,(02)}\frac{L\,(02)}{\rho\,(1)}$$

$$- EIR\,(1)\frac{L\,(1,3)}{L\,(03)}\frac{L\,(03)}{\rho\,(1)} - \cdots - EIR\,(1)\frac{L\,(1,N)}{L\,(0N)}\frac{L\,(0N)}{\rho\,(1)} \tag{13}$$

Now arranging Eq. (13) in doublets results in

$$\frac{Q\,(1,\mathrm{NET})}{A\,(1)} = \left[EIR\,(2)\frac{L\,(1,2)}{L\,(02)}\frac{L\,(01)}{\rho\,(1)} - EIR\,(1)\frac{L\,(1,2)}{L\,(02)}\frac{L\,(02)}{\rho\,(1)}\right] + \left[EIR\,(3)\frac{L\,(1,3)}{L\,(03)}\frac{L\,(01)}{\rho\,(1)} - EIR\,(1)\frac{L\,(1,3)}{L\,(03)}\frac{L\,(03)}{\rho\,(1)}\right]$$

$$+ \cdots + \left[EIR\,(N)\frac{L\,(1,N)}{L\,(0N)}\frac{L\,(01)}{\rho\,(1)} - EIR\,(1)\frac{L\,(1,N)}{L\,(0N)}\frac{L\,(0N)}{\rho\,(1)}\right] \tag{14}$$

For thermal excitation, $L\,(0N) = EIR\,(N)\,\sigma\,T^4\,(N)$ and Eq. (14) can be written in terms of the discrete surface temperatures as follows:

$$\frac{Q\,(1,\mathrm{NET})}{A\,(1)} = \frac{EIR\,(1)\,EIR\,(2)}{\rho\,(1)}\frac{L\,(1,2)}{L\,(02)}[\sigma T^4\,(1) - \sigma T^4\,(2)] + \frac{EIR\,(1)\,EIR\,(3)}{\rho\,(1)}\frac{L\,(1,3)}{L\,(03)}[\sigma T^4\,(1) - \sigma T^4\,(3)]$$

$$+ \cdots + \frac{EIR\,(1)\,EIR\,(N)}{\rho\,(1)}\frac{L\,(1,N)}{L\,(0N)}[\sigma T^4\,(1) - \sigma T^4\,(N)] \tag{15}$$

Professor H. C. Hottel (Ref. 1) of MIT has suggested the following notation for Eq. (15):

$$\frac{Q\,(1,\mathrm{NET})}{A\,(1)} = \mathcal{G}\,(1,1)\,[\sigma T^4\,(1) - \sigma T^4\,(1)] + \mathcal{G}\,(1,2)\,[\sigma T^4\,(1) - \sigma T^4\,(2)] + \mathcal{G}\,(1,3)\,[\sigma T^4\,(1) - \sigma T^4\,(2)]$$

$$+ \cdots + \mathcal{G}\,(1,N)\,[\sigma T^4\,(1) - \sigma T^4\,(N)] \tag{16}$$

Combining Eqs. (15) and (16) leads to

$$\frac{EIR\,(1)}{\rho\,(1)}\left[EIR\,(2)\frac{L\,(1,2)}{L\,(02)} + EIR\,(3)\frac{L\,(1,3)}{L\,(03)} + \cdots + EIR\,(N)\frac{L\,(1,N)}{L\,(0N)}\right] = \mathcal{G}\,(1,2) + \mathcal{G}\,(1,3) + \cdots + \mathcal{G}\,(1,N) \tag{17}$$

A conservation relationship for the Hottel terms, obtained from the net transfer relationship at $A\,(1)$, takes the form

$$\frac{Q\,(1,\mathrm{NET})}{A\,(1)} = L\,(01) - EIR\,(1)\,[F\,(1,1)\,L\,(1) + F\,(1,2)\,L\,(2) + \cdots + F\,(1,N)\,L\,(N)] \tag{18}$$

In a uniform temperature enclosure, the net transfer is zero and $L\,(1) = L\,(2) = L\,(N) = \sigma\,T^4$. For this uniform temperature enclosure, Eq. (18) becomes

$$\frac{Q\,(1,\mathrm{NET})}{A\,(1)} = 0 = EIR\,(1)\,[\sigma T^4 - \sigma T^4\,(F\,(1,1) + F\,(1,2) + \cdots + F\,(1,N))] \tag{19}$$

Because the sum of the form factors is unity, Eq. (19) becomes simply

$$\frac{Q(1,\mathrm{NET})}{A(1)} = 0 = EIR(1)[\sigma T^4 - \sigma T^4] \tag{20}$$

For a uniform temperature enclosure, Eq. (16) becomes

$$\frac{Q(1,\mathrm{NET})}{A(1)} = 0 = [\mathcal{G}(1,1) + \mathcal{G}(1,2) + \mathcal{G}(1,3) + \cdots + \mathcal{G}(1,N)]\,[\sigma T^4 - \sigma T^4] \tag{21}$$

A conservation relationship, obtained by equating Eqs. (20) and (21), takes the form

$$\mathcal{G}(1,1) + \mathcal{G}(1,2) + \mathcal{G}(1,3) + \cdots + \mathcal{G}(1,N) = EIR(1) \tag{22}$$

Equation (22) may be rearranged as

$$EIR(1) - \mathcal{G}(1,1) = \mathcal{G}(1,2) + \mathcal{G}(1,3) + \cdots + \mathcal{G}(1,N) \tag{23}$$

Now substitute the left-hand side of Eq. (23) and the left-hand side of Eq. (12) into Eq. (17) to obtain

$$\frac{EIR(1)}{\rho(1)}\left[1 - EIR(1)\frac{L(1,1)}{L(01)}\right] = EIR(1) - \mathcal{G}(1,1) \tag{24}$$

Solving for $\mathcal{G}(1,1)$ in Eq. (24) results in

$$\mathcal{G}(1,1) = \frac{[EIR(1)]^2}{\rho(1)}\left[\frac{L(1,1)}{L(01)} - 1\right] \tag{25}$$

From Eqs. (15) and (16) we have

$$\mathcal{G}(1,2) = \frac{EIR(1)\,EIR(2)}{\rho(1)}\left[\frac{L(1,2)}{L(02)}\right] \tag{26}$$

and

$$\mathcal{G}(N,M) = \frac{EIR(N)\,EIR(M)}{\rho(N)}\,\frac{L(N,M)}{L(0M)} \tag{27}$$

Another useful form of Eq. (25), obtained from Eq. (1) when $A(1)$ is the only source, is

$$L(1,1) = L(01) + \rho(1)\,[F(1,1)\,L(1,1) + F(1,2)L(2,1) + \cdots + F(1,N)\,L(N,1)] \tag{28}$$

Now divide Eq. (28) through by $L(01)$ and rearrange terms to get

$$\frac{L(1,1)}{L(01)} - 1 = \rho(1)\left[F(1,1)\frac{L(1,1)}{L(01)} + F(1,2)\frac{L(2,1)}{L(01)} + \cdots + F(1,N)\frac{L(N,1)}{L(01)}\right] \tag{29}$$

Substituting the right-hand side of Eq. (29) into Eq. (25) gives

$$\mathcal{G}(1,1) = EIR^2(1)\left[F(1,1)\frac{L(1,1)}{L(01)} + F(1,2)\frac{L(2,1)}{L(01)} + \cdots + F(1,N)\frac{L(N,1)}{L(01)}\right] \tag{30}$$

Similarly,

$$\mathcal{G}(1,2) = EIR(1)\,EIR(2)\left[F(1,1)\frac{L(1,2)}{L(02)} + F(1,2)\frac{L(2,2)}{L(02)} + \cdots + F(1,N)\frac{L(N,2)}{L(02)}\right] \tag{31}$$

IV. Solution Scheme

The Hottel $\mathcal{G}$-factor and the heat input due to the solar flux are calculated first for each set of conditions. The solution for temperatures then follows.

The elements of the matrix equation for calculation of $\mathcal{G}$ are of the form

$$\mathcal{G}(1,1) = EIR^2(1)\left[F(1,1)\frac{L(1,1)}{L(01)} + F(1,2)\frac{L(2,1)}{L(01)} + \cdots + F(1,N)\frac{L(N,1)}{L(01)}\right]$$

$$\mathcal{G}(1,2) = EIR(1)\,EIR(2)\left[F(1,1)\frac{L(1,2)}{L(02)} + F(1,2)\frac{L(2,2)}{L(02)} + \cdots + F(1,N)\frac{L(N,2)}{L(02)}\right]$$

A. Calculation of $\mathcal{G}$-Factor

The calculation of $\mathcal{G}$ is performed in the following steps:

Step 1. A matrix is formed with elements of the form

$$A(I,J) = \delta(I,J) - (1 - EIR(I))\,F(I,J)$$

where

$$\delta(I,J), \text{ the Kronecker delta, } = 1 \quad \text{if } I = J$$
$$= 0 \quad \text{if } I \neq J$$

A printout of this matrix can be obtained by setting*

PRINT (26) = 1

Step 2. The matrix is next inverted to become

$$[B] = [A]^{-1}$$

A printout of this matrix can be obtained by setting

PRINT (27) = 1

Step 3. The matrix is now multiplied by the shape factor matrix to give elements of the form

$$C(I,J) = \sum_K F(I,K)\,B(K,J)$$

*See Table 2, Section V, for values for PRINT vector

A printout of this matrix can be obtained by setting

PRINT (28) = 1

Step 4. The matrix is now multiplied by the appropriate IR emittances to give a matrix with elements of the form

$$\mathcal{G}(I,J) = EIR(I)\,EIR(J)\,C(I,J)$$

This is the script $\mathcal{G}$ matrix and its printout may be requested by setting

PRINT (29) = 1

Step 5. The script $\mathcal{G}$ matrix is now multiplied by the area to give "the area times the script $\mathcal{G}$ matrix." A printout of this matrix may be requested by setting

PRINT (30) = 1

The elements of this matrix are also displayed in the detailed output in the fifth column (ASCRIPTFIR) of the tabular data for each node.

Step 6. Finally, a printout of the Stefan-Boltzmann constant multiplied by the area script $\mathcal{G}$ matrix may be requested by setting

PRINT (31) = 1

B. Calculation of Radiosity

The radiosity calculations necessary to determine the heat input from the solar flux are performed in the following steps:

Step 1. The elements of the excitation vector are of the form

$$L^*(I) = SOLCON \times ILUM(I) \times (1 - ESOL(I)) \times \cos(THETA(I))$$

These values may be printed by setting

$$\text{PRINT}(21) = 1$$

Step 2. The solar transfer matrix before inversion is found. Its elements are of the same form as used in the script $\mathcal{F}$ calculations, except solar emittances are used instead of IR emittances:

$$A(I,J) = \delta(I,J) - (1 - ESOL(I)) \times F(I,J)$$

Step 3. The solar transfer matrix is computed in the form

$$[B] = [A]^{-1}$$

This matrix may be printed by setting

$$\text{PRINT}(23) = 1$$

Step 4. Along with the matrix inversion process, the solar response vector $L^*(I)$ is computed. Its value may be printed by setting

$$\text{PRINT}(24) = 1$$

Step 5. Finally, the solar QNET vector is computed. Its values are of the form

$$QNET(I) = -A(I) \times SOLCON \times ILUM(I) \times \cos(THETA(I)) + \sum_J (\delta(I,J) - F(I,J)) \times A(I) \times L^*(J)$$

C. Numerical Techniques

To demonstrate the numerical techniques used in the calculations, it is necessary to develop the governing equations in matrix notation. The heat flow from node I to node J due to conduction or convection is

$$Q(I,J) = C(I,J)(T(I) - T(J))$$

where

$Q(I,J)$ = heat flow from node I to node J

$C(I,J)$ = conductance from node I to node J

$T(I), T(J)$ = temperatures of nodes I and J, respectively

The heat flow from node I to node J, due to radiation, is

$$Q(I,J) = \sigma \mathcal{F}(I,J) \times A(I) \times (T^4(I) - T^4(J))$$

where

$Q(I,J)$ = heat flow from node I to node J

σ = Stefan-Boltzmann constant

$\mathcal{F}(I,J)$ = script $\mathcal{F}$ from node I to node J

$T(I), T(J)$ = temperatures of nodes I and J, respectively

Since the rate of energy in steady state entering a node is equal to the rate of energy leaving a node, the energy balance may be written as follows:

$$Q(\text{CONDUCTION}) + Q(\text{RADIATION}) - P(\text{DISSIPATION} + \text{SOLAR INPUT}) = 0$$

When a mathematical thermal model is devised for a real spacecraft system for engineering purposes, it consists of conduction and irradiation terms connecting the various discrete elements with power in the form of electrical energy being dissipated in the node. Thus, the steady-state energy equation is

$$Q(I,J)(\text{CONDUCTION}) + Q(I,J)(\text{RADIATION}) - P(\text{DISSIPATION} + \text{SOLAR INPUT}) = 0$$

where the sign convention for power is negative for energy per unit time in and positive for energy per unit time out. In terms of actual discrete elements, the energy per unit time into node I due to conduction is

$$Q(\text{CONDUCTION}) = \sum_J C(I,J)(T(I) - T(J))$$

where

$C(I,J)$ = conductance from node I to node J; I denotes the node under consideration; J denotes all nodes except node I

The energy per unit into node I due to radiation is

$$Q(\text{RADIATION}) = \sum_J \sigma \times A(I) \times \mathcal{F}(I,J) \times (T^4(I) - T^4(J))$$

where

σ = Stefan-Boltzmann constant

A = area of node I

$\mathcal{F}(I, J)$ = script $\mathcal{F}$ from node I to node J (where node I and J have the same meaning as above)

The energy balance for node I may now be written in terms of the discrete thermal elements in the form

$$\sum_J (C(I,J) \times (T(I) - T(J)) + \sum_J \sigma A(I) \mathcal{F}(I,J) (T^4(I) - T^4(J)) - P(I) = 0$$

The energy balance written for all the nodes under consideration may be written in matrix form as follows:

$$[C][T] + [R][T^4] - [P] = 0$$

where

C = the symmetric conduction matrix whose elements are $C(I, J)$

R = the symmetric conduction matrix whose elements are $\sigma A(I) \mathcal{F}(I, J)$

T and T^4 = the temperature vectors whose elements are $T(I)$ and $T^4(J)$

P = the power vector, which includes not only the electrical power dissipation, but also the energy per unit time input from the solar radiosity

The solution of this matrix equation follows the Newton-Raphson iteration method described by Hildebrand (Ref. 2). For simplicity, the method is shown for two independent variables. The solution may then be extended for N unknowns.

Given two functions $f(x, y)$ and $g(x, y)$, which are simultaneous nonlinear algebraic equations, recurrence formulas of the following form may be written:

$$(x_{k+1} - x_k) f_x(x_k, y_k) + (y_{k+1} - y_k) f_y(x_k, y_k) = -f(x_k, y_k)$$

$$(x_{k+1} - y_k) g_x(x_k, y_k) + (y_{k+1} - y_k) g_y(x_k, y_k) = -g(x_k, y_k)$$

This may be written in matrix form as

$$\begin{bmatrix} f_x & f_y \\ g_x & g_y \end{bmatrix} \begin{bmatrix} \Delta x_k \\ \Delta y_k \end{bmatrix} = - \begin{bmatrix} f(x_k, y_k) \\ g(x_k, y_k) \end{bmatrix}$$

where

$$\Delta x_k = x_{k+1} - x_k$$

$$\Delta y_k = y_{k+1} - y_k$$

The square matrix is recognized as having the elements of the Jacobian determinant. The corrections Δx_k and Δy_k are added to x_k and y_k, respectively, to yield the following iteration.

The radiation-conduction matrix equation for steady-state constant properties may be brought into the form suggested above in the following manner.

We want the result in the form

$$[S][T] = [A]$$

where $[S]$ is a square matrix and T and A are vectors. Furthermore, we want $[S]$ to have the elements of the Jacobian determinant.

A typical off-diagonal element is of the form

$$S(I, J) = C(I, J) + 4\sigma A(I) F(I, J) T^3(J)$$

and a diagonal element is of the form

$$S(I, I) = S(I, I) - C(I, J) - 4\sigma A(I) F(I, J) T^3(I)$$

The vector A then has the form

$$A(I) = P(I) - Q(\text{SOLAR NET})(I) - 3\sigma A(I) F(I, J) (T^4(I) - T^4(J))$$

This formulation allows the matrix equation to be solved for T. The imbalance in the equation is computed and if it is not within the required limits, the resulting values of T are used to generate a new S matrix and a new A vector for the next iteration.

Although the actual method used differs somewhat from that described in Ref. 2, the number of iterations required for solution remains the same for several sets of conditions that were tested. The method described here was used because it results directly in the required temperatures.

V. Program Input

Data input is prepared on four types of cards: comment cards, title cards, data cards, and control cards.

A. Comment Cards

A comment card is designated by the letter C in column 1. Comments are placed in successive columns. A comment card is printed in the output listing of the data deck. The comments serve as notes to the user and are not used by the program. Any number of comments may be used in the data. Once the program recognizes the C in column 1, the card is printed out and the program continues to process the next card. The COMMENT CARD field is COL 2–72.

B. Title Cards

A title card is designated by the letter T in column 1. A maximum of 10 title cards may be used. Title cards may be placed in basic data, case data, or a combination of both. The total number of title cards for any one case data block and the basic data block may not exceed 10. If the maximum number of title cards is exceeded, the title cards in excess of 10 will be printed as comment cards and only the first 10 title cards will be used as title cards. Title cards are printed at the top of each output statement. The TITLE CARD field is COL 2–72.

C. Data Cards

A data card is designated by a blank in column 1. Any number of data cards may be used to prescribe a problem that lies within the capacity of the machine. The DATA CARD field is COL 2–72.

Data cards are of three types: matrix, vector, and single value. A single value such as the solar constant is entered as

$$\mathrm{SOLCON} = 430.$$

A vector value such as power is entered as

$$\mathrm{P}(10) = -10.$$

A matrix value such as a view factor is entered as

$$\mathrm{F}(2,3) = 0.5$$

The data input used in the program is actually a modified FORTRAN NAMELIST. The first column must be blank. Data must not be entered in columns 73–80; they must be left blank or used for sequence identification. The information in columns 73–80 will be printed with the card image. The program automatically inserts the beginning and ending characters required for NAMELIST. It also inserts a comma at the end of each card image if it is not present. Some of the convenience features of NAMELIST that may be used are as follows:

Variables with a single subscript (i.e., vectors) may be entered in sequence as

$$\mathrm{A}(1) = 1., 1.5, 3., 4.$$

which is the same as

$$\mathrm{A}(1) = 1.$$
$$\mathrm{A}(2) = 1.5$$
$$\mathrm{A}(3) = 3.$$
$$\mathrm{A}(4) = 4.$$

Variables with a double index (i.e., matrices) may be entered in sequence. Instead of entering each variable separately as

$$\mathrm{F}(2,1) = 0.5$$
$$\mathrm{F}(3,1) = 0.2$$
$$\mathrm{F}(4,1) = 0.3$$

we may enter them as

$$\mathrm{F}(2,1) = 0.5, 0.2, 0.3$$

It can be seen that the first index rotates most rapidly. Floating-point exponential notation may be employed for data as

$$\mathrm{A}(29) = 1.76\mathrm{D} + 12$$
$$\mathrm{BOLTZ} = 0.1714\mathrm{D} - 08$$

A list of the input variables for data cards is given in Table 1. Definitions of the symbols in Table 1 and examples of their use are listed as follows:

Symbol	Definition and use
N	Number of nodes. Nodes must be numbered sequentially so that N is the largest node number. Although the nodes must be numbered so that no node numbers are omitted, the data in a particular data block may be entered in any order. Example: 10-node problem Data input: N = 10 (integer)

Table 1. List of input variables for data cards

Symbol	Unspecified initial values
N	0
C(I, J)	0.0
F(I, J)	0.0
FA(I, J)	0.0
FAUSED	0
ESOL(I)	0.0
EIR(I)	0.0
ILUM(I)	1.0
THETA(I)	90.0
CT(I)	−500.0
T(I)	68.0
P(I)	0.0
SOLCON	442.0
RELTOL	1.D − 05
TNOTSP	68.0
BOLTZ	0.1714D − 08
PRINT(K)	0
ABSCVN	460.
NITER	15

C (I, J) Conductance from node I to node J.

Example: Conductance of 4.5 from node 5 to node 10

Data input: C (5, 10) = 4.5

F (I, J) Shape factor from node I to node J. The area A must also be entered.

Example: View factor of 0.5 from node 4 to node 9

Data input: F (4, 9) = 0.5

FA (I, J) FA product. The area A must also be entered from node I to node J.

Example: FA = 19.5 from node 3 to node 8; area of node 3 is 20; area of node 8 is 30

Data input: FA (3, 8) = 19.5
A (3) = 20.
A (8) = 30.

FAUSED Equals 1 if FA elements are input; equals 0 if F elements are used. The program assumes the value to be 0 unless 1 is input.

Example: It is desired to use FA elements in the input data.

Data input: FAUSED = 1 (integer)

Example: It is desired to use F elements in the input data.

Data input: No entry is necessary, and the program will automatically assume that the input will be F elements.

Either F or FA elements may be input; in either case, the area A (I) must also be entered so that the F elements, whose matrix is not symmetrical, may be calculated. If both sides of the matrix are symmetrical, the program will print an error message, pick one of the values as the correct value, calculate the other value, and proceed with the case. The data input must be either all F elements or all FA elements; F elements and FA elements cannot be used in the same problem.

EIR (I) Infrared emittance.

Example: IR emittance for node 5 is 0.85.

Data input: EIR (5) = 0.85

ESOL (I) Solar emittance.

Example: Solar emittance for node 6 is 0.5.

Data input: ESOL (6) = 0.5

ILUM (I) Fraction of the node exposed to direct solar flux. If a node is only partially exposed to the sun, ILUM would be used to reduce the node area in the shape factor calculation to that area exposed to solar flux. Normally this input would not be used because the user would usually define two nodes, one of which would be totally in the solar flux and the other totally in the shade. If no input is given for ILUM, the program assumes values as follows: If the theta value of the node is not equal to 90 deg, a value of 1.0 will be inferred. If the theta value of the node is 90 deg, there is no direct solar flux and the program enters 0 for the ILUM value.

Example: Node 10 is 25% exposed to direct solar flux and therefore 75% shadowed or not exposed to direct solar flux.

Data input: ILUM (10) = 0.25

Example: Node 11 is completely conduction-dependent and receives no radiant input.

Data input: No ILUM entry is necessary; the program will enter a value of 0.0.

Example: Node 12 is 100% exposed to direct solar flux.

Data input: No ILUM entry is necessary; the program will enter a value of 1.0 when the theta value for node 12 is less than 90 deg.

THETA (I) Angle from the normal to the surface to the sun. If THETA equals 90 deg, no direct solar energy is received at the surface. It is necessary to enter a THETA value only if a node receives direct solar flux.

Example: Node 10 has a 0-deg angle from the normal of its surface to the sun.

Data input: THETA (10) = 0.

Example: Node 11 has a 30-deg angle from the normal of its surface to the sun.

Data input: THETA (11) = 30.

Example: Node 20 is a conduction-only node and has no radiation exchange.

Data input: No THETA entry is required, and the program automatically enters a THETA value of 0.

CT (I) Constant-temperature or boundary node. All problems require at least one constant-temperature node. In space applications, this is the space temperature.

Example: Node 15 is a boundary node at a constant temperature of 200°F.

Data input: CT (15) = 200.

T (I) Starting temperature. If the user has intuitive insight into a problem, a starting temperature for a particular node may be specified. This will result in a slight saving in computer running time. The final answer will be the same whether or not a user-supplied starting temperature is specified.

Example: User has prior knowledge that the resulting temperature of node 9—which is not a constant-temperature node—will be approximately 150°F.

Data input: T (9) = 150.

P (I) Power input. The sign of the power input is determined by the convention "energy per unit time *in* is negative, and energy per unit time *out* is positive."

Example: Node 15 represents an electronic module where 10 Btu/h of electrical power is being dissipated.

Data input: P (15) = −10.

SOLCON Solar constant. If no value is input, a value of 442. is automatically used by the program.

Example: A run is being made in which the solar flux density is 420. Btu/h-ft^2.

Data input: SOLCON = 420.

Example: A run is being made in which the solar flux density is 442. Btu/h-ft^2.

Data input: No entry is necessary, as the program will insert a value of 442. if no SOLCON is specified.

RELTOL Relaxation tolerance of nodal flux. If the user does not specify a value, the program will automatically enter a value of 1×10^{-5}.

Example: User wants the heat balance solved to better than 1×10^{-6} Btu/h on every node that is not a constant-temperature node.

Data input: RELTOL = 1.D − 06
(Note that the exponent is denoted by D, not E. This is because double precision is being used.)

TNOTSP Temperature not specified value. If no value is specified, the program will use 68 as the starting temperature for the iterations. This temperature is used on all nodes that are not constant-temperature nodes or that have not already been specified by T (I).

Example: User expects the majority of temperatures in a particular problem to be about 150°F.

Data input: TNOTSP = 150.
(One or two iterations may be saved by judicious use of this parameter, but in general the computer time saving is insignificant.)

BOLTZ Stefan-Boltzmann constant. If the user does not specify a value, the program enters a value of 0.1714×10^{-8}.

Example: User wants to use a Stefan-Boltzmann constant of 0.1713×10^{-8} Btu/h-ft^2-deg R^4.

Data input: BOLTZ = 0.1713D − 08 (The exponent is denoted by D, not E, because the program is written in double precision.)

ABSCVN The value added to T that results in the absolute temperature. If the user does not specify a value, the program uses a value of 460.

Example: It is desired to have the program print out temperatures in degrees C.

Data input: ABSCVN = 273. (It is also necessary to specify the proper BOLTZ and SOLCON.)

Example: It is desired to have the program print out absolute temperatures.

Data input: ABSCVN = 0.

PRINT(K) The various values, vectors, and matrices printed at user request are listed in Table 2.

NITER Maximum number of iterations to be used in the solution.

Table 2. Values for PRINT vector

Data input	Printout
PRINT(10) = 1	Prints N, BOLTZ, SOLCON, RELTOL
PRINT(11) = 1	Prints THE SYMMETRIC CONDUCTION MATRIX
PRINT(12) = 1	Prints THE SYMMETRIC FA MATRIX
PRINT(13) = 1	Prints THE F MATRIX
PRINT(14) = 1	Prints THE AREAS
PRINT(15) = 1	Prints THE INFRARED EMITTANCES
PRINT(16) = 1	Prints THE SOLAR EMITTANCES
PRINT(17) = 1	Prints THE ILLUMINATIONS
PRINT(18) = 1	Prints THE ANGLES THETA TO THE SUN
PRINT(19) = 1	Prints THE CONSTANT TEMPERATURE NODES TEMPERATURE
PRINT(20) = 1	Prints THE POWERS
PRINT(21) = 1	Prints THE EXCITATION VECTOR
PRINT(22) = 1	Prints THE SOLAR TRANSFER MATRIX BEFORE INVERSION
PRINT(23) = 1	Prints THE SOLAR TRANSFER MATRIX AFTER INVERSION
PRINT(24) = 1	Prints THE SOLAR RESPONSE VECTOR
PRINT(25) = 1	Prints THE SOLAR Q NET VECTOR
PRINT(26) = 1	Prints STEP 1 OF THE SCRIPT F MATRIX
PRINT(27) = 1	Prints STEP 2 OF THE SCRIPT F MATRIX
PRINT(28) = 1	Prints STEP 3 OF THE SCRIPT F MATRIX
PRINT(29) = 1	Prints THE SCRIPT F MATRIX
PRINT(30) = 1	Prints THE AREA TIMES THE SCRIPT F MATRIX
PRINT(31) = 1	Prints THE BOLTZ TIMES THE AREA SCRIPT F MATRIX

D. Control Cards

A control card is a special card used to control the flow and execution of data into the machine under control of the stored program. The following control cards are used:

END OF BASIC DATA

As this card indicates, it is used to designate the end of a basic data block.

END OF CASE

As this card indicates, it is used to designate the end of a particular case data block.

END OF PROBLEM

As this card indicates, it is used to designate the end of problem.

Following the END OF PROBLEM card the program will accept a new basic data block. All parameters are returned to their initial value by the program. For instance, if the user enters a solar constant, the program will not return it to its program set value of 442. The initial value will be set to the value as indicated in Table 1. If no data follow the end of problem card, the program will attempt to read a card, at which point the system will terminate the job. It is important that the control cards appear exactly as listed with a blank between each word, with the first word starting in column 1. If there is an error in the entered card, the message card error will appear to the right of the card image on the output and it will be ignored. The run will continue, with the probability that the results will be incorrect. The purpose for continuing the run is mainly to uncover other errors in the data.

VI. Program Output

The program output is arranged so that the user may determine that data input is correct and check that the heat balance is valid.

A one-line heading that gives the case number is included before a data input block and before each new block of output.

A history of all input cards is included with the output. This listing is used to locate errors and to facilitate identification if several runs have been made. To the right of each card image, the card name is printed (title card, comment card, data card, or control card).

The detailed nodal output is the minimum output from the program. The detail of each node includes all the input information about that node and information concerning the calculation of the heat balance around that node. The temperature, area, IR emittance, solar emittance, illumination factor, and theta angle (the angle from the normal to the surface to the sun) are listed.

A detailed listing of the heat balance follows. The headings refer to the columns that follow. The first column (NODE) lists the nodes that contribute to the heat balance. The second column (CONDUCTANCE) lists the conductance between the nodes listed in column 1 and the node under question. The third column (Q COMP) lists the Q-component contribution due to conduction and/or convection in the heat balance. Its value for a node is

$$Q\,(\text{CONDUCTION}) = C\,(I, J)\,(T\,(J) - T\,(J))$$

Its sign will be negative if heat is being conducted into the node and positive if heat is being transferred by conduction from the node.

The fourth column (F) lists the shape factor from the nodes listed in column 1 and the node under question. The fifth column (ASCRIPTFIR) lists the area times script $\mathscr{F}$ for the IR region from the nodes listed in column 1 to the node under question. It is possible to have an $A\,(I)\,\mathscr{F}\,(I, J)$ term between two nodes even though there is a zero shape factor between the nodes due to multiple diffuse reflections. The sixth column (Q COMP) lists the Q-component contribution to the heat balance due to the infrared heat transfer. The Q-component value for a node I is

$$Q\,(\text{IR RADIATION}) = \sigma A\,(I)\,\mathscr{F}\,(I, J)\,(T^4\,(I) - T^4\,(J))$$

The seventh column (Q COMP) lists the Q-component contribution to the heat balance from the solar input. The value for a node I is

$$Q\,(\text{SOLAR RADIATION}) = A\,(I)\,(1 - \text{F}\,(I, J))\,L^*\,(I) - A\,(J) \times SOLCON \times ILUM\,(I) \times \cos \text{THETA}\,(I)$$

where

$L^*\,(I)$ = solar radiosity

$SOLCON$ = solar constant

$ILUM\,(I)$ = fraction of the surface exposed to the sun

The Q-component value for a node $I \neq J$ is

$$Q\,(\text{SOLAR RADIATION}) = -A\,(I)\,(\mathscr{F}\,(I, J) \times L^*\,(J))$$

If the term $-A\,(I) \times SOLCON \times ILUM\,(I) \times \cos$ THETA (I) is not zero, it is listed immediately below the tabular listings with the comment DIRECT SOLAR. Its value appears in the Q COMP column for solar input and the comment DIRECT SOLAR appears on the same line to the left of the value.

The eighth column (TOTAL) lists the total contribution from each node listed in column 1 to the node under question. Of course, POWER and DIRECT SOLAR are also listed, since they contribute to the heat balance. If power is present it is listed in the next-to-the-last row in the tabular information and its value is listed in column 8.

The last row in the tabular information lists the totals for the various columns where appropriate. The Q-components due to conduction and convection, IR radiation, and solar flux are summed.

The totals of the contributions from various nodes are listed in the bottom row of the eighth column. This is the value of the heat balance. Its value for nonconstant-temperature nodes should be smaller than the relaxation tolerance (RELTOL) set by the program. The program initializes RELTOL to $1. \times 10^{-5}$ and the user may change this value if desired.

The temperature of a constant-temperature node is not changed by the program and its heat balance will probably not be zero. Its value represents the amount of energy per unit time passing through that particular boundary. A constant-temperature node is recognized by the line THIS IS A CONSTANT TEMPERATURE NODE that appears immediately above the headings for the tabular data.

If special print outputs are requested, their titles correspond to those in Table 2. By requesting special print outputs, the user can verify the various computational steps in the infrared flux calculation and the solar radiosity calculation.

VII. Sample Problem

The sample problem chosen to illustrate the use of the program is that of an L-shape as shown in Fig. 1. The L-shape is infinite in the direction normal to the *X*-*Y* plane.

The solution of this problem has previously been discussed in Refs. 3 and 4. This problem, which was chosen because a reference solution is available, illustrates the method of using TAS I to obtain a temperature distribution for a particular geometry in which it is necessary to consider energy transfer in the infrared region and the solar region. The problem also requires the calculation of heat-transfer rate in the solar region due to direct solar flux and reflected solar energy. Conduction is not considered so that the computer solution may be compared with the analytic solution. However, the effect of conduction may be accounted for by the addition of the necessary data cards.

The assumptions made in the solution of the L-shape are (Ref. 3):

(1) The surfaces are semigray opaque with solar properties *ESOL* and long-wave or infrared properties of *EIR*.

(2) The surfaces emit and reflect diffusely.

(3) The shape factors describe the direct view coupling between the discrete areas.

(4) The discrete area or nodes are isothermal.

(5) The surfaces are insulated from the rear.

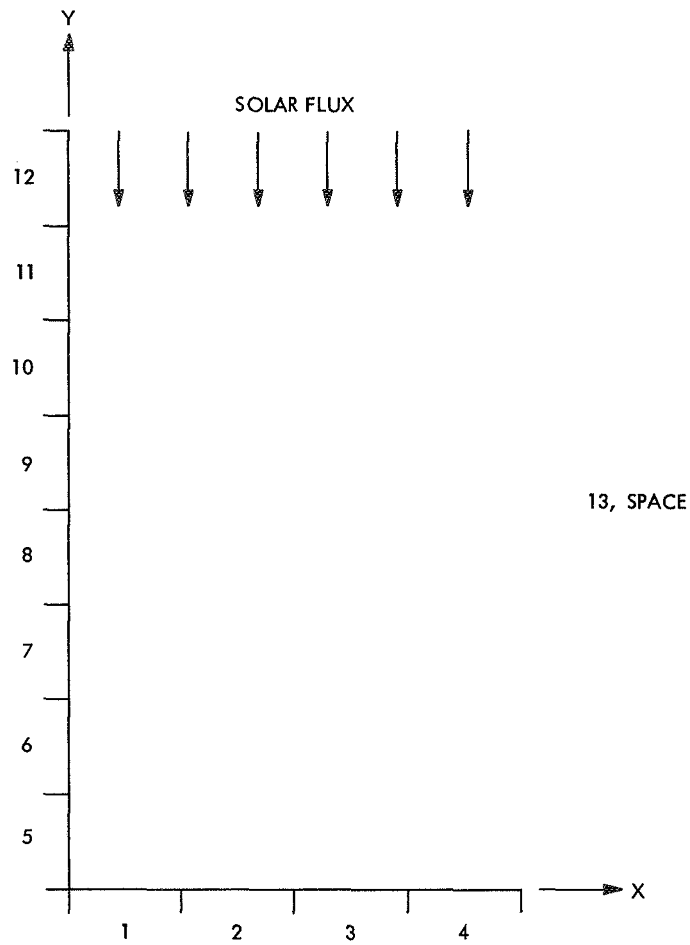

Fig. 1. Temperature distribution of an L-shape

(6) There is no coupling with the solar source (i.e., the form factor to the sun is zero).

(7) The surroundings are black and at absolute zero.

The discrete nodes and those associated with solar flux are shown in Fig. 1. Node 13 is the space node.

Since the L-shape is of infinite extent in one direction, the method outlined by Hottel (Ref. 1) (sometimes known as the method of crossed-uncrossed strings) may be used to calculate the view factors (*FA*). For example, the view factor $A(3) * F(3,6)$ for an L-shape with $X = 1$ and $Y = 2$ may be computed as follows:

$$A(3) * F(3,6) = \frac{(\text{length of crossed strings} - \text{length of uncrossed strings})}{2.0}$$

$$= \frac{(\sqrt{0.5^2 + 0.5^2} + \sqrt{0.25^2 + 0.75^2}) - (\sqrt{0.5^2 + 0.25^2} + \sqrt{0.5^2 + 0.75^2})}{2.0}$$

$$F(3,6) = 0.7454/\text{unit length}$$

The other view factors may be computed in a similar way. If shape factors are required for geometries that are not infinite in one dimension, a numerical technique such as that used in the computer program CONFAC II (Ref. 5) must be used.

An example of handwritten data input listing for TAS I is shown in Table 3. The data input listing starts with a number of comment cards. These comment cards are used for notes or comments on the input data and they will appear in the output.

The first data card is

$$N = 13 \text{ (integer)}$$

This indicates the number of nodes (four along the X-axis, eight along the Y-axis, and one for space).

Next, the shape factors in F elements are listed. Again, the order of entry in a particular data block is unimportant. Any grouping most convenient to the user is acceptable. The comment cards with a "C" in column 1, but otherwise blank, are used for clarity in the input. Their use is completely optional. Title cards with a "T" in column 1 appear on the output that follows.

Next, the areas are listed. For this particular problem, the areas of the nodes on the L-shape are set equal to 1, while the area of space is equal to the distance from $Y = 2$ to $X = 1$. The areas have been entered separately, one to a data card. However, they could have been entered as follows:

$$A(1) = 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 8.944$$

If one data card cannot contain all of the areas with columns 2 through 72, the user may put A (1) through A (10) on one card and A (11) through A (13) on the second card. Then the two data cards would appear as follows:

$$A(1) = 1., 1., 1., 1., 1., 1., 1., 1., 1., 1.,$$

$$A(11) = 1., 1., 8.944$$

The areas of all nodes involved in radiant transfer must be listed. The first character on each data card must always be a variable name.

The data cards following the areas are the angles theta to the solar input. Since nodes 1 through 4, which lie in the X-Z plane are normal to the sun, their angles are zero. Because the sun is located at the zenith position, nodes 5 through 12 receive no direct sunlight, so their angles are 90 deg. The computer program assumes that a node receives no direct solar input and automatically sets all theta values equal to 90 deg. It is therefore necessary to enter a theta value for each node that receives direct solar energy. The comment concerning multiple entries on a data card also apply for angles theta.

The data cards following the angles theta list the long-wave or infrared emittance (*EIR*). Every node with a shape factor or a view factor must have an infrared emittance. If no emittance value is input, a zero value will be assumed and used in the calculation. This means that there will be no infrared heat transfer to or from this node. The comments concerning multiple entries on a data card also apply for emittances.

The next set of data cards describes the solar emittance or solar absorptance (*ESOL*). Every node with a form factor that receives solar energy either directly or through solar reflection requires a solar emittance value for the calculation. As for infrared emittance, if no value of solar emittance is specified, the computer program uses the initialized value of zero in the calculation.

Finally, the space temperature is defined. A value of $-459.$ is entered as a constant-temperature node (*CT*). Since this is a constant-temperature node, its temperature will remain as defined and it is not dependent on any of its properties. However, its properties affect the temperature of other nonconstant-temperature nodes with which it has energy exchange. At least one node in every problem must be a constant-temperature node. If this requirement is not met, the program will be unable to find a unique solution because none exists.

The last card in a data block is always a control card. Because this first block contains the basic data, an END OF BASIC DATA card is used. All subsequent cases will use the data contained in the basic data block and any case data in a case data block.

The data cards unique to the first case follow next. Any number of comment cards may again be used. The number of title cards is limited to a total of 10 between the basic data card and the case being processed. The maximum of 10 title cards apportioned between the basic data and the case data is arbitrary so long as the maximum limit is not exceeded. If the limit is exceeded, the excess title cards will be printed as comment cards and processing will continue. The first case in the sample problem

Table 3. Example of handwritten data input listing for sample problem

FORTRAN Coding Form

PROGRAM: TAS — PROGRAMMER: J.A. HULTBERG — DATE: — PAGE 1 OF 3

```
T     TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
T     STEP RISER=Y, STEP TREAD=X
C
C     LOCAL RADIATION EQUILIBRIUM TEMPERATURES IN SEMIGRAY ENCLOSURES,
C     LOBCO, R.P., ALLENY, G.E., AND OTHMER, P.W.,
C     AEROSPACE TECHNOLOGY RESEARCH REPORT,
C     SSD 60475R  REPORT NUMBER 17  DECEMBER 1966
C     HUGHES AIRCRAFT COMPANY
C     SPACE SYSTEMS DIVISION
C     LOS ANGELES, CALIFORNIA
C
C     REF. 3. BOBCO, R.P., RADIATION FROM A DIRECTIONAL SOURCE, BEAM
C     DIVERGENCE IN SOLAR SIMULATORS, J. ENGR. FOR POWER, TRANS.ASME,
C     SER.A, VOL.87, NO 3, 1965, PP. 259-269.
C
C     FIGURE 1.  TEMPERATURE DISTRIBUTION OF AN L-SHAPE, Y=2X
C        1         2         3         4         5         6         7
C2345678901234567890123456789012345678901234567890123456789012345678901234567890
      N=13
      F(1,5)= .29289
      F(1,6)= .08907
      F(1,7)= .03689
      F(1,8)= .01959
      F(1,9)= .01204
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM TAS — PROGRAMMER J.A. HULTBERG — DATE — PAGE 2 OF 8

```
      F(1,10)=.00813
      F(1,11)=.00585
      F(1,12)=.00441
      F(1,13)=.53113
C
      F(2,5)= .08907
      F(2,6)= .11475
      F(2,7)= .07454
      F(2,8)= .04712
      F(2,9)= .03144
      F(2,10)=.02218
      F(2,11)=.01638
      F(2,12)=.01254
      F(2,13)=.59198
C
      F(3,5)= .03689
      F(3,6)= .07454
      F(3,7)= .07002
      F(3,8)= .05461
      F(3,9)= .04104
      F(3,10)=.03107
      F(3,11)=.02394
      F(3,12)=.01894
      F(3,13)=.64890
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM TAS

PROGRAMMER J.A. HULTBERG

DATE

PUNCHING INSTRUCTIONS: GRAPHIC / PUNCH

PAGE 3 OF 8

CARD ELECTRO NUMBER*

```
C
      F(4,5)=  .01959
      F(4,6)=  .04712
      F(4,7)=  .05461
      F(4,8)=  .05025
      F(4,9)=  .04234
      F(4,10)=.03464
      F(4,11)=.02821
      F(4,12)=.02311
      F(4,13)=.70013
C
      F(5,13)=.56156
      F(6,13)=.67452
      F(7,13)=.76394
      F(8,13)=.82843
      F(9,13)=.87314
      F(10,13)=.90398
      F(11,13)=.92557
      F(12,13)=.94100
C
      A(1)=1.0
      A(2)=1.0
      A(3)=1.0
      A(4)=1.0
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM TAS | PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | PAGE 4 OF 8

PROGRAMMER J.A. HULTBERG | DATE | CARD ELECTRO NUMBER*

```
C     STATEMENT NUMBER (1-5), CONT (6), FORTRAN STATEMENT (7-72), IDENTIFICATION SEQUENCE (73-80)
      A(5)=1.0
      A(6)=1.0
      A(7)=1.0
      A(8)=1.0
      A(9)=1.0
      A(10)=1.0
      A(11)=1.0
      A(12)=1.0
      A(13)=8.944272
C
C
C
      THETA(1)=0.0
      THETA(2)=0.0
      THETA(3)=0.0
      THETA(4)=0.0
C
      EIR(1)=0.90
      EIR(2)=0.90
      EIR(3)=0.90
      EIR(4)=0.90
      EIR(5)=0.90
      EIR(6)=0.90
      EIR(7)=0.90
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM TAS
PROGRAMMER J.A. HULTBERG
DATE
PUNCHING INSTRUCTIONS — GRAPHIC / PUNCH
PAGE 5 OF 8
CARD ELECTRO NUMBER*

```
      EIR(8)=0.90
      EIR(9)=0.90
      EIR(10)=0.90
      EIR(11)=0.90
      EIR(12)=0.90
      EIR(13)=1.0
C
      ESØL(1)=0.18
      ESØL(2)=0.18
      ESØL(3)=0.18
      ESØL(4)=0.18
      ESØL(5)=0.18
      ESØL(6)=0.18
      ESØL(7)=0.18
      ESØL(8)=0.18
      ESØL(9)=0.18
      ESØL(10)=0.18
      ESØL(11)=0.18
      ESØL(12)=0.18
      ESØL(13)=1.0
      CT(13)=-459.0
      END ØF BASIC DATA
T     CASE 1,Y=2X AND WHITE PAINT SURFACE
C
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM TAS | PROGRAMMER J.A. HULTBERG | DATE | PUNCHING INSTRUCTIONS: GRAPHIC / PUNCH | PAGE 6 OF 8 | CARD ELECTRO NUMBER*

```
C     THE RESULTING TEMPERATURES ARE
C              CASE 1     CASE 4
C              DEG F      DEG C
C     T(1)     66.24      19.02
C     T(2)     49.20       9.56
C     T(3)     39.89       4.38
C     T(4)     34.11       1.17
C     T(5)     12.79     -10.67
C     T(6)    -27.19     -32.89
C     T(7)    -62.91     -52.73
C     T(8)    -94.37     -70.20
C     T(9)   -121.45     -85.25
C     T(10)  -144.50     -98.05
C     T(11)  -164.12    -108.96
C     T(12)  -180.92    -118.29
C     T(13)  -459.00    -272.78  A CØNSTANT TEMPERATURE NØDE
C
      END ØF CASE
T     CASE 2, SAME CØNDITIØNS AS CASE 1, BUT DETAILED PRINTØUT REQUESTED
C        1         2         3         4         5         6         7
C23456789012345678901234567890123456789012345678901234567890123456789012
      PRINT(10)=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
      END ØF CASE
T     CASE 3, Y=2X AND ALUMINUM SURFACE
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM TAS
PROGRAMMER J.A. HULTBERG
DATE
PUNCHING INSTRUCTIONS — GRAPHIC / PUNCH
PAGE 7 OF 8
CARD ELECTRO NUMBER*
IDENTIFICATION SEQUENCE

STATEMENT NUMBER | CONT | FORTRAN STATEMENT

```
C        1         2         3         4         5         6         7
C23456789012345678901234567890123456789012345678901234567890123456789012
      EIR(1)=0.10
      EIR(2)=0.10
      EIR(3)=0.10
      EIR(4)=0.10
      EIR(5)=0.10
      EIR(6)=0.10
      EIR(7)=0.10
      EIR(8)=0.10
      EIR(9)=0.10
      EIR(10)=0.10
      EIR(11)=0.10
      EIR(12)=0.10
C
      ESØL(1)=0.20
      ESØL(2)=0.20
      ESØL(3)=0.20
      ESØL(4)=0.20
      ESØL(5)=0.20
      ESØL(6)=0.20
      ESØL(7)=0.20
      ESØL(8)=0.20
      ESØL(9)=0.20
```

JPL 0177-S DEC 66

Table 3 (contd)

FORTRAN Coding Form

PROGRAM: TAS
PROGRAMMER: J.A. HULTBERG
DATE:
PUNCHING INSTRUCTIONS — GRAPHIC / PUNCH
PAGE 8 OF 8
CARD ELECTRO NUMBER*

```
      ESØL(10)=0.20
      ESØL(11)=0.20
      ESØL(12)=0.20
      END ØF CASE
T     SAME AS CASE ØNE BUT WITH DIFFERENT UNITS, (WATTS, CM, DEG C)
      BØLTZ=.5675938835 1D-11
      ABSCVN=273.3333333333
      SØLCØN=.1394309344
      NITER=20
      CT(13)=-272.7777777777
      PRINT(10)=1
      END ØF CASE
      END ØF PRØBLEM
```

JPL 0177-S DEC 66

contains no data card, only comment cards. The temperatures listed are the results of the first case. They are shown as comment cards so that the card deck will be complete with answers from the first case to be used as a check case. The last card in the first-case data block is an END OF CASE control card. Therefore, the first case consists of the data in the basic data block and the data in the first-case data block.

The second case consists of only one data card. This card requests all of the additional output information to be printed. This is done by using the sequential method of entering data on a single card. Thus PRINT (10) through PRINT (31) (see Table 2) are all set equal to 1. If only certain additional outputs are required, they can be requested by separate cards. If we had wanted only those outputs requested by PRINT (10), PRINT (12), and PRINT (15), we could have requested them in several ways. The first method would be input

PRINT (10) = 1

PRINT (12) = 1

PRINT (15) = 1

Another method would be to write

PRINT (10) = 1, PRINT (12) = 1, PRINT (15) = 1

or, finally,

PRINT (10) = 1, 0, 1, 0, 0, 1

The second-case data block is entered with an END OF CASE control card. The second case is processed by the program initializing itself, the basic data, and finally reading the second-case data block. Any basic data which were overwritten in the first-case data block will be re-stored for subsequent case runs and the user is not required to re-enter the basic data values.

The third case involves changes in the *EIR* and *ESOL* values for the L-shape. This then gives the results for Case b discussed by Bobco (Refs. 3, 4). The third data block is also ended with an END OF CASE control card.

The fourth and final case illustrates the method by which the system of units may be changed. This fourth data block is also ended with an END OF CASE control card.

Finally, an END OF PROBLEM control card follows the last END OF CASE control card. Its purpose is to signal the program that a new basic data block may follow. The sample problem consists of only one problem with four cases. Therefore, when the program expects to find a new basic data block and none is present, control is returned to the computer executive system and the job is terminated.

The output for the sample problem is given in Table 4. The format of the output is described in Sect. VI. Note that all the shape factors sum to 1 as they should for any node with radiation exchange. Also note that only nodes 1 through 4 receive direct solar input as indicated by a THETA value not equal to 90 deg and also indicated in the solar portion of the tabulated output.

Table 4. Computer printout of sample problem: temperature disribution of an L-shape

```
  TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  0
T      TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY                    TITLE CARD
T      STEP RISER=Y, STEP TREAD=X                                            TITLE CARD
C                                                                            COMMENT CARD
C      LOCAL RADIATION EQUILIBRIUM TEMPERATURES IN SEMIGRAY ENCLOSURES,      COMMENT CARD
C      BOBCO,R.P., ALLENY,G.E., AND OTHMER,P,W.,                             COMMENT CARD
C      AEROSPACE TECHNOLOGY RESEARCH REPORT,                                 COMMENT CARD
C      SSD 60475R  REPORT NUMBER 17  DECEMBER 1966                           COMMENT CARD
C      HUGHES AIRCRAFT COMPANY                                               COMMENT CARD
C      SPACE SYSTEMS DIVISION                                                COMMENT CARD
C      LOSANGELES, CALIFORNIA                                                COMMENT CARD
C                                                                            COMMENT CARD
C      REF. 3, BOBCO, R.P., RADIATION FROM A DIRECTIONAL SOURCE, BEAM        COMMENT CARD
C      DIVERGENCE IN SOLAR SIMULATORS, J. ENGR. FOR POWER, TRANS.ASME,       COMMENT CARD
C      SER.A, VOL.87, NO 3, 1965, PP.259-269.                                COMMENT CARD
C                                                                            COMMENT CARD
C      FIGURE 1.  TEMPERATURE DISTRIBUTION OF AN L-SHAPE, Y=2X               COMMENT CARD
C        1         2         3         4         5         6         7       COMMENT CARD
C234567890123456789012345678901234567890123456789012345678901234567890123456789012  COMMENT CARD
      N=13                                                                   DATA CARD
      F(1,5)= .29289                                                         DATA CARD
      F(1,6)= .08907                                                         DATA CARD
      F(1,7)= .03689                                                         DATA CARD
      F(1,8)= .01959                                                         DATA CARD
      F(1,9)= .01204                                                         DATA CARD
      F(1,10)=.00813                                                         DATA CARD
      F(1,11)=.00585                                                         DATA CARD
      F(1,12)=.00441                                                         DATA CARD
      F(1,13)=.53113                                                         DATA CARD
C                                                                            COMMENT CARD
      F(2,5)= .08907                                                         DATA CARD
      F(2,6)= .11475                                                         DATA CARD
      F(2,7)= .07454                                                         DATA CARD
      F(2,8)= .04712                                                         DATA CARD
      F(2,9)= .03144                                                         DATA CARD
      F(2,10)=.02218                                                         DATA CARD
      F(2,11)=.01638                                                         DATA CARD
      F(2,12)=.01254                                                         DATA CARD
      F(2,13)=.59198                                                         DATA CARD
C                                                                            COMMENT CARD
      F(3,5)= .03689                                                         DATA CARD
      F(3,6)= .07454                                                         DATA CARD
      F(3,7)= .07002                                                         DATA CARD
      F(3,8)= .05461                                                         DATA CARD
      F(3,9)= .04104                                                         DATA CARD
      F(3,10)=.03107                                                         DATA CARD
      F(3,11)=.02399                                                         DATA CARD
      F(3,12)=.01894                                                         DATA CARD
      F(3,13)=.64890                                                         DATA CARD
C                                                                            COMMENT CARD
      F(4,5)= .01959                                                         DATA CARD
      F(4,6)= .04712                                                         DATA CARD
      F(4,7)= .05461                                                         DATA CARD
      F(4,8)= .05025                                                         DATA CARD
      F(4,9)= .04234                                                         DATA CARD
      F(4,10)=.03464                                                         DATA CARD
      F(4,11)=.02821                                                         DATA CARD
      F(4,12)=.02311                                                         DATA CARD
      F(4,13)=.70013                                                         DATA CARD
C                                                                            COMMENT CARD
      F(5,13)=.56156                                                         DATA CARD
      F(6,13)=.67452                                                         DATA CARD
      F(7,13)=.76394                                                         DATA CARD
      F(8,13)=.82843 ------------------------------------------------------- DATA CARD
      F(9,13)=.87314                                                         DATA CARD
      F(10,13)=.90398                                                        DATA CARD
      F(11,13)=.92557                                                        DATA CARD
      F(12,13)=.94100                                                        DATA CARD
C                                                                            COMMENT CARD
      A(1)=1.0                                                               DATA CARD
      A(2)=1.0                                                               DATA CARD
      A(3)=1.0                                                               DATA CARD
      A(4)=1.0                                                               DATA CARD
      A(5)=1.0                                                               DATA CARD
      A(6)=1.0                                                               DATA CARD
      A(7)=1.0                                                               DATA CARD
      A(8)=1.0                                                               DATA CARD
      A(9)=1.0                                                               DATA CARD
      A(10)=1.0                                                              DATA CARD
      A(11)=1.0                                                              DATA CARD
      A(12)=1.0                                                              DATA CARD
      A(13)=8.944272                                                         DATA CARD
C                                                                            COMMENT CARD
C                                                                            COMMENT CARD
C                                                                            COMMENT CARD
      THETA(1)=0.0                                                           DATA CARD
      THETA(2)=0.0                                                           DATA CARD
      THETA(3)=0.0                                                           DATA CARD
      THETA(4)=0.0                                                           DATA CARD
C                                                                            COMMENT CARD
      EIR(1)=0.90                                                            DATA CARD
      EIR(2)=0.90                                                            DATA CARD
      EIR(3)=0.90                                                            DATA CARD
      EIR(4)=0.90                                                            DATA CARD
      EIR(5)=0.90                                                            DATA CARD
      EIR(6)=0.90                                                            DATA CARD
      EIR(7)=0.90                                                            DATA CARD
      EIR(8)=0.90                                                            DATA CARD
      EIR(9)=0.90                                                            DATA CARD
      EIR(10)=0.90                                                           DATA CARD
      EIR(11)=0.90                                                           DATA CARD
      EIR(12)=0.90                                                           DATA CARD
      EIR(13)=1.0                                                            DATA CARD
```

-------- SIGNIFIES THE EXTENT OF THE ORIGINAL COMPUTER PAGE

Table 4 (contd)

```
C                                                                              COMMENT CARD
     ESOL(1)=0.18                                                              DATA CARD
     ESOL(2)=0.18                                                              DATA CARD
     ESOL(3)=0.18                                                              DATA CARD
     ESOL(4)=0.18                                                              DATA CARD
     ESOL(5)=0.18                                                              DATA CARD
     ESOL(6)=0.18                                                              DATA CARD
     ESOL(7)=0.18                                                              DATA CARD
     ESOL(8)=0.18                                                              DATA CARD
     ESOL(9)=0.18                                                              DATA CARD
     ESOL(10)=0.18                                                             DATA CARD
     ESOL(11)=0.18                                                             DATA CARD
     ESOL(12)=0.18                                                             DATA CARD
     ESOL(13)=1.0                                                              DATA CARD
     CT(13)=-459.0                                                             DATA CARD
     END OF BASIC DATA                                                         CONTROL CARD
```

```
  TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  1
    TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
    STEP RISER=Y, STEP TREAD=X
T    CASE 1, Y=2X AND WHITE PAINT SURFACE                                      TITLE CARD
C                                                                              COMMENT CARD
C    THE RESULTING TEMPERATURES ARE                                            COMMENT CARD
C              CASE 1     CASE 4                                               COMMENT CARD
C              DEG F      DEG C                                                COMMENT CARD
C    T(1)      66.24      19.02                                                COMMENT CARD
C    T(2)      49.20       9.56                                                COMMENT CARD
C    T(3)      39.89       4.38                                                COMMENT CARD
C    T(4)      34.11       1.17                                                COMMENT CARD
C    T(5)      12.79     -10.67                                                COMMENT CARD
C    T(6)     -27.19     -32.89                                                COMMENT CARD
C    T(7)     -62.91     -52.73                                                COMMENT CARD
C    T(8)     -94.37     -70.20                                                COMMENT CARD
C    T(9)    -121.45     -85.25                                                COMMENT CARD
C    T(10)   -144.50     -98.05                                                COMMENT CARD
C    T(11)   -164.12    -108.96                                                COMMENT CARD
C    T(12)   -180.92    -118.29                                                COMMENT CARD
C    T(13)   -459.00    -272.78  A CONSTANT TEMPERATURE NODE                   COMMENT CARD
C                                                                              COMMENT CARD
     END OF CASE                                                               CONTROL CARD
```

```
 TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  1
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 1, Y=2X AND WHITE PAINT SURFACE

  THE RESIDUES ARE
 1 = -0.22356963D 02   2 = -0.11339817D 02   3 = -0.28987155D 01   4 =  0.40090641D 01   5 =  0.38734681D 02
 6 =  0.60359433D 02   7 =  0.76932599D 02   8 =  0.88744152D 02   9 =  0.96891237D 02  10 =  0.10249620D 03
11 =  0.10641417D 03  12 =  0.10921168D 03  13 = -0.24151977D 04

  THE TEMPERATURES ARE
 1 =  0.68000000D 02   2 =  0.68000000D 02   3 =  0.68000000D 02   4 =  0.68000000D 02   5 =  0.68000000D 02
 6 =  0.68000000D 02   7 =  0.68000000D 02   8 =  0.68000000D 02   9 =  0.68000000D 02  10 =  0.68000000D 02
11 =  0.68000000D 02  12 =  0.68000000D 02  13 = -0.45900000D 03

  THE RESIDUES ARE
 1 = -0.42535637D 01   2 = -0.53402384D 01   3 = -0.47119868D 01   4 = -0.36726924D 01   5 =  0.50219929D 01
 6 =  0.11852708D 02   7 =  0.18124068D 02   8 =  0.23077140D 02   9 =  0.26718371D 02  10 =  0.29326499D 02
11 =  0.31198392D 02  12 =  0.32559117D 02  13 = -0.19278998D 04

  THE TEMPERATURES ARE
 1 =  0.66252734D 02   2 =  0.50181027D 02   3 =  0.42055845D 02   4 =  0.37239138D 02   5 =  0.20859498D 02
 6 = -0.44045546D 01   7 = -0.21773576D 02   8 = -0.33645471D 02   9 = -0.41688388D 02  10 = -0.47171089D 02
11 = -0.50983662D 02  12 = -0.53697166D 02  13 = -0.45900000D 03

  THE RESIDUES ARE
 1 = -0.41692335D 00   2 = -0.88136062D 00   3 = -0.10501660D 01   4 = -0.10591243D 01   5 =  0.10412061D 00
 6 =  0.80322014D 00   7 =  0.21214549D 01   8 =  0.37119108D 01   9 =  0.52309571D 01  10 =  0.65153739D 01
11 =  0.75428049D 01  12 =  0.83465184D 01  13 = -0.17989688D 04

  THE TEMPERATURES ARE
 1 =  0.66243994D 02   2 =  0.49203445D 02   3 =  0.39903569D 02   4 =  0.34143775D 02   5 =  0.12988041D 02
 6 = -0.25540004D 02   7 = -0.57473399D 02   8 = -0.82582336D 02   9 = -0.10139868D 03  10 = -0.11516982D 03
11 = -0.12523707D 03  12 = -0.13266244D 03  13 = -0.45900000D 03

  THE RESIDUES ARE
 1 = -0.24953717D-01   2 = -0.65915772D-01   3 = -0.90541760D-01   4 = -0.10092641D 00   5 = -0.17662267D-02
 6 =  0.25815070D-02   7 =  0.40453732D-01   8 =  0.16201837D 00   9 =  0.38961431D 00  10 =  0.69555239D 00
11 =  0.10330691D 01  12 =  0.13641286D 01  13 = -0.17714033D 04

  THE TEMPERATURES ARE
 1 =  0.66243993D 02   2 =  0.49200623D 02   3 =  0.39889590D 02   4 =  0.34114447D 02   5 =  0.12787159D 02
 6 = -0.27184151D 02   7 = -0.62802984D 02   8 = -0.93825735D 02   9 = -0.11982981D 03  10 = -0.14096276D 03
11 = -0.15785632D 03  12 = -0.17125830D 03  13 = -0.45900000D 03

  THE RESIDUES ARE
 1 = -0.53645589D-03   2 = -0.14946159D-02   3 = -0.21887189D-02   4 = -0.25823931D-02   5 = -0.42157859D-04
 6 = -0.50258155D-04   7 = -0.25139260D-04   8 =  0.32755244D-03   9 =  0.27365911D-02  10 =  0.11276139D-01
11 =  0.30737026D-01  12 =  0.63745309D-01  13 = -0.17681019D 04

  THE TEMPERATURES ARE
 1 =  0.66243993D 02   2 =  0.49200623D 02   3 =  0.39889589D 02   4 =  0.34114444D 02   5 =  0.12787031D 02
 6 = -0.27193567D 02   7 = -0.62912181D 02   8 = -0.94365023D 02   9 = -0.12143819D 03  10 = -0.14443804D 03
11 = -0.16392980D 03  12 = -0.18044526D 03  13 = -0.45900000D 03

  THE RESIDUES ARE
 1 = -0.82645983D-06   2 = -0.23339067D-05   3 = -0.34953383D-05   4 = -0.42252475D-05   5 = -0.66165924D-07
 6 = -0.80106506D-07   7 = -0.67991275D-07   8 = -0.51168017D-07   9 =  0.10056181D-06  10 =  0.30962271D-05
11 =  0.29882002D-04  12 =  0.16159605D-03  13 = -0.17680002D 04

  THE TEMPERATURES ARE
 1 =  0.66243993D 02   2 =  0.49200623D 02   3 =  0.39889589D 02   4 =  0.34114444D 02   5 =  0.12787031D 02
 6 = -0.27193567D 02   7 = -0.62912226D 02   8 = -0.94366218D 02   9 = -0.12144972D 03  10 = -0.14449629D 03
11 = -0.16412184D 03  12 = -0.18091821D 03  13 = -0.45900000D 03
```

THE RESIDUES ARE

1 =	-0.45901061D-11	2 =	-0.12477130D-10	3 =	-0.18793855D-10	4 =	-0.22687630D-10	5 =	-0.38014036D-12
6 =	-0.42277293D-12	7 =	-0.41922021D-12	8 =	-0.38014036D-12	9 =	-0.24691360D-12	10 =	0.48849813D-13
11 =	0.28209435D-10	12 =	0.10465522D-08	13 =	-0.17680000D 04				

THE TEMPERATURES ARE

1 =	0.66243993D 02	2 =	0.49200623D 02	3 =	0.39889589D 02	4 =	0.34114444D 02	5 =	0.12787031D 02
6 =	-0.27193567D 02	7 =	-0.62912226D 02	8 =	-0.94366218D 02	9 =	-0.12144972D 03	10 =	-0.14449631D 03
11 =	-0.16412202D 03	12 =	-0.18091942D 03	13 =	-0.45900000D 03				

....

TAS I, MAY 6, 1969 VERSION, JAH X2777, CASE NUMBER 1
TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
STEP RISER=Y, STEP TREAD=X
CASE 1, Y=2X AND WHITE PAINT SURFACE

ENERGY PER UNIT TIME IN IS NEGATIVE AND ENERGY PER UNIT TIME OUT IS POSITIVE

DETAIL OF NODE 1 TEMPERATURE = 66.24 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	0.0000D-38	0.0000D-38	0.7763D-02	-0.0000D-38	0.4087D 03	0.4087D 03
2	0.0000D-38	0.0000D-38	0.0000D-38	0.3301D-02	0.5354D-01	-0.0000D-38	0.5354D-01
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1790D-02	0.4372D-01	-0.0000D-38	0.4372D-01
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1135D-02	0.3324D-01	-0.0000D-38	0.3324D-01
5	0.0000D-38	0.0000D-38	0.2929D 00	0.2375D 00	0.1088D 02	-0.4229D 02	-0.3141D 02
6	0.0000D-38	0.0000D-38	0.8907D-01	0.7227D-01	0.5153D 01	-0.9325D 01	-0.4171D 01
7	0.0000D-38	0.0000D-38	0.3689D-01	0.2995D-01	0.2661D 01	-0.2774D 01	-0.1128D 00
8	0.0000D-38	0.0000D-38	0.1959D-01	0.1591D-01	0.1604D 01	-0.1066D 01	0.5387D 00
9	0.0000D-38	0.0000D-38	0.1204D-01	0.9784D-02	0.1066D 01	-0.4831D 00	0.5827D 00
10	0.0000D-38	0.0000D-38	0.8130D-02	0.6608D-02	0.7564D 00	-0.2465D 00	0.5099D 00
11	0.0000D-38	0.0000D-38	0.5850D-02	0.4756D-02	0.5627D 00	-0.1374D 00	0.4253D 00
12	0.0000D-38	0.0000D-38	0.4410D-02	0.3586D-02	0.4341D 00	-0.8205D-01	0.3520D 00
13	0.0000D-38	0.0000D-38	0.5311D 00	0.5056D 00	0.6646D 02	-0.0000D-38	0.6646D 02
TOTALS		0.0000D-38	0.1000D 01		0.8971D 02	-0.8971D 02	-0.4583D-11

DETAIL OF NODE 2 TEMPERATURE = 49.20 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.3301D-02	-0.5354D-01	-0.0000D-38	-0.5354D-01
2	0.0000D-38	0.0000D-38	0.0000D-38	0.2496D-02	-0.0000D-38	0.3916D 03	0.3916D 03
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1803D-02	0.1479D-01	-0.0000D-38	0.1479D-01
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1333D-02	0.1741D-01	-0.0000D-38	0.1741D-01
5	0.0000D-38	0.0000D-38	0.8907D-01	0.7227D-01	0.2139D 01	-0.1286D 02	-0.1072D 02
6	0.0000D-38	0.0000D-38	0.1147D 00	0.9303D-01	0.5124D 01	-0.1201D 02	-0.6889D 01
7	0.0000D-38	0.0000D-38	0.7454D-01	0.6043D-01	0.4388D 01	-0.5605D 01	-0.1217D 01
8	0.0000D-38	0.0000D-38	0.4712D-01	0.3820D-01	0.3232D 01	-0.2563D 01	0.6685D 00
9	0.0000D-38	0.0000D-38	0.3144D-01	0.2549D-01	0.2363D 01	-0.1261D 01	0.1102D 01
10	0.0000D-38	0.0000D-38	0.2218D-01	0.1798D-01	0.1767D 01	-0.6726D 00	0.1094D 01
11	0.0000D-38	0.0000D-38	0.1638D-01	0.1328D-01	0.1356D 01	-0.3847D 00	0.9713D 00
12	0.0000D-38	0.0000D-38	0.1254D-01	0.1017D-01	0.1066D 01	-0.2333D 00	0.8327D 00
13	0.0000D-38	0.0000D-38	0.5920D 00	0.5602D 00	0.6455D 02	-0.0000D-38	0.6455D 02
TOTALS		0.0000D-38	0.1000D 01		0.8597D 02	-0.8597D 02	-0.1246D-10

DETAIL OF NODE 3 TEMPERATURE = 39.89 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.1790D-02	-0.4372D-01	-0.0000D-38	-0.4372D-01
2	0.0000D-38	-0.0000D-38	0.0000D-38	0.1803D-02	-0.1479D-01	-0.0000D-38	-0.1479D-01
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1491D-02	-0.0000D-38	0.3828D 03	0.3828D 03
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1194D-02	0.5805D-02	-0.0000D-38	0.5805D-02
5	0.0000D-38	0.0000D-38	0.3689D-01	0.2996D-01	0.6408D 00	-0.5327D 01	-0.4686D 01
6	0.0000D-38	0.0000D-38	0.7454D-01	0.6043D-01	0.2833D 01	-0.7803D 01	-0.4970D 01
7	0.0000D-38	0.0000D-38	0.7002D-01	0.5675D-01	0.3656D 01	-0.5265D 01	-0.1609D 01
8	0.0000D-38	0.0000D-38	0.5461D-01	0.4426D-01	0.3381D 01	-0.2971D 01	0.4107D 00
9	0.0000D-38	0.0000D-38	0.4104D-01	0.3326D-01	0.2811D 01	-0.1647D 01	0.1164D 01
10	0.0000D-38	0.0000D-38	0.3107D-01	0.2518D-01	0.2267D 01	-0.9422D 00	0.1325D 01
11	0.0000D-38	0.0000D-38	0.2399D-01	0.1944D-01	0.1826D 01	-0.5634D 00	0.1262D 01
12	0.0000D-38	0.0000D-38	0.1894D-01	0.1535D-01	0.1483D 01	-0.3524D 00	0.1131D 01
13	0.0000D-38	0.0000D-38	0.6489D 00	0.6091D 00	0.6519D 02	-0.0000D-38	0.6519D 02
TOTALS		0.0000D-38	0.1000D 01		0.8404D 02	-0.8404D 02	-0.1876D-10

DETAIL OF NODE 4 TEMPERATURE = 34.11 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.1135D-02	-0.3324D-01	-0.0000D-38	-0.3324D-01
2	0.0000D-38	-0.0000D-38	0.0000D-38	0.1333D-02	-0.1741D-01	-0.0000D-38	-0.1741D-01
3	0.0000D-38	-0.0000D-38	0.0000D-38	0.1194D-02	-0.5805D-02	-0.0000D-38	-0.5805D-02
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1008D-02	-0.0000D-38	0.3776D 03	0.3776D 03
5	0.0000D-38	0.0000D-38	0.1959D-01	0.1592D-01	0.2632D 00	-0.2829D 01	-0.2566D 01
6	0.0000D-38	0.0000D-38	0.4712D-01	0.3821D-01	0.1606D 01	-0.4933D 01	-0.3327D 01
7	0.0000D-38	0.0000D-38	0.5461D-01	0.4426D-01	0.2636D 01	-0.4106D 01	-0.1470D 01
8	0.0000D-38	0.0000D-38	0.5025D-01	0.4072D-01	0.2913D 01	-0.2733D 01	0.1796D 00
9	0.0000D-38	0.0000D-38	0.4234D-01	0.3431D-01	0.2733D 01	-0.1699D 01	0.1034D 01
10	0.0000D-38	0.0000D-38	0.3464D-01	0.2807D-01	0.2391D 01	-0.1050D 01	0.1341D 01
11	0.0000D-38	0.0000D-38	0.2821D-01	0.2286D-01	0.2035D 01	-0.6625D 00	0.1373D 01
12	0.0000D-38	0.0000D-38	0.2311D-01	0.1873D-01	0.1719D 01	-0.4300D 00	0.1289D 01
13	0.0000D-38	0.0000D-38	0.7001D 00	0.6523D 00	0.6664D 02	-0.0000D-38	0.6664D 02
TOTALS		0.0000D-38	0.1000D 01		0.8288D 02	-0.8288D 02	-0.2270D-10

Table 4 (contd)

DETAIL OF NODE 5 TEMPERATURE = 12.79 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.2929D 00	0.2375D 00	-0.1088D 02	-0.1197D 03	-0.1306D 03
2	0.0000D-38	-0.0000D-38	0.8907D-01	0.7227D-01	-0.2139D 01	-0.3488D 02	-0.3702D 02
3	0.0000D-38	-0.0000D-38	0.3689D-01	0.2996D-01	-0.6408D 00	-0.1412D 02	-0.1476D 02
4	0.0000D-38	-0.0000D-38	0.1959D-01	0.1592D-01	-0.2632D 00	-0.7396D 01	-0.7660D 01
5	0.0000D-38	0.0000D-38	0.0000D-38	0.7742D-02	-0.0000D-38	0.1444D 03	0.1444D 03
6	0.0000D-38	0.0000D-38	0.0000D-38	0.3243D-02	0.8269D-01	-0.0000D-38	0.8269D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1712D-02	0.7364D-01	-0.0000D-38	0.7364D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1049D-02	0.5772D-01	-0.0000D-38	0.5772D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7035D-03	0.4441D-01	-0.0000D-38	0.4441D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5016D-03	0.3444D-01	-0.0000D-38	0.3444D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3741D-03	0.2712D-01	-0.0000D-38	0.2712D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2889D-03	0.2174D-01	-0.0000D-38	0.2174D-01
13	0.0000D-38	0.0000D-38	0.5616D 00	0.5287D 00	0.4528D 02	-0.0000D-38	0.4528D 02
TOTALS		0.0000D-38	0.1000D 01		0.3170D 02	-0.3170D 02	-0.3766D-12

DETAIL OF NODE 6 TEMPERATURE = -27.19 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8907D-01	0.7227D-01	-0.5153D 01	-0.3640D 02	-0.4156D 02
2	0.0000D-38	-0.0000D-38	0.1147D 00	0.9303D-01	-0.5124D 01	-0.4494D 02	-0.5006D 02
3	0.0000D-38	-0.0000D-38	0.7454D-01	0.6043D-01	-0.2833D 01	-0.2854D 02	-0.3137D 02
4	0.0000D-38	-0.0000D-38	0.4712D-01	0.3821D-01	-0.1606D 01	-0.1779D 02	-0.1940D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.3243D-02	-0.8269D-01	-0.0000D-38	-0.8269D-01
6	0.0000D-38	0.0000D-38	0.0000D-38	0.2342D-02	-0.0000D-38	0.1047D 03	0.1047D 03
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1592D-02	0.2790D-01	-0.0000D-38	0.2790D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1102D-02	0.3252D-01	-0.0000D-38	0.3252D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7893D-03	0.2970D-01	-0.0000D-38	0.2970D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5852D-03	0.2526D-01	-0.0000D-38	0.2526D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.4474D-03	0.2103D-01	-0.0000D-38	0.2103D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.3513D-03	0.1747D-01	-0.0000D-38	0.1747D-01
13	0.0000D-38	0.0000D-38	0.6745D 00	0.6256D 00	0.3763D 02	-0.0000D-38	0.3763D 02
TOTALS		0.0000D-38	0.1000D 01		0.2298D 02	-0.2298D 02	-0.4334D-12

DETAIL OF NODE 7 TEMPERATURE = -62.91 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.3689D-01	0.2995D-01	-0.2661D 01	-0.1508D 02	-0.1774D 02
2	0.0000D-38	-0.0000D-38	0.7454D-01	0.6043D-01	-0.4388D 01	-0.2919D 02	-0.3358D 02
3	0.0000D-38	-0.0000D-38	0.7C02D-01	0.5675D-01	-0.3656D 01	-0.2681D 02	-0.3046D 02
4	0.0000D-38	-0.0000D-38	0.5461D-01	0.4426D-01	-0.2636D 01	-0.2062D 02	-0.2325D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1712D-02	-0.7364D-01	-0.0000D-38	-0.7364D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1592D-02	-0.2790D-01	-0.0000D-38	-0.2790D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1200D-02	-0.0000D-38	0.7519D 02	0.7519D 02
8	0.0000D-38	0.0000D-38	0.0000D-38	0.8758D-03	0.1049D-01	-0.0000D-38	0.1049D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.6464D-03	0.1299D-01	-0.0000D-38	0.1299D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.4880D-03	0.1251D-01	-0.0000D-38	0.1251D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3775D-03	0.1113D-01	-0.0000D-38	0.1113D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2988D-03	0.9625D-02	-0.0000D-38	0.9625D-02
13	0.0000D-38	0.0000D-38	0.7639D 00	0.7014D 00	0.2989D 02	-0.0000D-38	0.2989D 02
TOTALS		0.0000D-38	0.1000D 01		0.1650D 02	-0.1650D 02	-0.4157D-12

DETAIL OF NODE 8 TEMPERATURE = -94.37 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1959D-01	0.1591D-01	-0.1604D 01	-0.8006D 01	-0.9611D 01
2	0.0000D-38	-0.0000D-38	0.4712D-01	0.3820D-01	-0.3232D 01	-0.1845D 02	-0.2169D 02
3	0.0000D-38	-0.0000D-38	0.5461D-01	0.4426D-01	-0.3381D 01	-0.2091D 02	-0.2429D 02
4	0.0000D-38	-0.0000D-38	0.5025D-01	0.4072D-01	-0.2913D 01	-0.1897D 02	-0.2189D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1049D-02	-0.5772D-01	-0.0000D-38	-0.5772D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1102D-02	-0.3252D-01	-0.0000D-38	-0.3252D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.8758D-03	-0.1049D-01	-0.0000D-38	-0.1049D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.6575D-03	-0.0000D-38	0.5440D 02	0.5440D 02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.4933D-03	0.4004D-02	-0.0000D-38	0.4004D-02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.3762D-03	0.5136D-02	-0.0000D-38	0.5136D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2929D-03	0.5126D-02	-0.0000D-38	0.5126D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2329D-03	0.4712D-02	-0.0000D-38	0.4712D-02
13	0.0000D-38	0.0000D-38	0.8284D 00	0.7558D 00	0.2315D 02	-0.0000D-38	0.2315D 02
TOTALS		0.0000D-38	0.1000D 01		0.1194D 02	-0.1194D 02	-0.3677D-12

DETAIL OF NODE 9 TEMPERATURE = -121.45 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1204D-01	0.9784D-02	-0.1066D 01	-0.4921D 01	-0.5987D 01
2	0.0000D-38	-0.0000D-38	0.3144D-01	0.2549D-01	-0.2363D 01	-0.1231D 02	-0.1468D 02
3	0.0000D-38	-0.0000D-38	0.4104D-01	0.3326D-01	-0.2811D 01	-0.1571D 02	-0.1852D 02
4	0.0000D-38	-0.0000D-38	0.4234D-01	0.3431D-01	-0.2733D 01	-0.1599D 02	-0.1872D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.7035D-03	-0.4441D-01	-0.0000D-38	-0.4441D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.7893D-03	-0.2970D-01	-0.0000D-38	-0.2970D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.6464D-03	-0.1299D-01	-0.0000D-38	-0.1299D-01
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.4933D-03	-0.4004D-02	-0.0000D-38	-0.4004D-02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.3737D-03	-0.0000D-38	0.4012D 02	0.4012D 02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.2867D-03	0.1586D-02	-0.0000D-38	0.1586D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2241D-03	0.2102D-02	-0.0000D-38	0.2102D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1786D-03	0.2164D-02	-0.0000D-38	0.2164D-02
13	0.0000D-38	0.0000D-38	0.8731D 00	0.7935D 00	0.1787D 02	-0.0000D-38	0.1787D 02
TOTALS		0.0000D-38	0.1000D 01		0.8808D 01	-0.8808D 01	-0.2451D-12

Table 4 (contd)

```
DETAIL OF NODE  10  TEMPERATURE = -144.50                    AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
  NODE CONDUCTANCE   Q COMP          F       ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
     1  0.0000D-38 -0.0000D-38  0.8130D-02  0.6608D-02 -0.7564D 00 -0.3323D 01 -0.4079D 01
     2  0.0000D-38 -0.0000D-38  0.2218D-01  0.1798D-01 -0.1767D 01 -0.8686D 01 -0.1045D 02
     3  0.0000D-38 -0.0000D-38  0.3107D-01  0.2518D-01 -0.2267D 01 -0.1189D 02 -0.1416D 02
     4  0.0000D-38 -0.0000D-38  0.3464D-01  0.2807D-01 -0.2391D 01 -0.1308D 02 -0.1547D 02
     5  0.0000D-38 -0.0000D-38  0.0000D-38  0.5016D-03 -0.3444D-01 -0.0000D-38 -0.3444D-01
     6  0.0000D-38 -0.0000D-38  0.0000D-38  0.5852D-03 -0.2526D-01 -0.0000D-38 -0.2526D-01
     7  0.0000D-38 -0.0000D-38  0.0000D-38  0.4880D-03 -0.1251D-01 -0.0000D-38 -0.1251D-01
     8  0.0000D-38 -0.0000D-38  0.0000D-38  0.3762D-03 -0.5136D-02 -0.0000D-38 -0.5136D-02
     9  0.0000D-38 -0.0000D-38  0.0C00D-38  0.2867D-03 -0.1586D-02 -0.0000D-38 -0.1586D-02
    10  0.0000D-38  0.0000D-38  0.0000D-38  0.2207D-03 -0.0000D-38  0.3033D 02  0.3033D 02
    11  0.0000D-38  0.0000D-38  0.0000D-38  0.1729D-03  0.6653D-03 -0.0000D-38  0.6653D-03
    12  0.0000D-38  0.0000D-38  0.0000D-38  0.1380D-03  0.9091D-03 -0.0000D-38  0.9091D-03
    13  0.0000D-38  0.0000D-38  0.9040D 00  0.8194D 00  0.1392D 02 -0.0000D-38  0.1392D 02
TOTALS                  0.0000D-38  0.1000D 01              0.6657D 01 -0.6657D 01  0.5684D-13


DETAIL OF NODE  11  TEMPERATURE = -164.12                    AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
  NODE CONDUCTANCE   Q COMP          F       ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
     1  0.0000D-38 -0.0000D-38  0.5850D-02  0.4756D-02 -0.5627D 00 -0.2391D 01 -0.2954D 01
     2  0.0000D-38 -0.0000D-38  0.1638D-01  0.1328D-01 -0.1356D 01 -0.6415D 01 -0.7771D 01
     3  0.0000D-38 -0.0000D-38  0.2399D-01  0.1944D-01 -0.1826D 01 -0.9184D 01 -0.1101D 02
     4  0.0000D-38 -0.0000D-38  0.2821D-01  0.2286D-01 -0.2035D 01 -0.1065D 02 -0.1269D 02
     5  0.0000D-38 -0.0000D-38  0.0000D-38  0.3741D-03 -0.2712D-01 -0.0000D-38 -0.2712D-01
     6  0.0000D-38 -0.0000D-38  0.0000D-38  0.4474D-03 -0.2103D-01 -0.0000D-38 -0.2103D-01
     7  0.0000D-38 -0.0000D-38  0.0000D-38  0.3775D-03 -0.1113D-01 -0.0000D-38 -0.1113D-01
     8  0.0000D-38 -0.0000D-38  0.0000D-38  0.2929D-03 -0.5126D-02 -0.0000D-38 -0.5126D-02
     9  0.0000D-38 -0.0000D-38  0.0000D-38  0.2241D-03 -0.2102D-02 -0.0000D-38 -0.2102D-02
    10  0.0000D-38 -0.0000D-38  0.0000D-38  0.1729D-03 -0.6653D-03 -0.0000D-38 -0.6653D-03
    11  0.0000D-38  0.0000D-38  0.0000D-38  0.1357D-03 -0.0000D-38  0.2349D 02  0.2349D 02
    12  0.0000D-38  0.0000D-38  0.0000D-38  0.1084D-03  0.2969D-03 -0.0000D-38  0.2969D-03
    13  0.0000D-38  0.0000D-38  0.9256D 00  0.8375D 00  0.1100D 02 -0.0000D-38  0.1100D 02
TOTALS                  0.0000D-38  0.1000D 01              0.5155D 01 -0.5155D 01  0.2822D-10


DETAIL OF NODE  12  TEMPERATURE = -180.92                    AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
  NODE CONDUCTANCE   Q COMP          F       ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
     1  0.0000D-38 -0.0000D-38  0.4410D-02  0.3586D-02 -0.4341D 00 -0.1802D 01 -0.2236D 01
     2  0.0000D-38 -0.0000D-38  0.1254D-01  0.1017D-01 -0.1066D 01 -0.4911D 01 -0.5977D 01
     3  0.0000D-38 -0.0000D-38  0.1894D-01  0.1535D-01 -0.1483D 01 -0.7251D 01 -0.8734D 01
     4  0.0000D-38 -0.0000D-38  0.2311D-01  0.1873D-01 -0.1719D 01 -0.8725D 01 -0.1044D 02
     5  0.0000D-38 -0.0000D-38  0.0000D-38  0.2889D-03 -0.2174D-01 -0.0000D-38 -0.2174D-01
     6  0.0000D-38 -0.0000D-38  0.0000D-38  0.3513D-03 -0.1747D-01 -0.0000D-38 -0.1747D-01
     7  0.0000D-38 -0.0000D-38  0.0000D-38  0.2988D-03 -0.9625D-02 -0.0000D-38 -0.9625D-02
     8  0.0000D-38 -0.0000D-38  0.0000D-38  0.2329D-03 -0.4712D-02 -0.0000D-38 -0.4712D-02
     9  0.0000D-38 -0.0000D-38  0.0000D-38  0.1786D-03 -0.2164D-02 -0.0000D-38 -0.2164D-02
    10  0.0000D-38 -0.0000D-38  0.0000D-38  0.1380D-03 -0.9091D-03 -0.0000D-38 -0.9091D-03
    11  0.0000D-38 -0.0000D-38  0.0000D-38  0.1084D-03 -0.2969D-03 -0.0000D-38 -0.2969D-03
    12  0.0000D-38  0.0000D-38  0.0000D-38  0.8668D-04 -0.0000D-38  0.1861D 02  0.1861D 02
    13  0.0000D-38  0.0000D-38  0.9410D 00  0.8505D 00  0.8843D 01 -0.0000D-38  0.8843D 01
TOTALS                  0.0000D-38  0.1000D 01              0.4084D 01 -0.4084D 01  0.1047D-08


DETAIL OF NODE  13  TEMPERATURE = -459.00                    AREA = 0.8944D 01
                    IR EMITTANCE = 1.0000       SOLAR EMITTANCE = 1.0000
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
   THIS IS A CONSTANT TEMPERATURE NODE
  NODE CONDUCTANCE   Q COMP          F       ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
     1  0.0000D-38 -0.0000D-38  0.5938D-01  0.5056D 00 -0.6646D 02 -0.2171D 03 -0.2835D 03
     2  0.0000D-38 -0.0000D-38  0.6619D-01  0.5602D 00 -0.6455D 02 -0.2318D 03 -0.2964D 03
     3  0.0000D-38 -0.0000D-38  0.7255D-01  0.6091D 00 -0.6519D 02 -0.2484D 03 -0.3136D 03
     4  0.0000D-38 -0.0000D-38  0.7828D-01  0.6523D 00 -0.6664D 02 -0.2643D 03 -0.3310D 03
     5  0.0000D-38 -0.0000D-38  0.6278D-01  0.5287D 00 -0.4528D 02 -0.8109D 02 -0.1264D 03
     6  0.0000D-38 -0.0000D-38  0.7541D-01  0.6256D 00 -0.3763D 02 -0.7061D 02 -0.1082D 03
     7  0.0000D-38 -0.0000D-38  0.8541D-01  0.7014D 00 -0.2989D 02 -0.5744D 02 -0.8733D 02
     8  0.0000D-38 -0.0000D-38  0.9262D-01  0.7558D 00 -0.2315D 02 -0.4506D 02 -0.6822D 02
     9  0.0000D-38 -0.0000D-38  0.9762D-01  0.7935D 00 -0.1787D 02 -0.3503D 02 -0.5290D 02
    10  0.0000D-38 -0.0000D-38  0.1011D 00  0.8194D 00 -0.1392D 02 -0.2741D 02 -0.4133D 02
    11  0.0000D-38 -0.0000D-38  0.1035D 00  0.8375D 00 -0.1100D 02 -0.2174D 02 -0.3274D 02
    12  0.0000D-38 -0.0000D-38  0.1052D 00  0.8505D 00 -0.8843D 01 -0.1751D 02 -0.2635D 02
    13  0.0000D-38  0.0000D-38  0.0000D-38  0.7047D 00 -0.0000D-38  0.0000D-38  0.0000D-38
TOTALS                  0.0000D-38  0.1000D 01             -0.4504D 03 -0.1318D 04 -0.1768D 04
```

```
  TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
     TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
     STEP RISER=Y, STEP TREAD=X
T      CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED          TITLE CARD
C          1         2         3         4         5         6         7           COMMENT CARD
C2345678901234567890123456789012345678901234567890123456789012345678901 2         COMMENT CARD
      PRINT(10)=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1                    DATA CARD
      END OF CASE                                                                 CONTROL CARD
```

```
$NAME2

N      =             13,

BOLTZ  =       0.17140000000000000D-08,

SOLCON =       0.44199999999999999D 03,

RELTOL =       0.99999999999999997D-05,

ABSCVN =       0.45999999999999999D 03,

NITER  =             15,

$ END
```

Table 4 (contd)

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE SYMMETRIC CONDUCTION MATRIX IS

ROW  1
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  2
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  3
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  4
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  5
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  6
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  7
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  8
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW  9
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW 10
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW 11
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW 12
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

ROW 13
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE SYMMETRIC FA MATRIX IS

ROW  1
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.29289000D 00
 6 =  0.89070000D-01   7 =  0.36890000D-01   8 =  0.19590000D-01   9 =  0.12040000D-01  10 =  0.81300000D-02
11 =  0.58500000D-02  12 =  0.44100000D-02  13 =  0.53113000D 00

ROW  2
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.89070000D-01
 6 =  0.11475000D 00   7 =  0.74540000D-01   8 =  0.47120000D-01   9 =  0.31440000D-01  10 =  0.22180000D-01
11 =  0.16380000D-01  12 =  0.12540000D-01  13 =  0.59198000D 00

ROW  3
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.36890000D-01
 6 =  0.74540000D-01   7 =  0.70020000D-01   8 =  0.54610000D-01   9 =  0.41040000D-01  10 =  0.31070000D-01
11 =  0.23990000D-01  12 =  0.18940000D-01  13 =  0.64890000D 00

ROW  4
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.19590000D-01
 6 =  0.47120000D-01   7 =  0.54610000D-01   8 =  0.50250000D-01   9 =  0.42340000D-01  10 =  0.34640000D-01
11 =  0.28210000D-01  12 =  0.23110000D-01  13 =  0.70013000D 00

ROW  5
 1 =  0.29289000D 00   2 =  0.89070000D-01   3 =  0.36890000D-01   4 =  0.19590000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.56156000D 00

ROW  6
 1 =  0.89070000D-01   2 =  0.11475000D 00   3 =  0.74540000D-01   4 =  0.47120000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.67452000D 00
```

```
ROW  7
 1 =  0.36890000D-01   2 =  0.74540000D-01   3 =  0.70020000D-01   4 =  0.54610000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.76394000D 00

ROW  8
 1 =  0.19590000D-01   2 =  0.47120000D-01   3 =  0.54610000D-01   4 =  0.50250000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.82843000D 00

ROW  9
 1 =  0.12040000D-01   2 =  0.31440000D-01   3 =  0.41040000D-01   4 =  0.42340000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.87314000D 00

ROW 10
 1 =  0.81300000D-02   2 =  0.22180000D-01   3 =  0.31070000D-01   4 =  0.34640000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.90398000D 00

ROW 11
 1 =  0.58500000D-02   2 =  0.16380000D-01   3 =  0.23990000D-01   4 =  0.28210000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.92557000D 00

ROW 12
 1 =  0.44100000D-02   2 =  0.12540000D-01   3 =  0.18940000D-01   4 =  0.23110000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00CC0000D-38  13 =  0.94100000D 00

ROW 13
 1 =  0.53113000D 00   2 =  0.59198000D 00   3 =  0.64890000D 00   4 =  0.70013000D 00   5 =  0.56156000D 00
 6 =  0.67452000D 00   7 =  0.76394000D 00   8 =  0.82843000D 00   9 =  0.87314000D 00  10 =  0.90398000D 00
11 =  0.92557000D 00  12 =  0.94100000D 00  13 =  0.00000000D-38


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE F MATRIX IS

ROW  1
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.29289000D 00
 6 =  0.89070000D-01   7 =  0.36890000D-01   8 =  0.19590000D-01   9 =  0.12040000D-01  10 =  0.81300000D-02
11 =  0.58500000D-02  12 =  0.44100000D-02  13 =  0.53113000D 00

ROW  2
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.89070000D-01
 6 =  0.11475000D 00   7 =  0.74540000D-01   8 =  0.47120000D-01   9 =  0.31440000D-01  10 =  0.22180000D-01
11 =  0.16380000D-01  12 =  0.12540000D-01  13 =  0.59198000D 00

ROW  3
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.36890000D-01
 6 =  0.74540000D-01   7 =  0.70020000D-01   8 =  0.54610000D-01   9 =  0.41040000D-01  10 =  0.31070000D-01
11 =  0.23990000D-01  12 =  0.18940000D-01  13 =  0.64890000D 00

ROW  4
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.19590000D-01
 6 =  0.47120000D-01   7 =  0.54610000D-01   8 =  0.50250000D-01   9 =  0.42340000D-01  10 =  0.34640000D-01
11 =  0.28210000D-01  12 =  0.23110000D-01  13 =  0.70013000D 00

ROW  5
 1 =  0.29289000D 00   2 =  0.89070000D-01   3 =  0.36890000D-01   4 =  0.19590000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.56156000D 00

ROW  6
 1 =  0.89070000D-01   2 =  0.11475000D 00   3 =  0.74540000D-01   4 =  0.47120000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.67452000D 00

ROW  7
 1 =  0.36890000D-01   2 =  0.74540000D-01   3 =  0.70020000D-01   4 =  0.54610000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.76394000D 00

ROW  8
 1 =  0.19590000D-01   2 =  0.47120000D-01   3 =  0.54610000D-01   4 =  0.50250000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.82843000D 00

ROW  9
 1 =  0.12040000D-01   2 =  0.31440000D-01   3 =  0.41040000D-01   4 =  0.42340000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.87314000D 00

ROW 10
 1 =  0.81300000D-02   2 =  0.22180000D-01   3 =  0.31070000D-01   4 =  0.34640000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.90398000D 00

ROW 11
 1 =  0.58500000D-02   2 =  0.16380000D-01   3 =  0.23990000D-01   4 =  0.28210000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.92557000D 00

ROW 12
 1 =  0.44100000D-02   2 =  0.12540000D-01   3 =  0.18940000D-01   4 =  0.23110000D-01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.94100000D 00

ROW 13
 1 =  0.59382139D-01   2 =  0.66185375D-01   3 =  0.72549225D-01   4 =  0.78276913D-01   5 =  0.62784316D-01
 6 =  0.75413628D-01   7 =  0.85411088D-01   8 =  0.92621289D-01   9 =  0.97620019D-01  10 =  0.10106804D 00
11 =  0.10348187D 00  12 =  0.10520700D 00  13 =  0.00000000D-38
```

Table 4 (contd)

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE AREAS ARE
 1 =  0.10000000D 01   2 =  0.10000000D 01   3 =  0.10000000D 01   4 =  0.10000000D 01   5 =  0.10000000D 01
 6 =  0.10000000D 01   7 =  0.10000000D 01   8 =  0.10000000D 01   9 =  0.10000000D 01  10 =  0.10000000D 01
11 =  0.10000000D 01  12 =  0.10000000D 01  13 =  0.89442720D 01

  THE IR EMITTANCES ARE
 1 =  0.90000000D 00   2 =  0.90000000D 00   3 =  0.90000000D 00   4 =  0.90000000D 00   5 =  0.90000000D 00
 6 =  0.90000000D 00   7 =  0.90000000D 00   8 =  0.90000000D 00   9 =  0.90000000D 00  10 =  0.90000000D 00
11 =  0.90000000D 00  12 =  0.90000000D 00  13 =  0.10000000D 01

  THE SOLAR EMITTANCES ARE
 1 =  0.18000000D 00   2 =  0.18000000D 00   3 =  0.18000000D 00   4 =  0.18000000D 00   5 =  0.18000000D 00
 6 =  0.18000000D 00   7 =  0.18000000D 00   8 =  0.18000000D 00   9 =  0.18000000D 00  10 =  0.18000000D 00
11 =  0.18000000D 00  12 =  0.18000000D 00  13 =  0.10000000D 01

  THE ILLUMINATIONS ARE
 1 =  0.10000000D 01   2 =  0.10000000D 01   3 =  0.10000000D 01   4 =  0.10000000D 01   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38

  THE ANGLES THETA TO THE SUN ARE
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.90000000D 02
 6 =  0.90000000D 02   7 =  0.90000000D 02   8 =  0.90000000D 02   9 =  0.90000000D 02  10 =  0.90000000D 02
11 =  0.90000000D 02  12 =  0.90000000D 02  13 =  0.90000000D 02

  THE CONSTANT TEMPERATURE NODES ARE
 1 = -0.50000000D 03   2 = -0.50000000D 03   3 = -0.50000000D 03   4 = -0.50000000D 03   5 = -0.50000000D 03
 6 = -0.50000000D 03   7 = -0.50000000D 03   8 = -0.50000000D 03   9 = -0.50000000D 03  10 = -0.50000000D 03
11 = -0.50000000D 03  12 = -0.50000000D 03  13 = -0.45900000D 03

  THE POWERS ARE
 1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38
                    ..........................................................................
```

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

THE EXCITATION VECTOR IS
 1 =  0.36244000D 03   2 =  0.36244000D 03   3 =  0.36244000D 03   4 =  0.36244000D 03   5 =  0.00000000D-38
 6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.00000000D-38
                    ..........................................................................
```

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

THE SOLAR TRANSFER MATRIX BEFORE INVERSION IS

 ROW  1
 1 =  0.10000000D 01   2 = -0.00000000D-38   3 = -0.00000000D-38   4 = -0.00000000D-38   5 = -0.24016980D 00
 6 = -0.73037400D-01   7 = -0.30249800D-01   8 = -0.16063800D-01   9 = -0.98728000D-02  10 = -0.66666000D-02
11 = -0.47970000D-02  12 = -0.36162000D-02  13 = -0.43552660D 00

 ROW  2
 1 = -0.00000000D-38   2 =  0.10000000D 01   3 = -0.00000000D-38   4 = -0.00000000D-38   5 = -0.73037400D-01
 6 = -0.94095000D-01   7 = -0.61122800D-01   8 = -0.38638400D-01   9 = -0.25780800D-01  10 = -0.18187600D-01
11 = -0.13431600D-01  12 = -0.10282800D-01  13 = -0.48542360D 00

 ROW  3
 1 = -0.00000000D-38   2 = -0.00000000D-38   3 =  0.10000000D 01   4 = -0.00000000D-38   5 = -0.30249800D-01
 6 = -0.61122800D-01   7 = -0.57416400D-01   8 = -0.44780200D-01   9 = -0.33652800D-01  10 = -0.25477400D-01
11 = -0.19671800D-01  12 = -0.15530800D-01  13 = -0.53209800D 00

 ROW  4
 1 = -0.00000000D-38   2 = -0.00000000D-38   3 = -0.00000000D-38   4 =  0.10000000D 01   5 = -0.16063800D-01
 6 = -0.38638400D-01   7 = -0.44780200D-01   8 = -0.41205000D-01   9 = -0.34718800D-01  10 = -0.28404800D-01
11 = -0.23132200D-01  12 = -0.18950200D-01  13 = -0.57410660D 00

 ROW  5
 1 = -0.24016980D 00   2 = -0.73037400D-01   3 = -0.30249800D-01   4 = -0.16063800D-01   5 =  0.10000000D 01
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.46047920D 00

 ROW  6
 1 = -0.73037400D-01   2 = -0.94095000D-01   3 = -0.61122800D-01   4 = -0.38638400D-01   5 = -0.00000000D-38
 6 =  0.10000000D 01   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.55310640D 00

 ROW  7
 1 = -0.30249800D-01   2 = -0.61122800D-01   3 = -0.57416400D-01   4 = -0.44780200D-01   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 =  0.10000000D 01   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.62643080D 00

 ROW  8
 1 = -0.16063800D-01   2 = -0.38638400D-01   3 = -0.44780200D-01   4 = -0.41205000D-01   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 =  0.10000000D 01   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.67931260D 00

 ROW  9
 1 = -0.98728000D-02   2 = -0.25780800D-01   3 = -0.33652800D-01   4 = -0.34718800D-01   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 =  0.10000000D 01  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.71597480D 00
```

Table 4 (contd)

```
ROW 10
 1 = -0.66666000D-02   2 = -0.18187600D-01   3 = -0.25477400D-01   4 = -0.28404800D-01   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 =  0.10000000D 01
11 = -0.00000000D-38  12 = -0.0000C000D-38  13 = -0.74126360D 00

ROW 11
 1 = -0.47970000D-02   2 = -0.13431600D-01   3 = -0.19671800D-01   4 = -0.23132200D-01   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 =  0.10000000D 01  12 = -0.0000C000D-38  13 = -0.75896740D 00

ROW 12
 1 = -0.36162000D-02   2 = -0.10282800D-01   3 = -0.15530800D-01   4 = -0.18950200D-01   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.0000C000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 =  0.10000000D 01  13 = -0.77162000D 00

ROW 13
 1 = -0.00000000D-38   2 = -0.0000C000D-38   3 = -0.00000000D-38   4 = -0.00000000D-38   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 =  0.10000000D 01


 TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
    TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
    STEP RISER=Y, STEP TREAD=X
    CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

THE SOLAR TRANSFER MATRIX AFTER INVERSION IS

 ROW  1
  1 =  0.10700515D 01   2 =  0.30270782D-01   3 =  0.16641565D-01   4 =  0.10655861D-01   5 =  0.25987954D 00
  6 =  0.82431015D-01   7 =  0.35651750D-01   8 =  0.19542996D-01   9 =  0.12274804D-01  10 =  0.84108198D-02
 11 =  0.61134852D-02  12 =  0.46411762D-02  13 =  0.71981824D 00

 ROW  2
  1 =  0.30270782D-01   2 =  0.10223610D 01   3 =  0.16054686D-01   4 =  0.11845446D-01   5 =  0.82616649D-01
  6 =  0.99848952D-01   7 =  0.64857494D-01   8 =  0.41195680D-01   9 =  0.27607686D-01  10 =  0.19541595D-01
 11 =  0.14466988D-01  12 =  0.11096014D-01  13 =  0.74048267D 00

 ROW  3
  1 =  0.16641565D-01   2 =  0.16054686D-01   3 =  0.10131155D 01   4 =  0.10456724D-01   5 =  0.35983910D-01
  6 =  0.65054610D-01   7 =  0.60122411D-01   8 =  0.46686038D-01   9 =  0.35035420D-01  10 =  0.26511509D-01
 11 =  0.20467162D-01  12 =  0.16157918D-01  13 =  0.75478826D 00

 ROW  4
  1 =  0.10655861D-01   2 =  0.11845446D-01   3 =  0.10456724D-01   4 =  0.10087686D 01   5 =  0.19945348D-01
  6 =  0.41509223D-01   7 =  0.46819613D-01   8 =  0.42663428D-01   9 =  0.35785722D-01  10 =  0.29206760D-01
 11 =  0.23750960D-01  12 =  0.19439107D-01  13 =  0.76584757D 00

 ROW  5
  1 =  0.25987954D 00   2 =  0.82616649D-01   3 =  0.35983910D-01   4 =  0.19945348D-01   5 =  0.10698582D 01
  6 =  0.29724833D-01   7 =  0.15870288D-01   8 =  0.98000428D-02   9 =  0.65990999D-02  10 =  0.47184316D-02
 11 =  0.35255640D-02  12 =  0.27261341D-02  13 =  0.72257535D 00

 ROW  6
  1 =  0.82431015D-01   2 =  0.99848952D-01   3 =  0.65054610D-01   4 =  0.41509223D-01   5 =  0.29724833D-01
  6 =  0.10209960D 01   7 =  0.14190562D-01   8 =  0.98057051D-02   9 =  0.70184310D-02  10 =  0.52020309D-02
 11 =  0.39764937D-02  12 =  0.31217721D-02  13 =  0.75108167D 00

 ROW  7
  1 =  0.35651750D-01   2 =  0.64857494D-01   3 =  0.60122411D-01   4 =  0.46819613D-01   5 =  0.15870288D-01
  6 =  0.14190562D-01   7 =  0.10105913D 01   8 =  0.77001881D-02   9 =  0.56728689D-02  10 =  0.42789426D-02
 11 =  0.33079180D-02  12 =  0.26168307D-02  13 =  0.77109756D 00

 ROW  8
  1 =  0.19542996D-01   2 =  0.41195680D-01   3 =  0.46686038D-01   4 =  0.42663428D-01   5 =  0.98000428D-02
  6 =  0.98057051D-02   7 =  0.77001881D-02   8 =  0.10057542D 01   9 =  0.43073406D-02  10 =  0.32808209D-02
 11 =  0.25523690D-02  12 =  0.20278303D-02  13 =  0.78484300D 00

 ROW  9
  1 =  0.12274804D-01   2 =  0.27607686D-01   3 =  0.35035420D-01   4 =  0.35785722D-01   5 =  0.65990999D-02
  6 =  0.70184310D-02   7 =  0.56728689D-02   8 =  0.43073406D-02   9 =  0.10032544D 01  10 =  0.24930464D-02
 11 =  0.19467099D-02  12 =  0.15505472D-02  13 =  0.79416170D 00

 ROW 10
  1 =  0.84108198D-02   2 =  0.19541595D-01   3 =  0.26511509D-01   4 =  0.29206760D-01   5 =  0.47184316D-02
  6 =  0.52020309D-02   7 =  0.42789426D-02   8 =  0.32808209D-02   9 =  0.24930464D-02  10 =  0.10019165D 01
 11 =  0.14999673D-02  12 =  0.11965764D-02  13 =  0.80051373D 00

 ROW 11
  1 =  0.61134852D-02   2 =  0.14466988D-01   3 =  0.20467162D-01   4 =  0.23750960D-01   5 =  0.35255640D-02
  6 =  0.39764937D-02   7 =  0.33079180D-02   8 =  0.25523690D-02   9 =  0.19467099D-02  10 =  0.14999673D-02
 11 =  0.10011757D 01  12 =  0.93882557D-03  13 =  0.80493002D 00

 ROW 12
  1 =  0.46411762D-02   2 =  0.11096014D-01   3 =  0.16157918D-01   4 =  0.19439107D-01   5 =  0.27261341D-02
  6 =  0.31217721D-02   7 =  0.26168307D-02   8 =  0.20278303D-02   9 =  0.15505472D-02  10 =  0.11965764D-02
 11 =  0.93882557D-03  12 =  0.10007502D 01  13 =  0.80807267D 00

 ROW 13
  1 =  0.00000000D-38   2 =  0.00000000D-38   3 =  0.00000000D-38   4 =  0.00000000D-38   5 =  0.00000000D-38
  6 =  0.00000000D-38   7 =  0.00000000D-38   8 =  0.00000000D-38   9 =  0.00000000D-38  10 =  0.00000000D-38
 11 =  0.00000000D-38  12 =  0.00000000D-38  13 =  0.10000000D 01


 TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
    TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
    STEP RISER=Y, STEP TREAD=X
    CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

THE RESPONSE VECTOR IS
  1 =  0.40869450D 03   2 =  0.39162798D 03   3 =  0.38283395D 03   4 =  0.37756341D 03   5 =  0.14440532D 03
  6 =  0.10468855D 03   7 =  0.75188637D 02   8 =  0.54397946D 02   9 =  0.40123424D 02  10 =  0.30325602D 02
 11 =  0.23485603D 02  12 =  0.18605573D 02  13 =  0.00000000D-38

   THE SOLAR QNET VECTOR IS
  1 = -0.89713426D 02   2 = -0.85967117D 02   3 = -0.84036720D 02   4 = -0.82879773D 02   5 = -0.31698728D 02
  6 = -0.22980413D 02   7 = -0.16504823D 02   8 = -0.11941013D 02   9 = -0.88075809D 01  10 = -0.66568396D 01
 11 = -0.51553763D 01  12 = -0.40841501D 01  13 = -0.13175740D 04
```

Table 4 (contd)

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  STEP 1 OF THE SCRIPT F MATRIX IS

ROW  1
 1 =  0.10000000D 01   2 = -0.00000000D-38   3 = -0.00000000D-38   4 = -0.00000000D-38   5 = -0.29289000D-01
 6 = -0.89070000D-02   7 = -0.36890000D-02   8 = -0.19590000D-02   9 = -0.12040000D-02  10 = -0.81300000D-03
11 = -0.58500000D-03  12 = -0.44100000D-03  13 = -0.53113000D-01

ROW  2
 1 = -0.00000000D-38   2 =  0.10000000D 01   3 = -0.00000000D-38   4 = -0.00000000D-38   5 = -0.89070000D-02
 6 = -0.11475000D-01   7 = -0.74540000D-02   8 = -0.47120000D-02   9 = -0.31440000D-02  10 = -0.22180000D-02
11 = -0.16380000D-02  12 = -0.12540000D-02  13 = -0.59198000D-01

ROW  3
 1 = -0.00000000D-38   2 = -0.00000000D-38   3 =  0.10000000D 01   4 = -0.00000000D-38   5 = -0.36890000D-02
 6 = -0.74540000D-02   7 = -0.70020000D-02   8 = -0.54610000D-02   9 = -0.41040000D-02  10 = -0.31070000D-02
11 = -0.23990000D-02  12 = -0.18940000D-02  13 = -0.64890000D-01

ROW  4
 1 = -0.00000000D-38   2 = -0.00000000D-38   3 = -0.00000000D-38   4 =  0.10000000D 01   5 = -0.19590000D-02
 6 = -0.47120000D-02   7 = -0.54610000D-02   8 = -0.50250000D-02   9 = -0.42340000D-02  10 = -0.34640000D-02
11 = -0.28210000D-02  12 = -0.23110000D-02  13 = -0.70013000D-01

ROW  5
 1 = -0.29289000D-01   2 = -0.89070000D-02   3 = -0.36890000D-02   4 = -0.19590000D-02   5 =  0.10000000D 01
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.56156000D-01

ROW  6
 1 = -0.89070000D-02   2 = -0.11475000D-01   3 = -0.74540000D-02   4 = -0.47120000D-02   5 = -0.00000000D-38
 6 =  0.10000000D 01   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.67452000D-01

ROW  7
 1 = -0.36890000D-02   2 = -0.74540000D-02   3 = -0.70020000D-02   4 = -0.54610000D-02   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 =  0.10000000D 01   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.76394000D-01

ROW  8
 1 = -0.19590000D-02   2 = -0.47120000D-02   3 = -0.54610000D-02   4 = -0.50250000D-02   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 =  0.10000000D 01   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.82843000D-01

ROW  9
 1 = -0.12040000D-02   2 = -0.31440000D-02   3 = -0.41040000D-02   4 = -0.42340000D-02   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 =  0.10000000D 01  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.87314000D-01

ROW 10
 1 = -0.81300000D-03   2 = -0.22180000D-02   3 = -0.31070000D-02   4 = -0.34640000D-02   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 =  0.10000000D 01
11 = -0.00000000D-38  12 = -0.00000000D-38  13 = -0.90398000D-01

ROW 11
 1 = -0.58500000D-03   2 = -0.16380000D-02   3 = -0.23990000D-02   4 = -0.28210000D-02   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 =  0.10000000D 01  12 = -0.00000000D-38  13 = -0.92557000D-01

ROW 12
 1 = -0.44100000D-03   2 = -0.12540000D-02   3 = -0.18940000D-02   4 = -0.23110000D-02   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 =  0.10000000D 01  13 = -0.94100000D-01

ROW 13
 1 = -0.00000000D-38   2 = -0.00000000D-38   3 = -0.00000000D-38   4 = -0.00000000D-38   5 = -0.00000000D-38
 6 = -0.00000000D-38   7 = -0.00000000D-38   8 = -0.00000000D-38   9 = -0.00000000D-38  10 = -0.00000000D-38
11 = -0.00000000D-38  12 = -0.00000000D-38  13 =  0.10000000D 01


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  STEP 2 OF THE SCRIPT F MATRIX IS

ROW  1
 1 =  0.10009584D 01   2 =  0.40750106D-03   3 =  0.22103768D-03   4 =  0.14017104D-03   5 =  0.29321791D-01
 6 =  0.89225209D-02   7 =  0.36978863D-02   8 =  0.19647091D-02   9 =  0.12079358D-02  10 =  0.81585535D-03
11 =  0.58715386D-03  12 =  0.44267625D-03  13 =  0.56181103D-01

ROW  2
 1 =  0.40750106D-03   2 =  0.10003082D 01   3 =  0.22264030D-03   4 =  0.16457769D-03   5 =  0.89228239D-02
 6 =  0.11484601D-01   7 =  0.74602581D-02   8 =  0.47162932D-02   9 =  0.31470701D-02  10 =  0.22202767D-02
11 =  0.16397416D-02  12 =  0.12553682D-02  13 =  0.62245608D-01

ROW  3
 1 =  0.22103768D-03   2 =  0.22264030D-03   3 =  0.10001840D 01   4 =  0.14742601D-03   5 =  0.36984247D-02
 6 =  0.74605899D-02   7 =  0.70065685D-02   8 =  0.54642278D-02   9 =  0.41063455D-02  10 =  0.31087559D-02
11 =  0.24003513D-02  12 =  0.18950659D-02  13 =  0.67676097D-01

ROW  4
 1 =  0.14017104D-03   2 =  0.16457769D-03   3 =  0.14742601D-03   4 =  0.10001244D 01   5 =  0.19653590D-02
 6 =  0.47168222D-02   7 =  0.54644556D-02   8 =  0.50274804D-02   9 =  0.42358180D-02  10 =  0.34653680D-02
11 =  0.28220562D-02  12 =  0.23118350D-02  13 =  0.72472787D-01

ROW  5
 1 =  0.29321791D-01   2 =  0.89228239D-02   3 =  0.36984247D-02   4 =  0.19653590D-02   5 =  0.10009558D 01
 6 =  0.40038743D-03   7 =  0.21130801D-03   8 =  0.12955876D-03   9 =  0.86856459D-04  10 =  0.61928448D-04
11 =  0.46185632D-04  12 =  0.35666892D-04  13 =  0.58747541D-01

ROW  6
 1 =  0.89225209D-02   2 =  0.11484601D-01   3 =  0.74605899D-02   4 =  0.47168222D-02   5 =  0.40038743D-03
 6 =  0.10002891D 01   7 =  0.19651901D-03   8 =  0.13603897D-03   9 =  0.97439587D-04  10 =  0.72245979D-04
11 =  0.55235562D-04  12 =  0.43367455D-04  13 =  0.69512623D-01
```

Table 4 (contd)

```
ROW  7
 1 =  0.369788630-02   2 =  0.746025810-02   3 =  0.700656850-02   4 =  0.546445560-02   5 =  0.211308010-03
 6 =  0.196519010-03   7 =  0.10001482D 01   8 =  0.108118660-03   9 =  0.797987690-04  10 =  0.602515170-04
11 =  0.466071530-04  12 =  0.368847290-04  13 =  0.779348730-01

ROW  8
 1 =  0.196470910-02   2 =  0.471629320-02   3 =  0.546422780-02   4 =  0.502748040-02   5 =  0.129558760-03
 6 =  0.136038970-03   7 =  0.108118660-03   8 =  0.10000812D 01   9 =  0.609050790-04  10 =  0.464505950-04
11 =  0.361658480-04  12 =  0.287484230-04  13 =  0.839801150-01

ROW  9
 1 =  0.120793580-02   2 =  0.314707010-02   3 =  0.410634550-02   4 =  0.423581800-02   5 =  0.868564590-04
 6 =  0.974395870-04   7 =  0.797987690-04   8 =  0.609050790-04   9 =  0.10000461D 01  10 =  0.353935420-04
11 =  0.276619090-04  12 =  0.220455190-04  13 =  0.881619350-01

ROW 10
 1 =  0.815855350-03   2 =  0.222027670-02   3 =  0.310875590-02   4 =  0.346536800-02   5 =  0.619284480-04
 6 =  0.722459790-04   7 =  0.602515170-04   8 =  0.464505950-04   9 =  0.353935420-04  10 =  0.10000273D 01
11 =  0.213477970-04  12 =  0.170404680-04  13 =  0.910430510-01

ROW 11
 1 =  0.587153860-03   2 =  0.163974160-02   3 =  0.240035130-02   4 =  0.282205620-02   5 =  0.461856320-04
 6 =  0.552355620-04   7 =  0.466071530-04   8 =  0.361658480-04   9 =  0.276619090-04  10 =  0.213477970-04
11 =  0.10000167D 01  12 =  0.133832080-04  13 =  0.930586250-01
                        ....................................................................................
ROW 12
 1 =  0.442676250-03   2 =  0.125536820-02   3 =  0.189506590-02   4 =  0.231183500-02   5 =  0.356668920-04
 6 =  0.433674550-04   7 =  0.368847290-04   8 =  0.287484230-04   9 =  0.220455190-04  10 =  0.170404680-04
11 =  0.133832080-04  12 =  0.10000107D 01  13 =  0.944984950-01

ROW 13
 1 =  0.000000000-38   2 =  0.000000000-38   3 =  0.000000000-38   4 =  0.000000000-38   5 =  0.000000000-38
 6 =  0.000000000-38   7 =  0.000000000-38   8 =  0.000000000-38   9 =  0.000000000-38  10 =  0.000000000-38
11 =  0.000000000-38  12 =  0.000000000-38  13 =  0.10000000D 01
                        ....................................................................................


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  STEP 3 OF THE SCRIPT F MATRIX IS

ROW  1
 1 =  0.958425550-02   2 =  0.407501060-02   3 =  0.221037680-02   4 =  0.140171040-02   5 =  0.29321791D 00
 6 =  0.892252090-01   7 =  0.369788630-01   8 =  0.196470910-01   9 =  0.120793580-01  10 =  0.815855350-02
11 =  0.587153860-02  12 =  0.442676250-02  13 =  0.56181103D 00

ROW  2
 1 =  0.407501060-02   2 =  0.308172420-02   3 =  0.222640300-02   4 =  0.164577690-02   5 =  0.892282390-01
 6 =  0.11484601D 00   7 =  0.746025810-01   8 =  0.471629320-01   9 =  0.314707010-01  10 =  0.222027670-01
11 =  0.163974160-01  12 =  0.125536820-01  13 =  0.62245608D 00

ROW  3
 1 =  0.221037680-02   2 =  0.222640300-02   3 =  0.184013910-02   4 =  0.147426010-02   5 =  0.369842470-01
 6 =  0.746058990-01   7 =  0.700656850-01   8 =  0.546422780-01   9 =  0.410634550-01  10 =  0.310875590-01
11 =  0.240035130-01  12 =  0.189506590-01  13 =  0.67676097D 00

ROW  4
 1 =  0.140171040-02   2 =  0.164577690-02   3 =  0.147426010-02   4 =  0.124422450-02   5 =  0.196535900-01
 6 =  0.471682220-01   7 =  0.546445560-01   8 =  0.502748040-01   9 =  0.423581800-01  10 =  0.346536800-01
11 =  0.282205620-01  12 =  0.231183500-01  13 =  0.72472787D 00

ROW  5
 1 =  0.29321791D 00   2 =  0.892282390-01   3 =  0.369842470-01   4 =  0.196535900-01   5 =  0.955775150-02
 6 =  0.400387430-02   7 =  0.211308010-02   8 =  0.129558760-02   9 =  0.868564590-03  10 =  0.619284480-03
11 =  0.461856320-03  12 =  0.356668920-03  13 =  0.58747541D 00

ROW  6
 1 =  0.892252090-01   2 =  0.11484601D 00   3 =  0.746058990-01   4 =  0.471682220-01   5 =  0.400387430-02
 6 =  0.289095590-02   7 =  0.196519010-02   8 =  0.136038970-02   9 =  0.974395870-03  10 =  0.722459790-03
11 =  0.552355620-03  12 =  0.433674550-03  13 =  0.69512623D 00

ROW  7
 1 =  0.369788630-01   2 =  0.746025810-01   3 =  0.700656850-01   4 =  0.546445560-01   5 =  0.211308010-02
 6 =  0.196519010-02   7 =  0.148151650-02   8 =  0.108118660-02   9 =  0.797987690-03  10 =  0.602515170-03
11 =  0.466071530-03  12 =  0.368847290-03  13 =  0.77934873D 00

ROW  8
 1 =  0.196470910-01   2 =  0.471629320-01   3 =  0.546422780-01   4 =  0.502748040-01   5 =  0.129558760-02
 6 =  0.136038970-02   7 =  0.108118660-02   8 =  0.811752760-03   9 =  0.609050790-03  10 =  0.464505950-03
11 =  0.361658480-03  12 =  0.287484230-03  13 =  0.83980115D 00

ROW  9
 1 =  0.120793580-01   2 =  0.314707010-01   3 =  0.410634550-01   4 =  0.423581800-01   5 =  0.868564590-03
 6 =  0.974395870-03   7 =  0.797987690-03   8 =  0.609050790-03   9 =  0.461356380-03  10 =  0.353935420-03
11 =  0.276619090-03  12 =  0.220455190-03  13 =  0.88161935D 00

ROW 10
 1 =  0.815855350-02   2 =  0.222027670-01   3 =  0.310875590-01   4 =  0.346536800-01   5 =  0.619284480-03
 6 =  0.722459790-03   7 =  0.602515170-03   8 =  0.464505950-03   9 =  0.353935420-03  10 =  0.272508040-03
11 =  0.213477970-03  12 =  0.170404680-03  13 =  0.91043051D 00

ROW 11
 1 =  0.587153860-02   2 =  0.163974160-01   3 =  0.240035130-01   4 =  0.282205620-01   5 =  0.461856320-03
 6 =  0.552355620-03   7 =  0.466071530-03   8 =  0.361658480-03   9 =  0.276619090-03  10 =  0.213477970-03
11 =  0.167488450-03  12 =  0.133832080-03  13 =  0.93058625D 00
                        ....................................................................................
ROW 12
 1 =  0.442676250-02   2 =  0.125536820-01   3 =  0.189506590-01   4 =  0.231183500-01   5 =  0.356668920-03
 6 =  0.433674550-03   7 =  0.368847290-03   8 =  0.287484230-03   9 =  0.220455190-03  10 =  0.170404680-03
11 =  0.133832080-03  12 =  0.107013570-03  13 =  0.94498495D 00

ROW 13
 1 =  0.628123820-01   2 =  0.695927050-01   3 =  0.756641760-01   4 =  0.810270390-01   5 =  0.656817470-01
 6 =  0.777174740-01   7 =  0.871338360-01   8 =  0.938926220-01   9 =  0.985680390-01  10 =  0.10178922D 00
11 =  0.10404270D 00  12 =  0.10565253D 00  13 =  0.787838650-01
```

Table 4 (contd)

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE SCRIPT F MATRIX IS

ROW  1
 1 =  0.77632469D-02   2 =  0.33007586D-02   3 =  0.17904052D-02   4 =  0.11353854D-02   5 =  0.23750651D 00
 6 =  0.72272419D-01   7 =  0.29952879D-01   8 =  0.15914144D-01   9 =  0.97842796D-02  10 =  0.66084284D-02
11 =  0.47559462D-02  12 =  0.35856776D-02  13 =  0.50562992D 00

ROW  2
 1 =  0.33007586D-02   2 =  0.24961966D-02   3 =  0.18033864D-02   4 =  0.13330793D-02   5 =  0.72274874D-01
 6 =  0.93025268D-01   7 =  0.60428090D-01   8 =  0.38201975D-01   9 =  0.25491268D-01  10 =  0.17984241D-01
11 =  0.13281907D-01  12 =  0.10168482D-01  13 =  0.56021047D 00

ROW  3
 1 =  0.17904052D-02   2 =  0.18033864D-02   3 =  0.14905127D-02   4 =  0.11941507D-02   5 =  0.29957240D-01
 6 =  0.60430778D-01   7 =  0.56753205D-01   8 =  0.44260245D-01   9 =  0.33261399D-01  10 =  0.25180923D-01
11 =  0.19442846D-01  12 =  0.15350034D-01  13 =  0.60908488D 00

ROW  4
 1 =  0.11353854D-02   2 =  0.13330793D-02   3 =  0.11941507D-02   4 =  0.10078218D-02   5 =  0.15919408D-01
 6 =  0.38206260D-01   7 =  0.44262090D-01   8 =  0.40722591D-01   9 =  0.34310126D-01  10 =  0.28069481D-01
11 =  0.22858656D-01  12 =  0.18725863D-01  13 =  0.65225509D 00

ROW  5
 1 =  0.23750651D 00   2 =  0.72274874D-01   3 =  0.29957240D-01   4 =  0.15919408D-01   5 =  0.77417787D-02
 6 =  0.32431381D-02   7 =  0.17115949D-02   8 =  0.10494260D-02   9 =  0.70353732D-03  10 =  0.50162043D-03
11 =  0.37410362D-03  12 =  0.28890182D-03  13 =  0.52872787D 00

ROW  6
 1 =  0.72272419D-01   2 =  0.93025268D-01   3 =  0.60430778D-01   4 =  0.38206260D-01   5 =  0.32431381D-02
 6 =  0.23416743D-02   7 =  0.15918040D-02   8 =  0.11019157D-02   9 =  0.78926065D-03  10 =  0.58519243D-03
11 =  0.44740805D-03  12 =  0.35127638D-03  13 =  0.62561361D 00

ROW  7
 1 =  0.29952879D-01   2 =  0.60428090D-01   3 =  0.56753205D-01   4 =  0.44262090D-01   5 =  0.17115949D-02
 6 =  0.15918040D-02   7 =  0.12000284D-02   8 =  0.87576111D-03   9 =  0.64637003D-03  10 =  0.48803728D-03
11 =  0.37751794D-03  12 =  0.29876631D-03  13 =  0.70141385D 00

ROW  8
 1 =  0.15914144D-01   2 =  0.38201975D-01   3 =  0.44260245D-01   4 =  0.40722591D-01   5 =  0.10494260D-02
 6 =  0.11019157D-02   7 =  0.87576111D-03   8 =  0.65751974D-03   9 =  0.49333114D-03  10 =  0.37624982D-03
11 =  0.29294337D-03  12 =  0.23286223D-03  13 =  0.75582104D 00

ROW  9
 1 =  0.97842796D-02   2 =  0.25491268D-01   3 =  0.33261399D-01   4 =  0.34310126D-01   5 =  0.70353732D-03
 6 =  0.78926065D-03   7 =  0.64637003D-03   8 =  0.49333114D-03   9 =  0.37369867D-03  10 =  0.28668769D-03
11 =  0.22406146D-03  12 =  0.17856871D-03  13 =  0.79345741D 00

ROW 10
 1 =  0.66084284D-02   2 =  0.17984241D-01   3 =  0.25180923D-01   4 =  0.28069481D-01   5 =  0.50162043D-03
 6 =  0.58519243D-03   7 =  0.48803728D-03   8 =  0.37624982D-03   9 =  0.28668769D-03  10 =  0.22073151D-03
11 =  0.17291716D-03  12 =  0.13802779D-03  13 =  0.81938746D 00

ROW 11
 1 =  0.47559462D-02   2 =  0.13281907D-01   3 =  0.19442846D-01   4 =  0.22858656D-01   5 =  0.37410362D-03
 6 =  0.44740805D-03   7 =  0.37751794D-03   8 =  0.29294337D-03   9 =  0.22406146D-03  10 =  0.17291716D-03
11 =  0.13566565D-03  12 =  0.10840399D-03  13 =  0.83752762D 00
                    ...........................................................................
ROW 12
 1 =  0.35856776D-02   2 =  0.10168482D-01   3 =  0.15350034D-01   4 =  0.18725863D-01   5 =  0.28890182D-03
 6 =  0.35127638D-03   7 =  0.29876631D-03   8 =  0.23286223D-03   9 =  0.17856871D-03  10 =  0.13802779D-03
11 =  0.10840399D-03  12 =  0.86680994D-04  13 =  0.85048645D 00

ROW 13
 1 =  0.56531143D-01   2 =  0.62633435D-01   3 =  0.68097759D-01   4 =  0.72924335D-01   5 =  0.59113573D-01
 6 =  0.69945727D-01   7 =  0.78420452D-01   8 =  0.84503360D-01   9 =  0.88711235D-01  10 =  0.91610302D-01
11 =  0.93638434D-01  12 =  0.95087275D-01  13 =  0.78783865D-01
                    ...........................................................................


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE AREA SCRIPT F MATRIX IS

ROW  1
 1 =  0.77632469D-02   2 =  0.33007586D-02   3 =  0.17904052D-02   4 =  0.11353854D-02   5 =  0.23750651D 00
 6 =  0.72272419D-01   7 =  0.29952879D-01   8 =  0.15914144D-01   9 =  0.97842796D-02  10 =  0.66084284D-02
11 =  0.47559462D-02  12 =  0.35856776D-02  13 =  0.50562992D 00

ROW  2
 1 =  0.33007586D-02   2 =  0.24961966D-02   3 =  0.18033864D-02   4 =  0.13330793D-02   5 =  0.72274874D-01
 6 =  0.93025268D-01   7 =  0.60428090D-01   8 =  0.38201975D-01   9 =  0.25491268D-01  10 =  0.17984241D-01
11 =  0.13281907D-01  12 =  0.10168482D-01  13 =  0.56021047D 00

ROW  3
 1 =  0.17904052D-02   2 =  0.18033864D-02   3 =  0.14905127D-02   4 =  0.11941507D-02   5 =  0.29957240D-01
 6 =  0.60430778D-01   7 =  0.56753205D-01   8 =  0.44260245D-01   9 =  0.33261399D-01  10 =  0.25180923D-01
11 =  0.19442846D-01  12 =  0.15350034D-01  13 =  0.60908488D 00

ROW  4
 1 =  0.11353854D-02   2 =  0.13330793D-02   3 =  0.11941507D-02   4 =  0.10078218D-02   5 =  0.15919408D-01
 6 =  0.38206260D-01   7 =  0.44262090D-01   8 =  0.40722591D-01   9 =  0.34310126D-01  10 =  0.28069481D-01
11 =  0.22858656D-01  12 =  0.18725863D-01  13 =  0.65225509D 00

ROW  5
 1 =  0.23750651D 00   2 =  0.72274874D-01   3 =  0.29957240D-01   4 =  0.15919408D-01   5 =  0.77417787D-02
 6 =  0.32431381D-02   7 =  0.17115949D-02   8 =  0.10494260D-02   9 =  0.70353732D-03  10 =  0.50162043D-03
11 =  0.37410362D-03  12 =  0.28890182D-03  13 =  0.52872787D 00

ROW  6
 1 =  0.72272419D-01   2 =  0.93025268D-01   3 =  0.60430778D-01   4 =  0.38206260D-01   5 =  0.32431381D-02
 6 =  0.23416743D-02   7 =  0.15918040D-02   8 =  0.11019157D-02   9 =  0.78926065D-03  10 =  0.58519243D-03
11 =  0.44740805D-03  12 =  0.35127638D-03  13 =  0.62561361D 00
```

Table 4 (contd)

```
ROW  7
 1 =  0.29952879D-01   2 =  0.60428090D-01   3 =  0.56753205D-01   4 =  0.44262090D-01   5 =  0.17115949D-02
 6 =  0.15918040D-02   7 =  0.12000284D-02   8 =  0.87576111D-03   9 =  0.64637003D-03  10 =  0.48803728D-03
11 =  0.37751794D-03  12 =  0.29876631D-03  13 =  0.70141385D 00

ROW  8
 1 =  0.15914144D-01   2 =  0.38201975D-01   3 =  0.44260245D-01   4 =  0.40722591D-01   5 =  0.10494260D-02
 6 =  0.11019157D-02   7 =  0.87576111D-03   8 =  0.65751974D-03   9 =  0.49333114D-03  10 =  0.37624982D-03
11 =  0.29294337D-03  12 =  0.23286223D-03  13 =  0.75582104D 00

ROW  9
 1 =  0.97842796D-02   2 =  0.25491268D-01   3 =  0.33261399D-01   4 =  0.34310126D-01   5 =  0.70353732D-03
 6 =  0.78926065D-03   7 =  0.64637003D-03   8 =  0.49333114D-03   9 =  0.37369867D-03  10 =  0.28668769D-03
11 =  0.22406146D-03  12 =  0.17856871D-03  13 =  0.79345741D 00

ROW 10
 1 =  0.66084284D-02   2 =  0.17984241D-01   3 =  0.25180923D-01   4 =  0.28069481D-01   5 =  0.50162043D-03
 6 =  0.58519243D-03   7 =  0.48803728D-03   8 =  0.37624982D-03   9 =  0.28668769D-03  10 =  0.22073151D-03
11 =  0.17291716D-03  12 =  0.13802779D-03  13 =  0.81938746D 00

ROW 11
 1 =  0.47559462D-02   2 =  0.13281907D-01   3 =  0.19442846D-01   4 =  0.22858656D-01   5 =  0.37410362D-03
 6 =  0.44740805D-03   7 =  0.37751794D-03   8 =  0.29294337D-03   9 =  0.22406146D-03  10 =  0.17291716D-03
11 =  0.13566565D-03  12 =  0.10840399D-03  13 =  0.83752762D 00
                    ..........................................................................
ROW 12
 1 =  0.35856776D-02   2 =  0.10168482D-01   3 =  0.15350034D-01   4 =  0.18725863D-01   5 =  0.28890182D-03
 6 =  0.35127638D-03   7 =  0.29876631D-03   8 =  0.23286223D-03   9 =  0.17856871D-03  10 =  0.13802779D-03
11 =  0.10840399D-03  12 =  0.86680994D-04  13 =  0.85048645D 00

ROW 13
 1 =  0.50562992D 00   2 =  0.56021047D 00   3 =  0.60908488D 00   4 =  0.65225509D 00   5 =  0.52872787D 00
 6 =  0.62561361D 00   7 =  0.70141385D 00   8 =  0.75582104D 00   9 =  0.79345741D 00  10 =  0.81938746D 00
11 =  0.83752762D 00  12 =  0.85048645D 00  13 =  0.70466432D 00
                    ..........................................................................


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE BOLTZ TIMES THE AREA SCRIPT F MATRIX IS

ROW  1
 1 =  0.13306205D-10   2 =  0.56575003D-11   3 =  0.30687545D-11   4 =  0.19460506D-11   5 =  0.40708615D-09
 6 =  0.12387493D-09   7 =  0.51339235D-10   8 =  0.27276843D-10   9 =  0.16770255D-10  10 =  0.11326846D-10
11 =  0.81516919D-11  12 =  0.61458515D-11  13 =  0.86664969D-09

ROW  2
 1 =  0.56575003D-11   2 =  0.42784809D-11   3 =  0.30910043D-11   4 =  0.22848980D-11   5 =  0.12387913D-09
 6 =  0.15944531D-09   7 =  0.10357375D-09   8 =  0.65478186D-10   9 =  0.43692033D-10  10 =  0.30824989D-10
11 =  0.22765188D-10  12 =  0.17428779D-10  13 =  0.96020075D-09

ROW  3
 1 =  0.30687545D-11   2 =  0.30910043D-11   3 =  0.25547387D-11   4 =  0.20467743D-11   5 =  0.51346709D-10
 6 =  0.10357835D-09   7 =  0.97274993D-10   8 =  0.75862060D-10   9 =  0.57010037D-10  10 =  0.43160102D-10
11 =  0.33325038D-10  12 =  0.26309958D-10  13 =  0.10439715D-08

ROW  4
 1 =  0.19460506D-11   2 =  0.22848980D-11   3 =  0.20467743D-11   4 =  0.17274066D-11   5 =  0.27285865D-10
 6 =  0.65485530D-10   7 =  0.75865223D-10   8 =  0.69798521D-10   9 =  0.58807556D-10  10 =  0.48111091D-10
11 =  0.39179736D-10  12 =  0.32096129D-10  13 =  0.11179652D-08

ROW  5
 1 =  0.40708615D-09   2 =  0.12387913D-09   3 =  0.51346709D-10   4 =  0.27285865D-10   5 =  0.13269409D-10
 6 =  0.55587388D-11   7 =  0.29336736D-11   8 =  0.17987161D-11   9 =  0.12058630D-11  10 =  0.85977742D-12
11 =  0.64121360D-12  12 =  0.49517773D-12  13 =  0.90623957D-09

ROW  6
 1 =  0.12387493D-09   2 =  0.15944531D-09   3 =  0.10357835D-09   4 =  0.65485530D-10   5 =  0.55587388D-11
 6 =  0.40136297D-11   7 =  0.27283520D-11   8 =  0.18886835D-11   9 =  0.13527928D-11  10 =  0.10030198D-11
11 =  0.76685740D-12  12 =  0.60208772D-12  13 =  0.10723017D-08

ROW  7
 1 =  0.51339235D-10   2 =  0.10357375D-09   3 =  0.97274993D-10   4 =  0.75865223D-10   5 =  0.29336736D-11
 6 =  0.27283520D-11   7 =  0.20568486D-11   8 =  0.15010545D-11   9 =  0.11078782D-11  10 =  0.83649591D-12
11 =  0.64706575D-12  12 =  0.51208545D-12  13 =  0.12022233D-08

ROW  8
 1 =  0.27276843D-10   2 =  0.65478186D-10   3 =  0.75862060D-10   4 =  0.69798521D-10   5 =  0.17987161D-11
 6 =  0.18886835D-11   7 =  0.15010545D-11   8 =  0.11269888D-11   9 =  0.84556957D-12  10 =  0.64489219D-12
11 =  0.50210493D-12  12 =  0.39912586D-12  13 =  0.12954773D-08

ROW  9
 1 =  0.16770255D-10   2 =  0.43692033D-10   3 =  0.57010037D-10   4 =  0.58807556D-10   5 =  0.12058630D-11
 6 =  0.13527928D-11   7 =  0.11078782D-11   8 =  0.84556957D-12   9 =  0.64051952D-12  10 =  0.49138271D-12
11 =  0.38404134D-12  12 =  0.30606676D-12  13 =  0.13599860D-08

ROW 10
 1 =  0.11326846D-10   2 =  0.30824989D-10   3 =  0.43160102D-10   4 =  0.48111091D-10   5 =  0.85977742D-12
 6 =  0.10030198D-11   7 =  0.83649591D-12   8 =  0.64489219D-12   9 =  0.49138271D-12  10 =  0.37833381D-12
11 =  0.29638001D-12  12 =  0.23657964D-12  13 =  0.14044301D-08

ROW 11
 1 =  0.81516919D-11   2 =  0.22765188D-10   3 =  0.33325038D-10   4 =  0.39179736D-10   5 =  0.64121360D-12
 6 =  0.76685740D-12   7 =  0.64706575D-12   8 =  0.50210493D-12   9 =  0.38404134D-12  10 =  0.29638001D-12
11 =  0.23253092D-12  12 =  0.18580443D-12  13 =  0.14355223D-08
                    ..........................................................................
ROW 12
 1 =  0.61458515D-11   2 =  0.17428779D-10   3 =  0.26309958D-10   4 =  0.32096129D-10   5 =  0.49517773D-12
 6 =  0.60208772D-12   7 =  0.51208545D-12   8 =  0.39912586D-12   9 =  0.30606676D-12  10 =  0.23657964D-12
11 =  0.18580443D-12  12 =  0.14857122D-12  13 =  0.14577338D-08

ROW 13
 1 =  0.86664969D-09   2 =  0.96020075D-09   3 =  0.10439715D-08   4 =  0.11179652D-08   5 =  0.90623957D-09
 6 =  0.10723017D-08   7 =  0.12022233D-08   8 =  0.12954773D-08   9 =  0.13599860D-08  10 =  0.14044301D-08
11 =  0.14355223D-08  12 =  0.14577338D-08  13 =  0.12077946D-08
                    ..........................................................................
```

Table 4 (contd)

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  THE RESIDUES ARE
 1 = -0.45901061D-11   2 = -0.12477130D-10   3 = -0.18793855D-10   4 = -0.22687630D-10   5 = -0.38014036D-12
 6 = -0.42277293D-12   7 = -0.41922021D-12   8 = -0.38014036D-12   9 = -0.24691360D-12  10 =  0.48849813D-13
11 =  0.28209435D-10  12 =  0.10465522D-08  13 = -0.17680000D 04

  THE TEMPERATURES ARE
 1 =  0.66243993D 02   2 =  0.49200623D 02   3 =  0.39889589D 02   4 =  0.34114444D 02   5 =  0.12787031D 02
 6 = -0.27193567D 02   7 = -0.62912226D 02   8 = -0.94366218D 02   9 = -0.12144972D 03  10 = -0.14449631D 03
11 = -0.16412202D 03  12 = -0.18091942D 03  13 = -0.45900000D 03
                         ..........................................................................
```

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  2
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQRESTED

  ENERGY PER UNIT TIME IN IS NEGATIVE AND ENERGY PER UNIT TIME OUT IS POSITIVE


DETAIL OF NODE   1  TEMPERATURE =   66.24                AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.1000D 01           THETA = 0.00000D-38
  NODE CONDUCTANCE   Q COMP          F      ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
                                                    DIRECT SOLAR -0.4420D 03 -0.4420D 03
    1  0.0000D-38  0.0000D-38  0.0000D-38  0.7763D-02 -0.0000D-38  0.4087D 03  0.4087D 03
    2  0.0000D-38  0.0000D-38  0.0000D-38  0.3301D-02  0.5354D-01 -0.0000D-38  0.5354D-01
    3  0.0000D-38  0.0000D-38  0.0000D-38  0.1790D-02  0.4372D-01 -0.0000D-38  0.4372D-01
    4  0.0000D-38  0.0000D-38  0.0000D-38  0.1135D-02  0.3324D-01 -0.0000D-38  0.3324D-01
    5  0.0000D-38  0.0000D-38  0.2929D 00  0.2375D 00  0.1088D 02 -0.4229D 02 -0.3141D 02
    6  0.0000D-38  0.0000D-38  0.8907D-01  0.7227D-01  0.5153D 01 -0.9325D 01 -0.4171D 01
    7  0.0000D-38  0.0000D-38  0.3689D-01  0.2995D-01  0.2661D 01 -0.2774D 01 -0.1128D 00
    8  0.0000D-38  0.0000D-38  0.1959D-01  0.1591D-01  0.1604D 01 -0.1066D 01  0.5387D 00
    9  0.0000D-38  0.0000D-38  0.1204D-01  0.9784D-02  0.1066D 01 -0.4831D 00  0.5827D 00
   10  0.0000D-38  0.0000D-38  0.8130D-02  0.6608D-02  0.7564D 00 -0.2465D 00  0.5099D 00
   11  0.0000D-38  0.0000D-38  0.5850D-02  0.4756D-02  0.5627D 00 -0.1374D 00  0.4253D 00
   12  0.0000D-38  0.0000D-38  0.4410D-02  0.3586D-02  0.4341D 00 -0.8205D-01  0.3520D 00
   13  0.0000D-38  0.0000D-38  0.5311D 00  0.5056D 00  0.6646D 02 -0.0000D-38  0.6646D 02
TOTALS             0.0000D-38  0.1000D 01              0.8971D 02 -0.8971D 02 -0.4583D-11


DETAIL OF NODE   2  TEMPERATURE =   49.20                AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.1000D 01           THETA = 0.00000D-38
  NODE CONDUCTANCE   Q COMP          F      ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
                                                    DIRECT SOLAR -0.4420D 03 -0.4420D 03
    1  0.0000D-38 -0.0000D-38  0.0000D-38  0.3301D-02 -0.5354D-01 -0.0000D-38 -0.5354D-01
    2  0.0000D-38  0.0000D-38  0.0000D-38  0.2496D-02 -0.0000D-38  0.3916D 03  0.3916D 03
    3  0.0000D-38  0.0000D-38  0.0000D-38  0.1803D-02  0.1479D-01 -0.0000D-38  0.1479D-01
    4  0.0000D-38  0.0000D-38  0.0000D-38  0.1333D-02  0.1741D-01 -0.0000D-38  0.1741D-01
    5  0.0000D-38  0.0000D-38  0.8907D-01  0.7227D-01  0.2139D 01 -0.1286D 02 -0.1072D 02
    6  0.0000D-38  0.0000D-38  0.1147D 00  0.9303D-01  0.5124D 01 -0.1201D 02 -0.6889D 01
    7  0.0000D-38  0.0000D-38  0.7454D-01  0.6043D-01  0.4388D 01 -0.5605D 01 -0.1217D 01
    8  0.0000D-38  0.0000D-38  0.4712D-01  0.3820D-01  0.3232D 01 -0.2563D 01  0.6685D 00
    9  0.0000D-38  0.0000D-38  0.3144D-01  0.2549D-01  0.2363D 01 -0.1261D 01  0.1102D 01
   10  0.0000D-38  0.0000D-38  0.2218D-01  0.1798D-01  0.1767D 01 -0.6726D 00  0.1094D 01
   11  0.0000D-38  0.0000D-38  0.1638D-01  0.1328D-01  0.1356D 01 -0.3847D 00  0.9713D 00
   12  0.0000D-38  0.0000D-38  0.1254D-01  0.1017D-01  0.1066D 01 -0.2333D 00  0.8327D 00
   13  0.0000D-38  0.0000D-38  0.5920D 00  0.5602D 00  0.6455D 02 -0.0000D-38  0.6455D 02
TOTALS             0.0000D-38  0.1000D 01              0.8597D 02 -0.8597D 02 -0.1246D-10


DETAIL OF NODE   3  TEMPERATURE =   39.89                AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.1000D 01           THETA = 0.00000D-38
  NODE CONDUCTANCE   Q COMP          F      ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
                                                    DIRECT SOLAR -0.4420D 03 -0.4420D 03
    1  0.0000D-38 -0.0000D-38  0.0000D-38  0.1790D-02 -0.4372D-01 -0.0000D-38 -0.4372D-01
    2  0.0000D-38 -0.0000D-38  0.0000D-38  0.1803D-02 -0.1479D-01 -0.0000D-38 -0.1479D-01
    3  0.0000D-38  0.0000D-38  0.0000D-38  0.1491D-02 -0.0000D-38  0.3828D 03  0.3828D 03
    4  0.0000D-38  0.0000D-38  0.0000D-38  0.1194D-02  0.5805D-02 -0.0000D-38  0.5805D-02
    5  0.0000D-38  0.0000D-38  0.3689D-01  0.2996D-01  0.6408D 00 -0.5327D 01 -0.4686D 01
    6  0.0000D-38  0.0000D-38  0.7454D-01  0.6043D-01  0.2833D 01 -0.7803D 01 -0.4970D 01
    7  0.0000D-38  0.0000D-38  0.7002D-01  0.5675D-01  0.3656D 01 -0.5265D 01 -0.1609D 01
    8  0.0000D-38  0.0000D-38  0.5461D-01  0.4426D-01  0.3381D 01 -0.2971D 01  0.4107D 00
    9  0.0000D-38  0.0000D-38  0.4104D-01  0.3326D-01  0.2811D 01 -0.1647D 01  0.1164D 01
   10  0.0000D-38  0.0000D-38  0.3107D-01  0.2518D-01  0.2267D 01 -0.9422D 00  0.1325D 01
   11  0.0000D-38  0.0000D-38  0.2399D-01  0.1944D-01  0.1826D 01 -0.5634D 00  0.1262D 01
   12  0.0000D-38  0.0000D-38  0.1894D-01  0.1535D-01  0.1483D 01 -0.3524D 00  0.1131D 01
   13  0.0000D-38  0.0000D-38  0.6489D 00  0.6091D 00  0.6519D 02 -0.0000D-38  0.6519D 02
TOTALS             0.0000D-38  0.1000D 01              0.8404D 02 -0.8404D 02 -0.1876D-10


DETAIL OF NODE   4  TEMPERATURE =   34.11                AREA = 0.1000D 01
                    IR EMITTANCE = 0.9000       SOLAR EMITTANCE = 0.1800
                    ILUM         = 0.1000D 01           THETA = 0.00000D-38
  NODE CONDUCTANCE   Q COMP          F      ASCRIPTFTIR   Q COMP    Q COMP          TOTAL
                                                    DIRECT SOLAR -0.4420D 03 -0.4420D 03
    1  0.0000D-38 -0.0000D-38  0.0000D-38  0.1135D-02 -0.3324D-01 -0.0000D-38 -0.3324D-01
    2  0.0000D-38 -0.0000D-38  0.0000D-38  0.1333D-02 -0.1741D-01 -0.0000D-38 -0.1741D-01
    3  0.0000D-38 -0.0000D-38  0.0000D-38  0.1194D-02 -0.5805D-02 -0.0000D-38 -0.5805D-02
    4  0.0000D-38  0.0000D-38  0.0000D-38  0.1008D-02 -0.0000D-38  0.3776D 03  0.3776D 03
    5  0.0000D-38  0.0000D-38  0.1959D-01  0.1592D-01  0.2632D 00 -0.2829D 01 -0.2566D 01
    6  0.0000D-38  0.0000D-38  0.4712D-01  0.3821D-01  0.1606D 01 -0.4933D 01 -0.3327D 01
    7  0.0000D-38  0.0000D-38  0.5461D-01  0.4426D-01  0.2636D 01 -0.4106D 01 -0.1470D 01
    8  0.0000D-38  0.0000D-38  0.5025D-01  0.4072D-01  0.2913D 01 -0.2733D 01  0.1796D 00
    9  0.0000D-38  0.0000D-38  0.4234D-01  0.3431D-01  0.2733D 01 -0.1699D 01  0.1034D 01
   10  0.0000D-38  0.0000D-38  0.3464D-01  0.2807D-01  0.2391D 01 -0.1050D 01  0.1341D 01
   11  0.0000D-38  0.0000D-38  0.2821D-01  0.2286D-01  0.2035D 01 -0.6625D 00  0.1373D 01
   12  0.0000D-38  0.0000D-38  0.2311D-01  0.1873D-01  0.1719D 01 -0.4300D 00  0.1289D 01
   13  0.0000D-38  0.0000D-38  0.7001D 00  0.6523D 00  0.6664D 02 -0.0000D-38  0.6664D 02
TOTALS             0.0000D-38  0.1000D 01              0.8288D 02 -0.8288D 02 -0.2270D-10
```

Table 4 (contd)

DETAIL OF NODE 5 TEMPERATURE = 12.79 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.2929D 00	0.2375D 00	-0.1088D 02	-0.1197D 03	-0.1306D 03
2	0.0000D-38	-0.0000D-38	0.8907D-01	0.7227D-01	-0.2139D 01	-0.3488D 02	-0.3702D 02
3	0.0000D-38	-0.0000D-38	0.3689D-01	0.2996D-01	-0.6408D 00	-0.1412D 02	-0.1476D 02
4	0.0000D-38	-0.0000D-38	0.1959D-01	0.1592D-01	-0.2632D 00	-0.7396D 01	-0.7660D 01
5	0.0000D-38	0.0000D-38	0.0000D-38	0.7742D-02	-0.0000D-38	0.1444D 03	0.1444D 03
6	0.0000D-38	0.0000D-38	0.0000D-38	0.3243D-02	0.8269D-01	-0.0000D-38	0.8269D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1712D-02	0.7364D-01	-0.0000D-38	0.7364D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1049D-02	0.5772D-01	-0.0000D-38	0.5772D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7035D-03	0.4441D-01	-0.0000D-38	0.4441D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5016D-03	0.3444D-01	-0.0000D-38	0.3444D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3741D-03	0.2712D-01	-0.0000D-38	0.2712D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2889D-03	0.2174D-01	-0.0000D-38	0.2174D-01
13	0.0000D-38	0.0000D-38	0.5616D 00	0.5287D 00	0.4528D 02	-0.0000D-38	0.4528D 02
TOTALS		0.0000D-38	0.1000D 01		0.3170D 02	-0.3170D 02	-0.3766D-12

DETAIL OF NODE 6 TEMPERATURE = -27.19 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8907D-01	0.7227D-01	-0.5153D 01	-0.3640D 02	-0.4156D 02
2	0.0000D-38	-0.0000D-38	0.1147D 00	0.9303D-01	-0.5124D 01	-0.4494D 02	-0.5006D 02
3	0.0000D-38	-0.0000D-38	0.7454D-01	0.6043D-01	-0.2833D 01	-0.2854D 02	-0.3137D 02
4	0.0000D-38	-0.0000D-38	0.4712D-01	0.3821D-01	-0.1606D 01	-0.1779D 02	-0.1940D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.3243D-02	-0.8269D-01	-0.0000D-38	-0.8269D-01
6	0.0000D-38	0.0000D-38	0.0000D-38	0.2342D-02	-0.0000D-38	0.1047D 03	0.1047D 03
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1592D-02	0.2790D-01	-0.0000D-38	0.2790D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1102D-02	0.3252D-01	-0.0000D-38	0.3252D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7893D-03	0.2970D-01	-0.0000D-38	0.2970D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5852D-03	0.2526D-01	-0.0000D-38	0.2526D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.4474D-03	0.2103D-01	-0.0000D-38	0.2103D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.3513D-03	0.1747D-01	-0.0000D-38	0.1747D-01
13	0.0000D-38	0.0000D-38	0.6745D 00	0.6256D 00	0.3763D 02	-0.0000D-38	0.3763D 02
TOTALS		0.0000D-38	0.1000D 01		0.2298D 02	-0.2298D 02	-0.4334D-12

DETAIL OF NODE 7 TEMPERATURE = -62.91 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.3689D-01	0.2995D-01	-0.2661D 01	-0.1508D 02	-0.1774D 02
2	0.0000D-38	-0.0000D-38	0.7454D-01	0.6043D-01	-0.4388D 01	-0.2919D 02	-0.3358D 02
3	0.0000D-38	-0.0000D-38	0.7002D-01	0.5675D-01	-0.3656D 01	-0.2681D 02	-0.3046D 02
4	0.0000D-38	-0.0000D-38	0.5461D-01	0.4426D-01	-0.2636D 01	-0.2062D 02	-0.2325D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1712D-02	-0.7364D-01	-0.0000D-38	-0.7364D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1592D-02	-0.2790D-01	-0.0000D-38	-0.2790D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1200D-02	-0.0000D-38	0.7519D 02	0.7519D 02
8	0.0000D-38	0.0000D-38	0.0000D-38	0.8758D-03	0.1049D-01	-0.0000D-38	0.1049D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.6464D-03	0.1299D-01	-0.0000D-38	0.1299D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.4880D-03	0.1251D-01	-0.0000D-38	0.1251D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3775D-03	0.1113D-01	-0.0000D-38	0.1113D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2988D-03	0.9625D-02	-0.0000D-38	0.9625D-02
13	0.0000D-38	0.0000D-38	0.7639D 00	0.7014D 00	0.2989D 02	-0.0000D-38	0.2989D 02
TOTALS		0.0000D-38	0.1000D 01		0.1650D 02	-0.1650D 02	-0.4157D-12

DETAIL OF NODE 8 TEMPERATURE = -94.37 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1959D-01	0.1591D-01	-0.1604D 01	-0.8006D 01	-0.9611D 01
2	0.0000D-38	-0.0000D-38	0.4712D-01	0.3820D-01	-0.3232D 01	-0.1845D 02	-0.2169D 02
3	0.0000D-38	-0.0000D-38	0.5461D-01	0.4426D-01	-0.3381D 01	-0.2091D 02	-0.2429D 02
4	0.0000D-38	-0.0000D-38	0.5025D-01	0.4072D-01	-0.2913D 01	-0.1897D 02	-0.2189D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1049D-02	-0.5772D-01	-0.0000D-38	-0.5772D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1102D-02	-0.3252D-01	-0.0000D-38	-0.3252D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.8758D-03	-0.1049D-01	-0.0000D-38	-0.1049D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.6575D-03	-0.0000D-38	0.5440D 02	0.5440D 02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.4933D-03	0.4004D-02	-0.0000D-38	0.4004D-02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.3762D-03	0.5136D-02	-0.0000D-38	0.5136D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2929D-03	0.5126D-02	-0.0000D-38	0.5126D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2329D-03	0.4712D-02	-0.0000D-38	0.4712D-02
13	0.0000D-38	0.0000D-38	0.8284D 00	0.7558D 00	0.2315D 02	-0.0000D-38	0.2315D 02
TOTALS		0.0000D-38	0.1000D 01		0.1194D 02	-0.1194D 02	-0.3677D-12

DETAIL OF NODE 9 TEMPERATURE = -121.45 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1204D-01	0.9784D-02	-0.1066D 01	-0.4921D 01	-0.5987D 01
2	0.0000D-38	-0.0000D-38	0.3144D-01	0.2549D-01	-0.2363D 01	-0.1231D 02	-0.1468D 02
3	0.0000D-38	-0.0000D-38	0.4104D-01	0.3326D-01	-0.2811D 01	-0.1571D 02	-0.1852D 02
4	0.0000D-38	-0.0000D-38	0.4234D-01	0.3431D-01	-0.2733D 01	-0.1599D 02	-0.1872D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.7035D-03	-0.4441D-01	-0.0000D-38	-0.4441D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.7893D-03	-0.2970D-01	-0.0000D-38	-0.2970D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.6464D-03	-0.1299D-01	-0.0000D-38	-0.1299D-01
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.4933D-03	-0.4004D-02	-0.0000D-38	-0.4004D-02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.3737D-03	-0.0000D-38	0.4012D 02	0.4012D 02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.2867D-03	0.1586D-02	-0.0000D-38	0.1586D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2241D-03	0.2102D-02	-0.0000D-38	0.2102D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1786D-03	0.2164D-02	-0.0000D-38	0.2164D-02
13	0.0000D-38	0.0000D-38	0.8731D 00	0.7935D 00	0.1787D 02	-0.0000D-38	0.1787D 02
TOTALS		0.0000D-38	0.1000D 01		0.8808D 01	-0.8808D 01	-0.2451D-12

Table 4 (contd)

DETAIL OF NODE 10 TEMPERATURE = -144.50 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8130D-02	0.6608D-02	-0.7564D 00	-0.3323D 01	-0.4079D 01
2	0.0000D-38	-0.0000D-38	0.2218D-01	0.1798D-01	-0.1767D 01	-0.8686D 01	-0.1045D 02
3	0.0000D-38	-0.0000D-38	0.3107D-01	0.2518D-01	-0.2267D 01	-0.1189D 02	-0.1416D 02
4	0.0000D-38	-0.0000D-38	0.3464D-01	0.2807D-01	-0.2391D 01	-0.1308D 02	-0.1547D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.5016D-03	-0.3444D-01	-0.0000D-38	-0.3444D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.5852D-03	-0.2526D-01	-0.0000D-38	-0.2526D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.4880D-03	-0.1251D-01	-0.0000D-38	-0.1251D-01
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.3762D-03	-0.5136D-02	-0.0000D-38	-0.5136D-02
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.2867D-03	-0.1586D-02	-0.0000D-38	-0.1586D-02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.2207D-03	-0.0000D-38	0.3033D 02	0.3033D 02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.1729D-03	0.6653D-03	-0.0000D-38	0.6653D-03
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1380D-03	0.9091D-03	-0.0000D-38	0.9091D-03
13	0.0000D-38	0.0000D-38	0.9040D 00	0.8194D 00	0.1392D 02	-0.0000D-38	0.1392D 02
TOTALS		0.0000D-38	0.1000D 01		0.6657D 01	-0.6657D 01	0.5684D-13

DETAIL OF NODE 11 TEMPERATURE = -164.12 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.5850D-02	0.4756D-02	-0.5627D 00	-0.2391D 01	-0.2954D 01
2	0.0000D-38	-0.0000D-38	0.1638D-01	0.1328D-01	-0.1356D 01	-0.6415D 01	-0.7771D 01
3	0.0000D-38	-0.0000D-38	0.2399D-01	0.1944D-01	-0.1826D 01	-0.9184D 01	-0.1101D 02
4	0.0000D-38	-0.0000D-38	0.2821D-01	0.2286D-01	-0.2035D 01	-0.1065D 02	-0.1269D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.3741D-03	-0.2712D-01	-0.0000D-38	-0.2712D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.4474D-03	-0.2103D-01	-0.0000D-38	-0.2103D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.3775D-03	-0.1113D-01	-0.0000D-38	-0.1113D-01
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.2929D-03	-0.5126D-02	-0.0000D-38	-0.5126D-02
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.2241D-03	-0.2102D-02	-0.0000D-38	-0.2102D-02
10	0.0000D-38	-0.0000D-38	0.0000D-38	0.1729D-03	-0.6653D-03	-0.0000D-38	-0.6653D-03
11	0.0000D-38	0.0000D-38	0.0000D-38	0.1357D-03	-0.0000D-38	0.2349D 02	0.2349D 02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1084D-03	0.2969D-03	-0.0000D-38	0.2969D-03
13	0.0000D-38	0.0000D-38	0.9256D 00	0.8375D 00	0.1100D 02	-0.0000D-38	0.1100D 02
TOTALS		0.0000D-38	0.1000D 01		0.5155D 01	-0.5155D 01	0.2822D-10

DETAIL OF NODE 12 TEMPERATURE = -180.92 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.4410D-02	0.3586D-02	-0.4341D 00	-0.1802D 01	-0.2236D 01
2	0.0000D-38	-0.0000D-38	0.1254D-01	0.1017D-01	-0.1066D 01	-0.4911D 01	-0.5977D 01
3	0.0000D-38	-0.0000D-38	0.1894D-01	0.1535D-01	-0.1483D 01	-0.7251D 01	-0.8734D 01
4	0.0000D-38	-0.0000D-38	0.2311D-01	0.1873D-01	-0.1719D 01	-0.8725D 01	-0.1044D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.2889D-03	-0.2174D-01	-0.0000D-38	-0.2174D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.3513D-03	-0.1747D-01	-0.0000D-38	-0.1747D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.2988D-03	-0.9625D-02	-0.0000D-38	-0.9625D-02
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.2329D-03	-0.4712D-02	-0.0000D-38	-0.4712D-02
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.1786D-03	-0.2164D-02	-0.0000D-38	-0.2164D-02
10	0.0000D-38	-0.0000D-38	0.0000D-38	0.1380D-03	-0.9091D-03	-0.0000D-38	-0.9091D-03
11	0.0000D-38	-0.0000D-38	0.0000D-38	0.1084D-03	-0.2969D-03	-0.0000D-38	-0.2969D-03
12	0.0000D-38	0.0000D-38	0.0000D-38	0.8668D-04	-0.0000D-38	0.1861D 02	0.1861D 02
13	0.0000D-38	0.0000D-38	0.9410D 00	0.8505D 00	0.8843D 01	-0.0000D-38	0.8843D 01
TOTALS		0.0000D-38	0.1000D 01		0.4084D 01	-0.4084D 01	0.1047D-08

DETAIL OF NODE 13 TEMPERATURE = -459.00 AREA = 0.8944D 01
IR EMITTANCE = 1.0000 SOLAR EMITTANCE = 1.0000
ILUM = 0.0000D-38 THETA = 0.90000D 02
THIS IS A CONSTANT TEMPERATURE NODE

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.5938D-01	0.5056D 00	-0.6646D 02	-0.2171D 03	-0.2835D 03
2	0.0000D-38	-0.0000D-38	0.6619D-01	0.5602D 00	-0.6455D 02	-0.2318D 03	-0.2964D 03
3	0.0000D-38	-0.0000D-38	0.7255D-01	0.6091D 00	-0.6519D 02	-0.2484D 03	-0.3136D 03
4	0.0000D-38	-0.0000D-38	0.7828D-01	0.6523D 00	-0.6664D 02	-0.2643D 03	-0.3310D 03
5	0.0000D-38	-0.0000D-38	0.6278D-01	0.5287D 00	-0.4528D 02	-0.8109D 02	-0.1264D 03
6	0.0000D-38	-0.0000D-38	0.7541D-01	0.6256D 00	-0.3763D 02	-0.7061D 02	-0.1082D 03
7	0.0000D-38	-0.0000D-38	0.8541D-01	0.7014D 00	-0.2989D 02	-0.5744D 02	-0.8733D 02
8	0.0000D-38	-0.0000D-38	0.9262D-01	0.7558D 00	-0.2315D 02	-0.4506D 02	-0.6822D 02
9	0.0000D-38	-0.0000D-38	0.9762D-01	0.7935D 00	-0.1787D 02	-0.3503D 02	-0.5290D 02
10	0.0000D-38	-0.0000D-38	0.1011D 00	0.8194D 00	-0.1392D 02	-0.2741D 02	-0.4133D 02
11	0.0000D-38	-0.0000D-38	0.1035D 00	0.8375D 00	-0.1100D 02	-0.2174D 02	-0.3274D 02
12	0.0000D-38	-0.0000D-38	0.1052D 00	0.8505D 00	-0.8843D 01	-0.1751D 02	-0.2635D 02
13	0.0000D-38	0.0000D-38	0.0000D-38	0.7047D 00	-0.0000D-38	0.0000D-38	0.0000D-38
TOTALS		0.0000D-38	0.1000D 01		-0.4504D 03	-0.1318D 04	-0.1768D 04

Table 4 (contd)

```
  TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  3
     TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
     STEP RISER=Y, STEP TREAD=X
T     CASE 3, Y=2X AND ALUMINUM SURFACE                                      TITLE CARD
C         1         2         3         4         5         6         7      COMMENT CARD
C23456789012345678901234567890123456789012345678901234567890123456789012     COMMENT CARD
      EIR(1)=0.10                                                            DATA CARD
      EIR(2)=0.10                                                            DATA CARD
      EIR(3)=0.10                                                            DATA CARD
      EIR(4)=0.10                                                            DATA CARD
      EIR(5)=0.10                                                            DATA CARD
      EIR(6)=0.10                                                            DATA CARD
      EIR(7)=0.10                                                            DATA CARD
      EIR(8)=0.10                                                            DATA CARD
      EIR(9)=0.10                                                            DATA CARD
      EIR(10)=0.10                                                           DATA CARD
      EIR(11)=0.10                                                           DATA CARD
      EIR(12)=0.10                                                           DATA CARD
C                                                                            COMMENT CARD
      ESOL(1)=0.20                                                           DATA CARD
      ESOL(2)=0.20                                                           DATA CARD
      ESOL(3)=0.20                                                           DATA CARD
      ESOL(4)=0.20                                                           DATA CARD
      ESOL(5)=0.20                                                           DATA CARD
      ESOL(6)=0.20                                                           DATA CARD
      ESOL(7)=0.20                                                           DATA CARD
      ESOL(8)=0.20                                                           DATA CARD
      ESOL(9)=0.20                                                           DATA CARD
      ESOL(10)=0.20                                                          DATA CARD
      ESOL(11)=0.20                                                          DATA CARD
      ESOL(12)=0.20                                                          DATA CARD
      END OF CASE                                                            CONTROL CARD

                .......................................................................
```

```
  TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  3
     TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
     STEP RISER=Y, STEP TREAD=X
     CASE 3, Y=2X AND ALUMINUM SURFACE

   THE RESIDUES ARE
 1 = -0.86526077D 02   2 = -0.83981872D 02   3 = -0.82658641D 02   4 = -0.81861432D 02   5 = -0.26362534D 02
 6 = -0.19282755D 02   7 = -0.13900313D 02   8 = -0.10074103D 02   9 = -0.74374763D 01  10 = -0.56243660D 01
11 = -0.43572739D 01  12 = -0.34526736D 01  13 = -0.13424805D 04

   THE TEMPERATURES ARE
 1 =  0.66243993D 02   2 =  0.49200623D 02   3 =  0.39889589D 02   4 =  0.34114444D 02   5 =  0.12787031D 02
 6 = -0.27193567D 02   7 = -0.62912226D 02   8 = -0.94366218D 02   9 = -0.12144972D 03  10 = -0.14449631D 03
11 = -0.16412202D 03  12 = -0.18091942D 03  13 = -0.45900000D 03

   THE RESIDUES ARE
 1 =  0.58202905D 03   2 =  0.66537534D 03   3 =  0.72021534D 03   4 =  0.75825648D 03   5 =  0.41714133D 02
 6 =  0.31720618D 02   7 =  0.23250236D 02   8 =  0.16982015D 02   9 =  0.12589775D 02  10 =  0.95438471D 01
11 =  0.74050850D 01  12 =  0.58737235D 01  13 = -0.46429556D 04

   THE TEMPERATURES ARE
 1 =  0.96116019D 03   2 =  0.99686659D 03   3 =  0.10196238D 04   4 =  0.10350234D 04   5 =  0.44313700D 03
 6 =  0.37974657D 03   7 =  0.31563566D 03   8 =  0.25648755D 03   9 =  0.20456734D 03  10 =  0.15996012D 03
11 =  0.12177107D 03  12 =  0.88979577D 02  13 = -0.45900000D 03

   THE RESIDUES ARE
 1 =  0.16131569D 03   2 =  0.18817337D 03   3 =  0.20579057D 03   4 =  0.21799145D 03   5 =  0.72119301D 01
 6 =  0.56057697D 01   7 =  0.41470478D 01   8 =  0.30419522D 01   9 =  0.22602928D 01  10 =  0.17157042D 01
11 =  0.13323183D 01  12 =  0.10573771D 01  13 = -0.25676435D 04

   THE TEMPERATURES ARE
 1 =  0.65798741D 03   2 =  0.67854883D 03   3 =  0.69231843D 03   4 =  0.70186266D 03   5 =  0.29604816D 03
 6 =  0.24033818D 03   7 =  0.18584038D 03   8 =  0.13614069D 03   9 =  0.92716685D 02  10 =  0.55494068D 02
11 =  0.23667210D 02  12 = -0.36405066D 01  13 = -0.45900000D 03

   THE RESIDUES ARE
 1 =  0.33679545D 02   2 =  0.41837164D 02   3 =  0.47252092D 02   4 =  0.51023918D 02   5 = -0.23569690D 00
 6 = -0.16774066D 00   7 = -0.11805885D 00   8 = -0.84590897D-01   9 = -0.62076344D-01  10 = -0.46781140D-01
11 = -0.36163856D-01  12 = -0.28615468D-01  13 = -0.19410130D 04

   THE TEMPERATURES ARE
 1 =  0.48554385D 03   2 =  0.49007431D 03   3 =  0.49442743D 03   4 =  0.49788455D 03   5 =  0.24117723D 03
 6 =  0.18683988D 03   7 =  0.13543785D 03   8 =  0.89145995D 02   9 =  0.48908508D 02  10 =  0.14506164D 02
11 = -0.14867147D 02  12 = -0.40047792D 02  13 = -0.45900000D 03

   THE RESIDUES ARE
 1 =  0.30412155D 01   2 =  0.45260307D 01   3 =  0.56146263D 01   4 =  0.64143513D 01   5 = -0.16467004D 00
 6 = -0.14405424D 00   7 = -0.11136674D 00   8 = -0.83404266D-01   9 = -0.62673124D-01  10 = -0.47888881D-01
11 = -0.37343687D-01  12 = -0.29720394D-01  13 = -0.17869151D 04

   THE TEMPERATURES ARE
 1 =  0.42611407D 03   2 =  0.41805224D 03   3 =  0.41454381D 03   4 =  0.41275340D 03   5 =  0.23404454D 03
 6 =  0.17944824D 03   7 =  0.12829293D 03   8 =  0.82403016D 02   9 =  0.42581610D 02  10 =  0.85638754D 01
11 = -0.20467230D 02  12 = -0.45347279D 02  13 = -0.45900000D 03

   THE RESIDUES ARE
 1 =  0.33089446D-01   2 =  0.75630194D-01   3 =  0.11766699D 00   4 =  0.15430458D 00   5 = -0.28209451D-02
 6 = -0.30375466D-02   7 = -0.25299244D-02   8 = -0.19613618D-02   9 = -0.15014131D-02  10 = -0.11597614D-02
11 = -0.91058362D-03  12 = -0.72800976D-03  13 = -0.17683660D 04

   THE TEMPERATURES ARE
 1 =  0.41958724D 03   2 =  0.40819189D 03   3 =  0.40221988D 03   4 =  0.39861821D 03   5 =  0.23393307D 03
 6 =  0.17931809D 03   7 =  0.12816064D 03   8 =  0.82275182D 02   9 =  0.42460123D 02  10 =  0.84489154D 01
11 = -0.20576082D 02  12 = -0.45450614D 02  13 = -0.45900000D 03

   THE RESIDUES ARE
 1 =  0.38805058D-05   2 =  0.22178038D-04   3 =  0.55134681D-04   4 =  0.96237505D-04   5 = -0.86863766D-06
 6 = -0.12639403D-05   7 = -0.11665499D-05   8 = -0.94964522D-06   9 = -0.74642371D-06  10 = -0.58562216D-06
11 = -0.46434183D-06  12 = -0.37368497D-06  13 = -0.17680002D 04

   THE TEMPERATURES ARE
 1 =  0.41951387D 03   2 =  0.40802136D 03   3 =  0.40195059D 03   4 =  0.39826145D 03   5 =  0.23393305D 03
 6 =  0.17931805D 03   7 =  0.12816060D 03   8 =  0.82275137D 02   9 =  0.42460079D 02  10 =  0.84488731D 01
11 = -0.20576123D 02  12 = -0.45450653D 02  13 = -0.45900000D 03
```

Table 4 (contd)

THE RESIDUES ARE

1 = -0.38369308D-12	2 = 0.14779289D-11	3 = 0.11759482D-10	4 = 0.37310599D-10	5 = -0.27711167D-12
6 = -0.40145665D-12	7 = -0.39257486D-12	8 = -0.33395509D-12	9 = -0.26911806D-12	10 = -0.21582736D-12
11 = -0.15765167D-12	12 = -0.13278267D-12	13 = -0.17680000D 04		

THE TEMPERATURES ARE

1 = 0.41951386D 03	2 = 0.40802131D 03	3 = 0.40195046D 03	4 = 0.39826123D 03	5 = 0.23393305D 03
6 = 0.17931805D 03	7 = 0.12816060D 03	8 = 0.82275137D 02	9 = 0.42460079D 02	10 = 0.84488731D 01
11 = -0.20576123D 02	12 = -0.45450653D 02	13 = -0.45900000D 03		

....

TAS I, MAY 6, 1969 VERSION, JAH X2777, CASE NUMBER 3
TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
STEP RISER=Y, STEP TREAD=X
CASE 3, Y=2X AND ALUMINUM SURFACE

ENERGY PER UNIT TIME IN IS NEGATIVE AND ENERGY PER UNIT TIME OUT IS POSITIVE

DETAIL OF NODE 1 TEMPERATURE = 419.51 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	0.0000D-38	0.0000D-38	0.9550D-03	-0.0000D-38	0.3963D 03	0.3963D 03
2	0.0000D-38	0.0000D-38	0.0000D-38	0.4141D-03	0.2177D-01	-0.0000D-38	0.2177D-01
3	0.0000D-38	0.0000D-38	0.0000D-38	0.2283D-03	0.1815D-01	-0.0000D-38	0.1815D-01
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1465D-03	0.1400D-01	-0.0000D-38	0.1400D-01
5	0.0000D-38	0.0000D-38	0.2929D 00	0.3224D-02	0.2025D 01	-0.4005D 02	-0.3802D 02
6	0.0000D-38	0.0000D-38	0.8907D-01	0.1032D-02	0.7626D 00	-0.8840D 01	-0.8077D 01
7	0.0000D-38	0.0000D-38	0.3689D-01	0.4500D-03	0.3692D 00	-0.2631D 01	-0.2262D 01
8	0.0000D-38	0.0000D-38	0.1959D-01	0.2481D-03	0.2177D 00	-0.1011D 01	-0.7933D 00
9	0.0000D-38	0.0000D-38	0.1204D-01	0.1565D-03	0.1434D 00	-0.4584D 00	-0.3150D 00
10	0.0000D-38	0.0000D-38	0.8130D-02	0.1075D-03	0.1014D 00	-0.2339D 00	-0.1326D 00
11	0.0000D-38	0.0000D-38	0.5850D-02	0.7828D-04	0.7528D-01	-0.1304D 00	-0.5509D-01
12	0.0000D-38	0.0000D-38	0.4410D-02	0.5950D-04	0.5801D-01	-0.7786D-01	-0.1985D-01
13	0.0000D-38	0.0000D-38	0.5311D 00	0.9290D-01	0.9528D 02	-0.0000D-38	0.9528D 02
TOTALS		0.0000D-38	0.1000D 01		0.9909D 02	-0.9909D 02	-0.3482D-12

DETAIL OF NODE 2 TEMPERATURE = 408.02 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.4141D-03	-0.2177D-01	-0.0000D-38	-0.2177D-01
2	0.0000D-38	0.0000D-38	0.0000D-38	0.3044D-03	-0.0000D-38	0.3806D 03	0.3806D 03
3	0.0000D-38	0.0000D-38	0.0000D-38	0.2182D-03	0.5879D-02	-0.0000D-38	0.5879D-02
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1609D-03	0.6926D-02	-0.0000D-38	0.6926D-02
5	0.0000D-38	0.0000D-38	0.8907D-01	0.1034D-02	0.5954D 00	-0.1218D 02	-0.1158D 02
6	0.0000D-38	0.0000D-38	0.1147D 00	0.1234D-02	0.8471D 00	-0.1139D 02	-0.1054D 02
7	0.0000D-38	0.0000D-38	0.7454D-01	0.8012D-03	0.6153D 00	-0.5316D 01	-0.4701D 01
8	0.0000D-38	0.0000D-38	0.4712D-01	0.5094D-03	0.4202D 00	-0.2432D 01	-0.2012D 01
9	0.0000D-38	0.0000D-38	0.3144D-01	0.3417D-03	0.2952D 00	-0.1197D 01	-0.9018D 00
10	0.0000D-38	0.0000D-38	0.2218D-01	0.2420D-03	0.2155D 00	-0.6382D 00	-0.4227D 00
11	0.0000D-38	0.0000D-38	0.1638D-01	0.1793D-03	0.1630D 00	-0.3650D 00	-0.2021D 00
12	0.0000D-38	0.0000D-38	0.1254D-01	0.1375D-03	0.1269D 00	-0.2214D 00	-0.9453D-01
13	0.0000D-38	0.0000D-38	0.5920D 00	0.9442D-01	0.9188D 02	-0.0000D-38	0.9188D 02
TOTALS		0.0000D-38	0.1000D 01		0.9515D 02	-0.9515D 02	0.1513D-11

DETAIL OF NODE 3 TEMPERATURE = 401.95 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.2283D-03	-0.1815D-01	-0.0000D-38	-0.1815D-01
2	0.0000D-38	-0.0000D-38	0.0000D-38	0.2182D-03	-0.5879D-02	-0.0000D-38	-0.5879D-02
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1778D-03	-0.0000D-38	0.3725D 03	0.3725D 03
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1416D-03	0.2279D-02	-0.0000D-38	0.2279D-02
5	0.0000D-38	0.0000D-38	0.3689D-01	0.4550D-03	0.2496D 00	-0.5044D 01	-0.4795D 01
6	0.0000D-38	0.0000D-38	0.7454D-01	0.8042D-03	0.5306D 00	-0.7398D 01	-0.6867D 01
7	0.0000D-38	0.0000D-38	0.7002D-01	0.7406D-03	0.5488D 00	-0.4994D 01	-0.4445D 01
8	0.0000D-38	0.0000D-38	0.5461D-01	0.5745D-03	0.4584D 00	-0.2818D 01	-0.2360D 01
9	0.0000D-38	0.0000D-38	0.4104D-01	0.4310D-03	0.3607D 00	-0.1562D 01	-0.1202D 01
10	0.0000D-38	0.0000D-38	0.3107D-01	0.3261D-03	0.2816D 00	-0.8941D 00	-0.6124D 00
11	0.0000D-38	0.0000D-38	0.2399D-01	0.2518D-03	0.2221D 00	-0.5346D 00	-0.3125D 00
12	0.0000D-38	0.0000D-38	0.1894D-01	0.1987D-03	0.1780D 00	-0.3344D 00	-0.1564D 00
13	0.0000D-38	0.0000D-38	0.6489D 00	0.9545D-01	0.9031D 02	-0.0000D-38	0.9031D 02
TOTALS		0.0000D-38	0.1000D 01		0.9312D 02	-0.9312D 02	0.1180D-10

DETAIL OF NODE 4 TEMPERATURE = 398.26 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.4420D 03	-0.4420D 03
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.1465D-03	-0.1400D-01	-0.0000D-38	-0.1400D-01
2	0.0000D-38	-0.0000D-38	0.0000D-38	0.1609D-03	-0.6926D-02	-0.0000D-38	-0.6926D-02
3	0.0000D-38	-0.0000D-38	0.0000D-38	0.1416D-03	-0.2279D-02	-0.0000D-38	-0.2279D-02
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1186D-03	-0.0000D-38	0.3676D 03	0.3676D 03
5	0.0000D-38	0.0000D-38	0.1959D-01	0.2542D-03	0.1354D 00	-0.2679D 01	-0.2543D 01
6	0.0000D-38	0.0000D-38	0.4712D-01	0.5141D-03	0.3309D 00	-0.4677D 01	-0.4346D 01
7	0.0000D-38	0.0000D-38	0.5461D-01	0.5765D-03	0.4179D 00	-0.3895D 01	-0.3477D 01
8	0.0000D-38	0.0000D-38	0.5025D-01	0.5242D-03	0.4098D 00	-0.2593D 01	-0.2183D 01
9	0.0000D-38	0.0000D-38	0.4234D-01	0.4393D-03	0.3606D 00	-0.1612D 01	-0.1251D 01
10	0.0000D-38	0.0000D-38	0.3464D-01	0.3583D-03	0.3037D 00	-0.9968D 00	-0.6931D 00
11	0.0000D-38	0.0000D-38	0.2821D-01	0.2913D-03	0.2523D 00	-0.6287D 00	-0.3764D 00
12	0.0000D-38	0.0000D-38	0.2311D-01	0.2384D-03	0.2096D 00	-0.4080D 00	-0.1984D 00
13	0.0000D-38	0.0000D-38	0.7001D 00	0.9624D-01	0.8950D 02	-0.0000D-38	0.8950D 02
TOTALS		0.0000D-38	0.1000D 01		0.9190D 02	-0.9190D 02	0.3733D-10

Table 4 (contd)

DETAIL OF NODE 5 TEMPERATURE = 233.93 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.2929D 00	0.3224D-02	-0.2025D 01	-0.1161D 03	-0.1181D 03
2	0.0000D-38	-0.0000D-38	0.8907D-01	0.1034D-02	-0.5954D 00	-0.3390D 02	-0.3449D 02
3	0.0000D-38	-0.0000D-38	0.3689D-01	0.4550D-03	-0.2496D 00	-0.1374D 02	-0.1399D 02
4	0.0000D-38	-0.0000D-38	0.1959D-01	0.2542D-03	-0.1354D 00	-0.7201D 01	-0.7336D 01
5	0.0000D-38	0.0000D-38	0.0000D-38	0.9523D-03	-0.0000D-38	0.1367D 03	0.1367D 03
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.4066D-03	0.4517D-01	-0.0000D-38	0.4517D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.2176D-03	0.4185D-01	-0.0000D-38	0.4185D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1346D-03	0.3354D-01	-0.0000D-38	0.3354D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.9069D-04	0.2614D-01	-0.0000D-38	0.2614D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.6488D-04	0.2043D-01	-0.0000D-38	0.2043D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.4850D-04	0.1618D-01	-0.0000D-38	0.1618D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.3751D-04	0.1301D-01	-0.0000D-38	0.1301D-01
13	0.0000D-38	0.0000D-38	0.5616D 00	0.9308D-01	0.3699D 02	-0.0000D-38	0.3699D 02
TOTALS		0.0000D-38	0.1000D 01		0.3419D 02	-0.3419D 02	-0.2665D-12

DETAIL OF NODE 6 TEMPERATURE = 179.32 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8907D-01	0.1032D-02	-0.7626D 00	-0.3530D 02	-0.3607D 02
2	0.0000D-38	-0.0000D-38	0.1147D 00	0.1234D-02	-0.8471D 00	-0.4367D 02	-0.4452D 02
3	0.0000D-38	-0.0000D-38	0.7454D-01	0.8042D-03	-0.5306D 00	-0.2776D 02	-0.2829D 02
4	0.0000D-38	-0.0000D-38	0.4712D-01	0.5141D-03	-0.3309D 00	-0.1732D 02	-0.1765D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.4066D-03	-0.4517D-01	-0.0000D-38	-0.4517D-01
6	0.0000D-38	0.0000D-38	0.0000D-38	0.2858D-03	-0.0000D-38	0.9925D 02	0.9925D 02
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1929D-03	0.1567D-01	-0.0000D-38	0.1567D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1333D-03	0.1841D-01	-0.0000D-38	0.1841D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.9538D-04	0.1689D-01	-0.0000D-38	0.1689D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.7069D-04	0.1441D-01	-0.0000D-38	0.1441D-01
11	0.0000D-38	0.0000D-38	0.0000D-38	0.5403D-04	0.1202D-01	-0.0000D-38	0.1202D-01
12	0.0000D-38	0.0000D-38	0.0000D-38	0.4242D-04	0.9998D-02	-0.0000D-38	0.9998D-02
13	0.0000D-38	0.0000D-38	0.6745D 00	0.9514D-01	0.2724D 02	-0.0000D-38	0.2724D 02
TOTALS		0.0000D-38	0.1000D 01		0.2481D 02	-0.2481D 02	-0.3944D-12

DETAIL OF NODE 7 TEMPERATURE = 128.16 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.3689D-01	0.4500D-03	-0.3692D 00	-0.1462D 02	-0.1499D 02
2	0.0000D-38	-0.0000D-38	0.7454D-01	0.8012D-03	-0.6153D 00	-0.2837D 02	-0.2898D 02
3	0.0000D-38	-0.0000D-38	0.7002D-01	0.7406D-03	-0.5488D 00	-0.2608D 02	-0.2663D 02
4	0.0000D-38	-0.0000D-38	0.5461D-01	0.5765D-03	-0.4179D 00	-0.2007D 02	-0.2049D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.2176D-03	-0.4185D-01	-0.0000D-38	-0.4185D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1929D-03	-0.1567D-01	-0.0000D-38	-0.1567D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1437D-03	-0.0000D-38	0.7132D 02	0.7132D 02
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1044D-03	0.5939D-02	-0.0000D-38	0.5939D-02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7687D-04	0.7369D-02	-0.0000D-38	0.7369D-02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5797D-04	0.7106D-02	-0.0000D-38	0.7106D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.4481D-04	0.6327D-02	-0.0000D-38	0.6327D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.3544D-04	0.5476D-02	-0.0000D-38	0.5476D-02
13	0.0000D-38	0.0000D-38	0.7639D 00	0.9656D-01	0.1981D 02	-0.0000D-38	0.1981D 02
TOTALS		0.0000D-38	0.1000D 01		0.1783D 02	-0.1783D 02	-0.3890D-12

DETAIL OF NODE 8 TEMPERATURE = 82.28 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1959D-01	0.2481D-03	-0.2177D 00	-0.7764D 01	-0.7982D 01
2	0.0000D-38	-0.0000D-38	0.4712D-01	0.5094D-03	-0.4202D 00	-0.1793D 02	-0.1835D 02
3	0.0000D-38	-0.0000D-38	0.5461D-01	0.5745D-03	-0.4584D 00	-0.2034D 02	-0.2080D 02
4	0.0000D-38	-0.0000D-38	0.5025D-01	0.5242D-03	-0.4098D 00	-0.1847D 02	-0.1888D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1346D-03	-0.3354D-01	-0.0000D-38	-0.3354D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1333D-03	-0.1841D-01	-0.0000D-38	-0.1841D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.1044D-03	-0.5939D-02	-0.0000D-38	-0.5939D-02
8	0.0000D-38	0.0000D-38	0.0000D-38	0.7792D-04	-0.0000D-38	0.5161D 02	0.5161D 02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.5830D-04	0.2272D-02	-0.0000D-38	0.2272D-02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.4439D-04	0.2916D-02	-0.0000D-38	0.2916D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3453D-04	0.2911D-02	-0.0000D-38	0.2911D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2743D-04	0.2677D-02	-0.0000D-38	0.2677D-02
13	0.0000D-38	0.0000D-38	0.8284D 00	0.9753D-01	0.1446D 02	-0.0000D-38	0.1446D 02
TOTALS		0.0000D-38	0.1000D 01		0.1290D 02	-0.1290D 02	-0.3286D-12

DETAIL OF NODE 9 TEMPERATURE = 42.46 AREA = 0.1000D 01
IR EMITTANCE = 0.1000 SOLAR EMITTANCE = 0.2000
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1204D-01	0.1565D-03	-0.1434D 00	-0.4772D 01	-0.4915D 01
2	0.0000D-38	-0.0000D-38	0.3144D-01	0.3417D-03	-0.2952D 00	-0.1197D 02	-0.1226D 02
3	0.0000D-38	-0.0000D-38	0.4104D-01	0.4310D-03	-0.3607D 00	-0.1529D 02	-0.1565D 02
4	0.0000D-38	-0.0000D-38	0.4234D-01	0.4393D-03	-0.3606D 00	-0.1556D 02	-0.1592D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.9069D-04	-0.2614D-01	-0.0000D-38	-0.2614D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.9538D-04	-0.1689D-01	-0.0000D-38	-0.1689D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.7687D-04	-0.7369D-02	-0.0000D-38	-0.7369D-02
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.5830D-04	-0.2272D-02	-0.0000D-38	-0.2272D-02
9	0.0000D-38	0.0000D-38	0.0000D-38	0.4402D-04	-0.0000D-38	0.3807D 02	0.3807D 02
10	0.0000D-38	0.0000D-38	0.0000D-38	0.3371D-04	0.9005D-03	-0.0000D-38	0.9005D-03
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2632D-04	0.1193D-02	-0.0000D-38	0.1193D-02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2096D-04	0.1229D-02	-0.0000D-38	0.1229D-02
13	0.0000D-38	0.0000D-38	0.8731D 00	0.9819D-01	0.1073D 02	-0.0000D-38	0.1073D 02
TOTALS		0.0000D-38	0.1000D 01		0.9517D 01	-0.9517D 01	-0.2682D-12

Table 4 (contd)

```
DETAIL OF NODE  10  TEMPERATURE =     8.45                   AREA = 0.1000D 01
                    IR EMITTANCE = 0.1000       SOLAR EMITTANCE = 0.2000
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
```

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8130D-02	0.1075D-03	-0.1014D 00	-0.3222D 01	-0.3324D 01
2	0.0000D-38	-0.0000D-38	0.2218D-01	0.2420D-03	-0.2155D 00	-0.8441D 01	-0.8657D 01
3	0.0000D-38	-0.0000D-38	0.3107D-01	0.3261D-03	-0.2816D 00	-0.1157D 02	-0.1185D 02
4	0.0000D-38	-0.0000D-38	0.3464D-01	0.3583D-03	-0.3037D 00	-0.1273D 02	-0.1304D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.6488D-04	-0.2043D-01	-0.0000D-38	-0.2043D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.7069D-04	-0.1441D-01	-0.0000D-38	-0.1441D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.5797D-04	-0.7106D-02	-0.0000D-38	-0.7106D-02
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.4439D-04	-0.2916D-02	-0.0000D-38	-0.2916D-02
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.3371D-04	-0.9005D-03	-0.0000D-38	-0.9005D-03
10	0.0000D-38	0.0000D-38	0.0000D-38	0.2591D-04	-0.0000D-38	0.2878D 02	0.2878D 02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2027D-04	0.3777D-03	-0.0000D-38	0.3777D-03
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1617D-04	0.5162D-03	-0.0000D-38	0.5162D-03
13	0.0000D-38	0.0000D-38	0.9040D 00	0.9863D-01	0.8141D 01	-0.0000D-38	0.8141D 01
TOTALS		0.0000D-38	0.1000D 01		0.7194D 01	-0.7194D 01	-0.2061D-12

```
DETAIL OF NODE  11  TEMPERATURE =  -20.58                    AREA = 0.1000D 01
                    IR EMITTANCE = 0.1000       SOLAR EMITTANCE = 0.2000
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
```

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.5850D-02	0.7828D-04	-0.7528D-01	-0.2319D 01	-0.2394D 01
2	0.0000D-38	-0.0000D-38	0.1638D-01	0.1793D-03	-0.1630D 00	-0.6234D 01	-0.6397D 01
3	0.0000D-38	-0.0000D-38	0.2399D-01	0.2518D-03	-0.2221D 00	-0.8935D 01	-0.9158D 01
4	0.0000D-38	-0.0000D-38	0.2821D-01	0.2913D-03	-0.2523D 00	-0.1037D 02	-0.1062D 02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.4850D-04	-0.1618D-01	-0.0000D-38	-0.1618D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.5403D-04	-0.1202D-01	-0.0000D-38	-0.1202D-01
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.4481D-04	-0.6327D-02	-0.0000D-38	-0.6327D-02
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.3453D-04	-0.2911D-02	-0.0000D-38	-0.2911D-02
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.2632D-04	-0.1193D-02	-0.0000D-38	-0.1193D-02
10	0.0000D-38	-0.0000D-38	0.0000D-38	0.2027D-04	-0.3777D-03	-0.0000D-38	-0.3777D-03
11	0.0000D-38	0.0000D-38	0.0000D-38	0.1589D-04	-0.0000D-38	0.2229D 02	0.2229D 02
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1268D-04	0.1685D-03	-0.0000D-38	0.1685D-03
13	0.0000D-38	0.0000D-38	0.9256D 00	0.9894D-01	0.6323D 01	-0.0000D-38	0.6323D 01
TOTALS		0.0000D-38	0.1000D 01		0.5572D 01	-0.5572D 01	-0.1510D-12

```
DETAIL OF NODE  12  TEMPERATURE =  -45.45                    AREA = 0.1000D 01
                    IR EMITTANCE = 0.1000       SOLAR EMITTANCE = 0.2000
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
```

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.4410D-02	0.5950D-04	-0.5801D-01	-0.1748D 01	-0.1806D 01
2	0.0000D-38	-0.0000D-38	0.1254D-01	0.1375D-03	-0.1269D 00	-0.4773D 01	-0.4899D 01
3	0.0000D-38	-0.0000D-38	0.1894D-01	0.1987D-03	-0.1780D 00	-0.7054D 01	-0.7232D 01
4	0.0000D-38	-0.0000D-38	0.2311D-01	0.2384D-03	-0.2096D 00	-0.8495D 01	-0.8705D 01
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.3751D-04	-0.1301D-01	-0.0000D-38	-0.1301D-01
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.4242D-04	-0.9998D-02	-0.0000D-38	-0.9998D-02
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.3544D-04	-0.5476D-02	-0.0000D-38	-0.5476D-02
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.2743D-04	-0.2677D-02	-0.0000D-38	-0.2677D-02
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.2096D-04	-0.1229D-02	-0.0000D-38	-0.1229D-02
10	0.0000D-38	-0.0000D-38	0.0000D-38	0.1617D-04	-0.5162D-03	-0.0000D-38	-0.5162D-03
11	0.0000D-38	-0.0000D-38	0.0000D-38	0.1268D-04	-0.1685D-03	-0.0000D-38	-0.1685D-03
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1013D-04	-0.0000D-38	0.1766D 02	0.1766D 02
13	0.0000D-38	0.0000D-38	0.9410D 00	0.9916D-01	0.5020D 01	-0.0000D-38	0.5020D 01
TOTALS		0.0000D-38	0.1000D 01		0.4414D 01	-0.4414D 01	-0.1297D-12

```
DETAIL OF NODE  13  TEMPERATURE = -459.00                    AREA = 0.8944D 01
                    IR EMITTANCE = 1.0000       SOLAR EMITTANCE = 1.0000
                    ILUM         = 0.0000D-38               THETA = 0.90000D 02
   THIS IS A CONSTANT TEMPERATURE NODE
```

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.5938D-01	0.9290D-01	-0.9528D 02	-0.2105D 03	-0.3058D 03
2	0.0000D-38	-0.0000D-38	0.6619D-01	0.9442D-01	-0.9188D 02	-0.2253D 03	-0.3172D 03
3	0.0000D-38	-0.0000D-38	0.7255D-01	0.9545D-01	-0.9031D 02	-0.2417D 03	-0.3320D 03
4	0.0000D-38	-0.0000D-38	0.7828D-01	0.9624D-01	-0.8950D 02	-0.2574D 03	-0.3469D 03
5	0.0000D-38	-0.0000D-38	0.6278D-01	0.9308D-01	-0.3699D 02	-0.7679D 02	-0.1138D 03
6	0.0000D-38	-0.0000D-38	0.7541D-01	0.9514D-01	-0.2724D 02	-0.6694D 02	-0.9419D 02
7	0.0000D-38	-0.0000D-38	0.8541D-01	0.9656D-01	-0.1981D 02	-0.5448D 02	-0.7429D 02
8	0.0000D-38	-0.0000D-38	0.9262D-01	0.9753D-01	-0.1446D 02	-0.4275D 02	-0.5721D 02
9	0.0000D-38	-0.0000D-38	0.9762D-01	0.9819D-01	-0.1073D 02	-0.3324D 02	-0.4397D 02
10	0.0000D-38	-0.0000D-38	0.1011D 00	0.9863D-01	-0.8141D 01	-0.2601D 02	-0.3415D 02
11	0.0000D-38	-0.0000D-38	0.1035D 00	0.9894D-01	-0.6323D 01	-0.2063D 02	-0.2695D 02
12	0.0000D-38	-0.0000D-38	0.1052D 00	0.9916D-01	-0.5020D 01	-0.1661D 02	-0.2163D 02
13	0.0000D-38	0.0000D-38	0.0000D-38	0.7788D 01	-0.0000D-38	0.0000D-38	0.0000D-38
TOTALS		0.0000D-38	0.1000D 01		-0.4957D 03	-0.1272D 04	-0.1768D 04

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  4
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
T     SAME AS CASE ONE BUT WITH DIFFERENT UNITS, (WATTS, CM, DEG C)        TITLE CARD
      BOLTZ=.56759388351D-11                                               DATA CARD
      ABSCVN=273.3333333333                                                DATA CARD
      SOLCON=.1394309344                                                   DATA CARD
      NITER=20                                                             DATA CARD
      CT(13)=-272.7777777777                                               DATA CARD
      PRINT(10)=1                                                          DATA CARD
      END OF CASE                                                          CONTROL CARD
```

Table 4 (contd)

```
$NAME2

N      =              13,

BOLTZ  =        0.56759388350999998D-11,

SOLCON =        0.13943093440000000D 00,

RELTOL =        0.99999999999999997D-05,

ABSCVN =        0.27333333333332999D 03,

NITER  =              20,

$ END
.........................................................


TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  4
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
   STEP RISER=Y, STEP TREAD=X
   SAME AS CASE ONE BUT WITH DIFFERENT UNITS, (WATTS, CM, DEG C)

  THE RESIDUES ARE
 1 =  0.25660428D 01   2 =  0.25821159D 01   3 =  0.25903876D 01   4 =  0.25953416D 01   5 = -0.23339704D-01
 6 = -0.14777369D-01   7 = -0.99680178D-02   8 = -0.69914229D-02   9 = -0.50692417D-02  10 = -0.37925260D-02
11 = -0.29181407D-02  12 = -0.23017583D-02  13 = -0.10822454D 02

  THE TEMPERATURES ARE
 1 =  0.41951386D 03   2 =  0.40802131D 03   3 =  0.40195046D 03   4 =  0.39826123D 03   5 =  0.23393305D 03
 6 =  0.17931805D 03   7 =  0.12816060D 03   8 =  0.82275137D 02   9 =  0.42460079D 02  10 =  0.84488731D 01
11 = -0.20576123D 02  12 = -0.45450653D 02  13 = -0.27277778D 03

  THE RESIDUES ARE
 1 =  0.80456362D 00   2 =  0.80995493D 00   3 =  0.81272998D 00   4 =  0.81439213D 00   5 = -0.99326272D-02
 6 = -0.65244674D-02   7 = -0.44822995D-02   8 = -0.31733512D-02   9 = -0.23129965D-02  10 = -0.17359201D-02
11 = -0.13383913D-02  12 = -0.10571246D-02  13 = -0.37688072D 01

  THE TEMPERATURES ARE
 1 =  0.38898661D 03   2 =  0.38013067D 03   3 =  0.37545171D 03   4 =  0.37260803D 03   5 =  0.25067735D 03
 6 =  0.20935317D 03   7 =  0.17069722D 03   8 =  0.13604219D 03   9 =  0.10597798D 03  10 =  0.80298842D 02
11 =  0.58385620D 02  12 =  0.39606545D 02  13 = -0.27277778D 03

  THE RESIDUES ARE
 1 =  0.24734570D 00   2 =  0.24934938D 00   3 =  0.25038185D 00   4 =  0.25100064D 00   5 = -0.55456061D-02
 6 = -0.38116918D-02   7 = -0.26747265D-02   8 = -0.19136553D-02   9 = -0.14029584D-02  10 = -0.10565801D-02
11 = -0.81641663D-03  12 = -0.64579734D-03  13 = -0.15379339D 01

  THE TEMPERATURES ARE
 1 =  0.22969292D 03   2 =  0.22250240D 03   3 =  0.21870103D 03   4 =  0.21638990D 03   5 =  0.12794442D 03
 6 =  0.96112237D 02   7 =  0.66452862D 02   8 =  0.39902278D 02   9 =  0.16882801D 02  10 = -0.27732434D 01
11 = -0.19543892D 02  12 = -0.33914466D 02  13 = -0.27277778D 03

  THE RESIDUES ARE
 1 =  0.71423719D-01   2 =  0.72330693D-01   3 =  0.72800828D-01   4 =  0.73083539D-01   5 = -0.37401061D-02
 6 = -0.26601230D-02   7 = -0.18949563D-02   8 = -0.13656432D-02   9 = -0.10051642D-02  10 = -0.75876931D-03
11 = -0.58716726D-03  12 = -0.46491763D-03  13 = -0.83488567D 00

  THE TEMPERATURES ARE
 1 =  0.11828552D 03   2 =  0.11167732D 03   3 =  0.10817662D 03   4 =  0.10604580D 03   5 =  0.46040202D 02
 6 =  0.20322787D 02   7 = -0.34005724D 01   8 = -0.24557515D 02   9 = -0.42872174D 02  10 = -0.58498746D 02
11 = -0.71825708D 02  12 = -0.83242456D 02  13 = -0.27277778D 03

UNDRFLOW AT 24413 IN AC AND MQ.

  THE RESIDUES ARE
 1 =  0.16874122D-01   2 =  0.17357954D-01   3 =  0.17614785D-01   4 =  0.17771316D-01   5 = -0.21981908D-02
 6 = -0.16068320D-02   7 = -0.11578381D-02   8 = -0.83895882D-03   9 = -0.61931416D-03  10 = -0.46830645D-03
11 = -0.36278820D-03  12 = -0.28746278D-03  13 = -0.61980222D 00

  THE TEMPERATURES ARE
 1 =  0.50790206D 02   2 =  0.43478185D 02   3 =  0.39580251D 02   4 =  0.37199013D 02   5 =  0.27239380D 01
 6 = -0.20091721D 02   7 = -0.40779412D 02   8 = -0.59106841D 02   9 = -0.74928134D 02  10 = -0.88408587D 02
11 = -0.99896388D 02  12 = -0.10973298D 03  13 = -0.27277778D 03

UNDRFLOW AT 24413 IN AC AND MQ.

  THE RESIDUES ARE
 1 =  0.21207607D-02   2 =  0.23039280D-02   3 =  0.24079626D-02   4 =  0.24738629D-02   5 = -0.57651447D-03
 6 = -0.44127360D-03   7 = -0.32395992D-03   8 = -0.23679899D-03   9 = -0.17562627D-03  10 = -0.13316920D-03
11 = -0.10334271D-03  12 = -0.81980487D-04  13 = -0.56495759D 00

  THE TEMPERATURES ARE
 1 =  0.23396617D 02   2 =  0.14625691D 02   3 =  0.98888744D 01   4 =  0.69726184D 01   5 = -0.97296983D 01
 6 = -0.31948069D 02   7 = -0.51839129D 02   8 = -0.69370660D 02   9 = -0.84471961D 02  10 = -0.97324841D 02
11 = -0.10827112D 03  12 = -0.11764053D 03  13 = -0.27277778D 03

UNDRFLOW AT 24413 IN AC AND MQ.

  THE RESIDUES ARE
 1 =  0.47316018D-04   2 =  0.60190231D-04   3 =  0.68649971D-04   4 =  0.74482998D-04   5 = -0.19609358D-04
 6 = -0.16572862D-04   7 = -0.12645058D-04   8 = -0.94101368D-05   9 = -0.70465938D-05  10 = -0.53732533D-05
11 = -0.41845825D-05  12 = -0.33274290D-05  13 = -0.55789621D 00

  THE TEMPERATURES ARE
 1 =  0.19120128D 02   2 =  0.96882246D 01   3 =  0.45415807D 01   4 =  0.13521124D 01   5 = -0.10668811D 02
 6 = -0.32879871D 02   7 = -0.52723666D 02   8 = -0.70198368D 02   9 = -0.85245052D 02  10 = -0.98048993D 02
11 = -0.10895242D 03  12 = -0.11828453D 03  13 = -0.27277778D 03

UNDRFLOW AT 24413 IN AC AND MQ.

  THE RESIDUES ARE
 1 =  0.23378691D-07   2 =  0.42464981D-07   3 =  0.58972737D-07   4 =  0.72362081D-07   5 = -0.12978270D-07
 6 = -0.13374330D-07   7 = -0.10948750D-07   8 = -0.84159177D-08   9 = -0.64120106D-08  10 = -0.49390433D-08
11 = -0.38709647D-08  12 = -0.30911260D-08  13 = -0.55772387D 00

  THE TEMPERATURES ARE
 1 =  0.19024488D 02   2 =  0.95559943D 01   3 =  0.43832405D 01   4 =  0.11748630D 01   5 = -0.10673872D 02
 6 = -0.32885315D 02   7 = -0.52729014D 02   8 = -0.70203454D 02   9 = -0.85249844D 02  10 = -0.98053505D 02
11 = -0.10895668D 03  12 = -0.11828857D 03  13 = -0.27277778D 03
```

Table 4 (contd)

```
TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBER  4
   TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
    STEP RISER=Y, STEP TREAD=X
    SAME AS CASE ONE BUT WITH DIFFERENT UNITS, (WATTS, CM, DEG C)
```

ENERGY PER UNIT TIME IN IS NEGATIVE AND ENERGY PER UNIT TIME OUT IS POSITIVE

DETAIL OF NODE 1 TEMPERATURE = 19.02 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.1394D 00	-0.1394D 00
1	0.0000D-38	0.0000D-38	0.0000D-38	0.7763D-02	-0.0000D-38	0.1289D 00	0.1289D 00
2	0.0000D-38	0.0000D-38	0.0000D-38	0.3301D-02	0.1689D-04	-0.0000D-38	0.1689D-04
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1790D-02	0.1379D-04	-0.0000D-38	0.1379D-04
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1135D-02	0.1049D-04	-0.0000D-38	0.1049D-04
5	0.0000D-38	0.0000D-38	0.2929D 00	0.2375D 00	0.3432D-02	-0.1334D-01	-0.9910D-02
6	0.0000D-38	0.0000D-38	0.8907D-01	0.7227D-01	0.1626D-02	-0.2941D-02	-0.1316D-02
7	0.0000D-38	0.0000D-38	0.3689D-01	0.2995D-01	0.8394D-03	-0.8750D-03	-0.3559D-04
8	0.0000D-38	0.0000D-38	0.1959D-01	0.1591D-01	0.5061D-03	-0.3362D-03	0.1700D-03
9	0.0000D-38	0.0000D-38	0.1204D-01	0.9784D-02	0.3362D-03	-0.1524D-03	0.1838D-03
10	0.0000D-38	0.0000D-38	0.8130D-02	0.6608D-02	0.2386D-03	-0.7777D-04	0.1608D-03
11	0.0000D-38	0.0000D-38	0.5850D-02	0.4756D-02	0.1775D-03	-0.4334D-04	0.1342D-03
12	0.0000D-38	0.0000D-38	0.4410D-02	0.3586D-02	0.1369D-03	-0.2588D-04	0.1110D-03
13	0.0000D-38	0.0000D-38	0.5311D 00	0.5056D 00	0.2097D-01	-0.0000D-38	0.2097D-01
TOTALS		0.0000D-38	0.1000D 01		0.2830D-01	-0.2830D-01	0.2338D-07

DETAIL OF NODE 2 TEMPERATURE = 9.56 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.1394D 00	-0.1394D 00
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.3301D-02	-0.1689D-04	-0.0000D-38	-0.1689D-04
2	0.0000D-38	0.0000D-38	0.0000D-38	0.2496D-02	-0.0000D-38	0.1235D 00	0.1235D 00
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1803D-02	0.4665D-05	-0.0000D-38	0.4665D-05
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1333D-02	0.5492D-05	-0.0000D-38	0.5492D-05
5	0.0000D-38	0.0000D-38	0.8907D-01	0.7227D-01	0.6747D-03	-0.4057D-02	-0.3383D-02
6	0.0000D-38	0.0000D-38	0.1147D 00	0.9303D-01	0.1617D-02	-0.3790D-02	-0.2173D-02
7	0.0000D-38	0.0000D-38	0.7454D-01	0.6043D-01	0.1384D-02	-0.1768D-02	-0.3838D-03
8	0.0000D-38	0.0000D-38	0.4712D-01	0.3820D-01	0.1019D-02	-0.8086D-03	0.2109D-03
9	0.0000D-38	0.0000D-38	0.3144D-01	0.2549D-01	0.7455D-03	-0.3979D-03	0.3476D-03
10	0.0000D-38	0.0000D-38	0.2218D-01	0.1798D-01	0.5574D-03	-0.2122D-03	0.3452D-03
11	0.0000D-38	0.0000D-38	0.1638D-01	0.1328D-01	0.4278D-03	-0.1214D-03	0.3064D-03
12	0.0000D-38	0.0000D-38	0.1254D-01	0.1017D-01	0.3363D-03	-0.7360D-04	0.2627D-03
13	0.0000D-38	0.0000D-38	0.5920D 00	0.5602D 00	0.2036D-01	-0.0000D-38	0.2036D-01
TOTALS		0.0000D-38	0.1000D 01		0.2712D-01	-0.2712D-01	0.4246D-07

DETAIL OF NODE 3 TEMPERATURE = 4.38 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.1394D 00	-0.1394D 00
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.1790D-02	-0.1379D-04	-0.0000D-38	-0.1379D-04
2	0.0000D-38	-0.0000D-38	0.0000D-38	0.1803D-02	-0.4665D-05	-0.0000D-38	-0.4665D-05
3	0.0000D-38	0.0000D-38	0.0000D-38	0.1491D-02	-0.0000D-38	0.1208D 00	0.1208D 00
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1194D-02	0.1831D-05	-0.0000D-38	0.1831D-05
5	0.0000D-38	0.0000D-38	0.3689D-01	0.2996D-01	0.2022D-03	-0.1680D-02	-0.1478D-02
6	0.0000D-38	0.0000D-38	0.7454D-01	0.6043D-01	0.8938D-03	-0.2462D-02	-0.1568D-02
7	0.0000D-38	0.0000D-38	0.7002D-01	0.5675D-01	0.1153D-02	-0.1661D-02	-0.5075D-03
8	0.0000D-38	0.0000D-38	0.5461D-01	0.4426D-01	0.1067D-02	-0.9371D-03	0.1296D-03
9	0.0000D-38	0.0000D-38	0.4104D-01	0.3326D-01	0.8868D-03	-0.5194D-03	0.3673D-03
10	0.0000D-38	0.0000D-38	0.3107D-01	0.2518D-01	0.7153D-03	-0.2972D-03	0.4181D-03
11	0.0000D-38	0.0000D-38	0.2399D-01	0.1944D-01	0.5759D-03	-0.1777D-03	0.3982D-03
12	0.0000D-38	0.0000D-38	0.1894D-01	0.1535D-01	0.4679D-03	-0.1112D-03	0.3568D-03
13	0.0000D-38	0.0000D-38	0.6489D 00	0.6091D 00	0.2056D-01	-0.0000D-38	0.2056D-01
TOTALS		0.0000D-38	0.1000D 01		0.2651D-01	-0.2651D-01	0.5897D-07

DETAIL OF NODE 4 TEMPERATURE = 1.17 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.1000D 01 THETA = 0.00000D-38

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
					DIRECT SOLAR	-0.1394D 00	-0.1394D 00
1	0.0000D-38	-0.0000D-38	0.0000D-38	0.1135D-02	-0.1049D-04	-0.0000D-38	-0.1049D-04
2	0.0000D-38	-0.0000D-38	0.0000D-38	0.1333D-02	-0.5492D-05	-0.0000D-38	-0.5492D-05
3	0.0000D-38	-0.0000D-38	0.0000D-38	0.1194D-02	-0.1831D-05	-0.0000D-38	-0.1831D-05
4	0.0000D-38	0.0000D-38	0.0000D-38	0.1008D-02	-0.0000D-38	0.1191D 00	0.1191D 00
5	0.0000D-38	0.0000D-38	0.1959D-01	0.1592D-01	0.8301D-04	-0.8924D-03	-0.8094D-03
6	0.0000D-38	0.0000D-38	0.4712D-01	0.3821D-01	0.5065D-03	-0.1556D-02	-0.1050D-02
7	0.0000D-38	0.0000D-38	0.5461D-01	0.4426D-01	0.8316D-03	-0.1295D-02	-0.4637D-03
8	0.0000D-38	0.0000D-38	0.5025D-01	0.4072D-01	0.9190D-03	-0.8623D-03	0.5667D-04
9	0.0000D-38	0.0000D-38	0.4234D-01	0.3431D-01	0.8621D-03	-0.5359D-03	0.3262D-03
10	0.0000D-38	0.0000D-38	0.3464D-01	0.2807D-01	0.7543D-03	-0.3314D-03	0.4229D-03
11	0.0000D-38	0.0000D-38	0.2821D-01	0.2286D-01	0.6420D-03	-0.2090D-03	0.4330D-03
12	0.0000D-38	0.0000D-38	0.2311D-01	0.1873D-01	0.5421D-03	-0.1356D-03	0.4065D-03
13	0.0000D-38	0.0000D-38	0.7001D 00	0.6523D 00	0.2102D-01	-0.0000D-38	0.2102D-01
TOTALS		0.0000D-38	0.1000D 01		0.2614D-01	-0.2614D-01	0.7236D-07

Table 4 (contd)

DETAIL OF NODE 5 TEMPERATURE = -10.67 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.2929D 00	0.2375D 00	-0.3432D-02	-0.3776D-01	-0.4119D-01
2	0.0000D-38	-0.0000D-38	0.8907D-01	0.7227D-01	-0.6747D-03	-0.1100D-01	-0.1168D-01
3	0.0000D-38	-0.0000D-38	0.3689D-01	0.2996D-01	-0.2022D-03	-0.4455D-02	-0.4657D-02
4	0.0000D-38	-0.0000D-38	0.1959D-01	0.1592D-01	-0.8301D-04	-0.2333D-02	-0.2416D-02
5	0.0000D-38	0.0000D-38	0.0000D-38	0.7742D-02	-0.0000D-38	0.4555D-01	0.4555D-01
6	0.0000D-38	0.0000D-38	0.0000D-38	0.3243D-02	0.2608D-04	-0.0000D-38	0.2608D-04
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1712D-02	0.2323D-04	-0.0000D-38	0.2323D-04
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1049D-02	0.1821D-04	-0.0000D-38	0.1821D-04
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7035D-03	0.1401D-04	-0.0000D-38	0.1401D-04
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5016D-03	0.1086D-04	-0.0000D-38	0.1086D-04
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3741D-03	0.8556D-05	-0.0000D-38	0.8556D-05
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2889D-03	0.6857D-05	-0.0000D-38	0.6857D-05
13	0.0000D-38	0.0000D-38	0.5616D 00	0.5287D 00	0.1428D-01	-0.0000D-38	0.1428D-01
TOTALS		0.0000D-38	0.1000D 01		0.9999D-02	-0.1000D-01	-0.1298D-07

DETAIL OF NODE 6 TEMPERATURE = -32.89 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8907D-01	0.7227D-01	-0.1626D-02	-0.1148D-01	-0.1311D-01
2	0.0000D-38	-0.0000D-38	0.1147D 00	0.9303D-01	-0.1617D-02	-0.1418D-01	-0.1579D-01
3	0.0000D-38	-0.0000D-38	0.7454D-01	0.6043D-01	-0.8938D-03	-0.9002D-02	-0.9896D-02
4	0.0000D-38	-0.0000D-38	0.4712D-01	0.3821D-01	-0.5065D-03	-0.5612D-02	-0.6119D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.3243D-02	-0.2608D-04	-0.0000D-38	-0.2608D-04
6	0.0000D-38	0.0000D-38	0.0000D-38	0.2342D-02	-0.0000D-38	0.3302D-01	0.3302D-01
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1592D-02	0.8802D-05	-0.0000D-38	0.8802D-05
8	0.0000D-38	0.0000D-38	0.0000D-38	0.1102D-02	0.1026D-04	-0.0000D-38	0.1026D-04
9	0.0000D-38	0.0000D-38	0.0000D-38	0.7893D-03	0.9368D-05	-0.0000D-38	0.9368D-05
10	0.0000D-38	0.0000D-38	0.0000D-38	0.5852D-03	0.7967D-05	-0.0000D-38	0.7967D-05
11	0.0000D-38	0.0000D-38	0.0000D-38	0.4474D-03	0.6634D-05	-0.0000D-38	0.6634D-05
12	0.0000D-38	0.0000D-38	0.0000D-38	0.3513D-03	0.5512D-05	-0.0000D-38	0.5512D-05
13	0.0000D-38	0.0000D-38	0.6745D 00	0.6256D 00	0.1187D-01	-0.0000D-38	0.1187D-01
TOTALS		0.0000D-38	0.1000D 01		0.7249D-02	-0.7249D-02	-0.1337D-07

DETAIL OF NODE 7 TEMPERATURE = -52.73 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.3689D-01	0.2995D-01	-0.8394D-03	-0.4756D-02	-0.5595D-02
2	0.0000D-38	-0.0000D-38	0.7454D-01	0.6043D-01	-0.1384D-02	-0.9209D-02	-0.1059D-01
3	0.0000D-38	-0.0000D-38	0.7002D-01	0.5675D-01	-0.1153D-02	-0.8456D-02	-0.9609D-02
4	0.0000D-38	-0.0000D-38	0.5461D-01	0.4426D-01	-0.8316D-03	-0.6504D-02	-0.7336D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1712D-02	-0.2323D-04	-0.0000D-38	-0.2323D-04
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1592D-02	-0.8802D-05	-0.0000D-38	-0.8802D-05
7	0.0000D-38	0.0000D-38	0.0000D-38	0.1200D-02	-0.0000D-38	0.2372D-01	0.2372D-01
8	0.0000D-38	0.0000D-38	0.0000D-38	0.8758D-03	0.3310D-05	-0.0000D-38	0.3310D-05
9	0.0000D-38	0.0000D-38	0.0000D-38	0.6464D-03	0.4098D-05	-0.0000D-38	0.4098D-05
10	0.0000D-38	0.0000D-38	0.0000D-38	0.4880D-03	0.3946D-05	-0.0000D-38	0.3946D-05
11	0.0000D-38	0.0000D-38	0.0000D-38	0.3775D-03	0.3511D-05	-0.0000D-38	0.3511D-05
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2988D-03	0.3036D-05	-0.0000D-38	0.3036D-05
13	0.0000D-38	0.0000D-38	0.7639D 00	0.7014D 00	0.9429D-02	-0.0000D-38	0.9429D-02
TOTALS		0.0000D-38	0.1000D 01		0.5207D-02	-0.5207D-02	-0.1095D-07

DETAIL OF NODE 8 TEMPERATURE = -70.20 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1959D-01	0.1591D-01	-0.5061D-03	-0.2526D-02	-0.3032D-02
2	0.0000D-38	-0.0000D-38	0.4712D-01	0.3820D-01	-0.1019D-02	-0.5821D-02	-0.6841D-02
3	0.0000D-38	-0.0000D-38	0.5461D-01	0.4426D-01	-0.1067D-02	-0.6595D-02	-0.7662D-02
4	0.0000D-38	-0.0000D-38	0.5025D-01	0.4072D-01	-0.9190D-03	-0.5985D-02	-0.6904D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.1049D-02	-0.1821D-04	-0.0000D-38	-0.1821D-04
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.1102D-02	-0.1026D-04	-0.0000D-38	-0.1026D-04
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.8758D-03	-0.3310D-05	-0.0000D-38	-0.3310D-05
8	0.0000D-38	0.0000D-38	0.0000D-38	0.6575D-03	-0.0000D-38	0.1716D-01	0.1716D-01
9	0.0000D-38	0.0000D-38	0.0000D-38	0.4933D-03	0.1263D-05	-0.0000D-38	0.1263D-05
10	0.0000D-38	0.0000D-38	0.0000D-38	0.3762D-03	0.1620D-05	-0.0000D-38	0.1620D-05
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2929D-03	0.1617D-05	-0.0000D-38	0.1617D-05
12	0.0000D-38	0.0000D-38	0.0000D-38	0.2329D-03	0.1486D-05	-0.0000D-38	0.1486D-05
13	0.0000D-38	0.0000D-38	0.8284D 00	0.7558D 00	0.7304D-02	-0.0000D-38	0.7304D-02
TOTALS		0.0000D-38	0.1000D 01		0.3767D-02	-0.3767D-02	-0.8416D-08

DETAIL OF NODE 9 TEMPERATURE = -85.25 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.1204D-01	0.9784D-02	-0.3362D-03	-0.1552D-02	-0.1888D-02
2	0.0000D-38	-0.0000D-38	0.3144D-01	0.2549D-01	-0.7455D-03	-0.3884D-02	-0.4630D-02
3	0.0000D-38	-0.0000D-38	0.4104D-01	0.3326D-01	-0.8868D-03	-0.4956D-02	-0.5843D-02
4	0.0000D-38	-0.0000D-38	0.4234D-01	0.3431D-01	-0.8621D-03	-0.5043D-02	-0.5905D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.7035D-03	-0.1401D-04	-0.0000D-38	-0.1401D-04
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.7893D-03	-0.9368D-05	-0.0000D-38	-0.9368D-05
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.6464D-03	-0.4098D-05	-0.0000D-38	-0.4098D-05
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.4933D-03	-0.1263D-05	-0.0000D-38	-0.1263D-05
9	0.0000D-38	0.0000D-38	0.0000D-38	0.3737D-03	-0.0000D-38	0.1266D-01	0.1266D-01
10	0.0000D-38	0.0000D-38	0.0000D-38	0.2867D-03	0.5004D-06	-0.0000D-38	0.5004D-06
11	0.0000D-38	0.0000D-38	0.0000D-38	0.2241D-03	0.6630D-06	-0.0000D-38	0.6630D-06
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1786D-03	0.6827D-06	-0.0000D-38	0.6827D-06
13	0.0000D-38	0.0000D-38	0.8731D 00	0.7935D 00	0.5636D-02	-0.0000D-38	0.5636D-02
TOTALS		0.0000D-38	0.1000D 01		0.2778D-02	-0.2778D-02	-0.6412D-08

Table 4 (contd)

DETAIL OF NODE 10 TEMPERATURE = -98.05 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.8130D-02	0.6608D-02	-0.2386D-03	-0.1048D-02	-0.1287D-02
2	0.0000D-38	-0.0000D-38	0.2218D-01	0.1798D-01	-0.5574D-03	-0.2740D-02	-0.3298D-02
3	0.0000D-38	-0.0000D-38	0.3107D-01	0.2518D-01	-0.7153D-03	-0.3752D-02	-0.4468D-02
4	0.0000D-38	-0.0000D-38	0.3464D-01	0.2807D-01	-0.7543D-03	-0.4126D-02	-0.4880D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.5016D-03	-0.1086D-04	-0.0000D-38	-0.1086D-04
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.5852D-03	-0.7967D-05	-0.0000D-38	-0.7967D-05
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.4880D-03	-0.3946D-05	-0.0000D-38	-0.3946D-05
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.3762D-03	-0.1620D-05	-0.0000D-38	-0.1620D-05
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.2867D-03	-0.5004D-06	-0.0000D-38	-0.5004D-06
10	0.0000D-38	0.0000D-38	0.0000D-38	0.2207D-03	-0.0000D-38	0.9566D-02	0.9566D-02
11	0.0000D-38	0.0000D-38	0.0000D-38	0.1729D-03	0.2099D-06	-0.0000D-38	0.2099D-06
12	0.0000D-38	0.0000D-38	0.0000D-38	0.1380D-03	0.2868D-06	-0.0000D-38	0.2868D-06
13	0.0000D-38	0.0000D-38	0.9040D 00	0.8194D 00	0.4390D-02	-0.0000D-38	0.4390D-02
TOTALS		0.0000D-38	0.1000D 01		0.2100D-02	-0.2100D-02	-0.4939D-08

DETAIL OF NODE 11 TEMPERATURE = -108.96 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.5850D-02	0.4756D-02	-0.1775D-03	-0.7542D-03	-0.9317D-03
2	0.0000D-38	-0.0000D-38	0.1638D-01	0.1328D-01	-0.4278D-03	-0.2024D-02	-0.2451D-02
3	0.0000D-38	-0.0000D-38	0.2399D-01	0.1944D-01	-0.5759D-03	-0.2897D-02	-0.3473D-02
4	0.0000D-38	-0.0000D-38	0.2821D-01	0.2286D-01	-0.6420D-03	-0.3360D-02	-0.4002D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.3741D-03	-0.8556D-05	-0.0000D-38	-0.8556D-05
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.4474D-03	-0.6634D-05	-0.0000D-38	-0.6634D-05
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.3775D-03	-0.3511D-05	-0.0000D-38	-0.3511D-05
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.2929D-03	-0.1617D-05	-0.0000D-38	-0.1617D-05
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.2241D-03	-0.6630D-06	-0.0000D-38	-0.6630D-06
10	0.0000D-38	-0.0000D-38	0.0000D-38	0.1729D-03	-0.2099D-06	-0.0000D-38	-0.2099D-06
11	0.0000D-38	0.0000D-38	0.0000D-38	0.1357D-03	-0.0000D-38	0.7409D-02	0.7409D-02
12	0.0000D-38	0.0000D-38	0.00000-38	0.1084D-03	0.9365D-07	-0.0000D-38	0.9365D-07
13	0.0000D-38	0.0000D-38	0.9256D 00	0.8375D 00	0.3471D-02	-0.0000D-38	0.3471D-02
TOTALS		0.0000D-38	0.1000D 01		0.1626D-02	-0.1626D-02	-0.3871D-08

DETAIL OF NODE 12 TEMPERATURE = -118.29 AREA = 0.1000D 01
IR EMITTANCE = 0.9000 SOLAR EMITTANCE = 0.1800
ILUM = 0.0000D-38 THETA = 0.90000D 02

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.4410D-02	0.3586D-02	-0.1369D-03	-0.5686D-03	-0.7055D-03
2	0.0000D-38	-0.0000D-38	0.1254D-01	0.1017D-01	-0.3363D-03	-0.1549D-02	-0.1885D-02
3	0.0000D-38	-0.0000D-38	0.1894D-01	0.1535D-01	-0.4679D-03	-0.2287D-02	-0.2755D-02
4	0.0000D-38	-0.0000D-38	0.2311D-01	0.1873D-01	-0.5421D-03	-0.2752D-02	-0.3295D-02
5	0.0000D-38	-0.0000D-38	0.0000D-38	0.2889D-03	-0.6857D-05	-0.0000D-38	-0.6857D-05
6	0.0000D-38	-0.0000D-38	0.0000D-38	0.3513D-03	-0.5512D-05	-0.0000D-38	-0.5512D-05
7	0.0000D-38	-0.0000D-38	0.0000D-38	0.2988D-03	-0.3036D-05	-0.0000D-38	-0.3036D-05
8	0.0000D-38	-0.0000D-38	0.0000D-38	0.2329D-03	-0.1486D-05	-0.0000D-38	-0.1486D-05
9	0.0000D-38	-0.0000D-38	0.0000D-38	0.1786D-03	-0.6827D-06	-0.0000D-38	-0.6827D-06
10	0.0000D-38	-0.0000D-38	0.0000D-38	0.1380D-03	-0.2868D-06	-0.0000D-38	-0.2868D-06
11	0.0000D-38	-0.0000D-38	0.0000D-38	0.1084D-03	-0.9365D-07	-0.0000D-38	-0.9365D-07
12	0.0000D-38	0.0000D-38	0.0000D-38	0.8668D-04	-0.0000D-38	0.5869D-02	0.5869D-02
13	0.0000D-38	0.0000D-38	0.9410D 00	0.8505D 00	0.2790D-02	-0.0000D-38	0.2790D-02
TOTALS		0.0000D-38	0.1000D 01		0.1288D-02	-0.1288D-02	-0.3091D-08

DETAIL OF NODE 13 TEMPERATURE = -272.78 AREA = 0.8944D 01
IR EMITTANCE = 1.0000 SOLAR EMITTANCE = 1.0000
ILUM = 0.0000D-38 THETA = 0.90000D 02
THIS IS A CONSTANT TEMPERATURE NODE

NODE	CONDUCTANCE	Q COMP	F	ASCRIPTFTIR	Q COMP	Q COMP	TOTAL
1	0.0000D-38	-0.0000D-38	0.5938D-01	0.5056D 00	-0.2097D-01	-0.6848D-01	-0.8944D-01
2	0.0000D-38	-0.0000D-38	0.6619D-01	0.5602D 00	-0.2036D-01	-0.7313D-01	-0.9350D-01
3	0.0000D-38	-0.0000D-38	0.7255D-01	0.6091D 00	-0.2056D-01	-0.7837D-01	-0.9893D-01
4	0.0000D-38	-0.0000D-38	0.7828D-01	0.6523D 00	-0.2102D-01	-0.8339D-01	-0.1044D 00
5	0.0000D-38	-0.0000D-38	0.6278D-01	0.5287D 00	-0.1428D-01	-0.2558D-01	-0.3986D-01
6	0.0000D-38	-0.0000D-38	0.7541D-01	0.6256D 00	-0.1187D-01	-0.2228D-01	-0.3415D-01
7	0.0000D-38	-0.0000D-38	0.8541D-01	0.7014D 00	-0.9429D-02	-0.1812D-01	-0.2755D-01
8	0.0000D-38	-0.0000D-38	0.9262D-01	0.7558D 00	-0.7304D-02	-0.1422D-01	-0.2152D-01
9	0.0000D-38	-0.0000D-38	0.9762D-01	0.7935D 00	-0.5636D-02	-0.1105D-01	-0.1669D-01
10	0.0000D-38	-0.0000D-38	0.1011D 00	0.8194D 00	-0.4390D-02	-0.8648D-02	-0.1304D-01
11	0.0000D-38	-0.0000D-38	0.1035D 00	0.8375D 00	-0.3471D-02	-0.6857D-02	-0.1033D-01
12	0.0000D-38	-0.0000D-38	0.1052D 00	0.8505D 00	-0.2790D-02	-0.5523D-02	-0.8312D-02
13	0.0000D-38	0.0000D-38	0.0000D-38	0.7047D 00	-0.0000D-38	0.0000D-38	0.0000D-38
TOTALS		0.0000D-38	0.1000D 01		-0.1421D 00	-0.4156D 00	-0.5577D 00

TAS I, MAY 6, 1969 VERSION, JAH X2777, CASE NUMBER 5
TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
STEP RISER=Y, STEP TREAD=X
END OF PROBLEM

CONTROL CARD

Appendix

Source Program Listing for TAS I

```
$JOB   JAH,5693000,52400-0,38132,A  IC  5,9000     TAS I  HULTBERG
$ASSIGN         SYSCK1
$ASSIGN         SYSUT6
$ASSIGN         SYSUT9
$IBJOB TAS I    GO,DLOGIC,MAP,FILES,SOURCE,ALTIO
$IBFTC 1000JA
C
C        JOHN A. HULTBERG
C        JET PROPULSION LABORATORY
C        4800 OAK GROVE DRIVE
C        PASADENA, CALIFORNIA  91103
C
C        PHONE  (213) 354-2777
C
C        LOGICAL TAPE UNIT   5 IS USED FOR INPUT
C        LOGICAL TAPE UNIT   6 IS USED FOR OUTPUT
C        LOGICAL TAPE UNIT   3 IS USED AS A SCRATCH TAPE
C        LOGICAL TAPE UNIT   9 IS USED AS A SCRATCH TAPE
C        LOGICAL TAPE UNIT  13 IS USED AS A SCRATCH TAPE
C        LOGICAL TAPE UNIT  14 IS USED AS A SCRATCH TAPE
C
      DOUBLE PRECISION F,FA,C,AMAT,BMAT,SMAT,ESOL,P,A,QNET,QTOTAL,
     1ALPHA,ILUM,T,TF,THETA,L,CT,TSTART,EIR,S2,BUFFER,
     1TNOTSP,DETIR,QIR,QIRT,GNTOT,BOLTZ,RELTOL,ABSCVN,QSOL,QCT,QSOLT,
     1SOLCON,QC,FT,DUMMY
      INTEGER BDCDCT,BDTICT
      INTEGER FAUSED
      INTEGER CARD
      COMMON F
      DIMENSION NTITLE (72,10)
      DIMENSION F       (80,80)
      DIMENSION FA      (80,80)
      DIMENSION C       (80,80)
      DIMENSION AMAT    (80,80)
      DIMENSION BMAT    (80,80)
      DIMENSION SMAT    (80,80)
      EQUIVALENCE (F,FA)
      EQUIVALENCE (F,C)
      EQUIVALENCE (F,AMAT)
      EQUIVALENCE (F,BMAT)
      EQUIVALENCE (F,SMAT)
      DIMENSION ESOL   (80)
      DIMENSION P      (80)
      DIMENSION A      (80)
      DIMENSION QNET   (80)
      DIMENSION QTOTAL(80)
      DIMENSION ALPHA  (80)
      DIMENSION ILUM   (80)
      DIMENSION T      (80)
      DIMENSION TF     (80)
      DIMENSION THETA  (80)
      DIMENSION L      (80)
      DIMENSION CT     (80)
      DIMENSION TSTART(80)
      DIMENSION EIR    (80)
      INTEGER S1
      DIMENSION S1     (240)
      DIMENSION S2     (80)
      DIMENSION BUFFER(240)
      EQUIVALENCE (BUFFER,S1)
      DIMENSION CARD(80)




      INTEGER PRINT
      DIMENSION PRINT (50)
C
      NAMELIST /INPUT/N,BOLTZ,SOLCON,FA,C,A,EIR,ESOL,ILUM,THETA,CT,P,F,R
     1ELTOL,TNOTSP,ABSCVN,TSTART,FAUSED,PRINT,DUMMY,NITER
C
      NAMELIST /NAME2/N,BOLTZ,SOLCON,RELTOL,ABSCVN,NITER
C
C
      NDIM=80
      NEOBD=0
   99 CALL        EDITA (NEOBD,BDCDCT,CARD,NTITLS,BDTICT,NCASE,NTITLE)
C
C     SET INITIAL VALUES
C
      BOLTZ = .1714D-08
      SOLCON=442.D0
      RELTOL=.00001D0
      ABSCVN=460.D0
      NITER=15
      TNOTSP=68.D0
      DO 101 I=1,NDIM
      A(I)=0.D0
      EIR(I)=0.D0
      ESOL(I)=0.D0
      P(I)=0.D0
      ILUM(I)=1.D0
      THETA(I)=90.D0
      L(I)=0.D0
      CT(I)=-500.D0
      TSTART(I)=-500.D0
  101 QNET(I)=0.D0
C
      DO 98 I=1,40
   98 PRINT(I)=0
C
C
      REWIND 13
      READ (13,INPUT)
```

```
      NX2=N*2
      NX3=N*3
C     MAKE ILUM ZERO FOR THETA EQUAL TO OR GREATER THAN 90 DEGREES
      DO 105 I=1,N
      IF (DABS(THETA(I)).GE.90.D0) ILUM(I)=0.D0
  105 CONTINUE
C
      REWIND 14
      DO 107 I=1,N
      WRITE (14) (BUFFER(J),J=1,NX3)
  107 CONTINUE
C
C
      IF (PRINT(10).EQ.1) WRITE (6,NAME2)
C
      CALL CEDIT (NDIM,N,CARD,NCASE,NTITLS,NTITLE,
     1PRINT(11),
     1  60H(/54H      THE SYMMETRIC CONDUCTION MATRIX IS                 ))
C
      CALL WRIT14 (NDIM,C,N,NX2,NX3,1,BUFFER)
C
      CALL        FEDIT (NDIM,N,A,CARD,NCASE,NTITLS,NTITLE,




     1PRINT(12),
     1  60H(/54H      THE SYMMETRIC FA MATRIX IS                         ),
     1PRINT(13),
     1  60H(/54H      THE F MATRIX IS                                    ))
C
      CALL WRIT14 (NDIM,F,N,NX2,NX3,2,BUFFER)
C     SELECT THE PROPER TEMPERATURES
      DO 120 I=1,N
      IF (CT(I).GE.0.D0) GO TO 116
      IF ((CT(I)+499.D0).GT.0.D0) GO TO 116
      IF (NCASE.GT.1) GO TO 120
  112 IF (TSTART(I).GT.0.D0) GO TO 114
      IF ((TSTART(I)+499.D0).GT.0.D0) GO TO 114
C     FLOW TO THIS POINT INDICATES A TEMPERATURE NOT SPECIFIED
      TF(I)=TNOTSP
      GO TO 118
  114 TF(I)=TSTART(I)
      GO TO 118
  116 TF(I)=CT(I)
  118 T(I)=TF(I)+ABSCVN
  120 CONTINUE
C
      IF ((PRINT(14)+PRINT(15)+PRINT(16)+PRINT(17)
     1    +PRINT(18)+PRINT(19)+PRINT(20)).NE.0)
     1CALL TITLE (NCASE,NTITLS,NTITLE)
C
      IF (PRINT(14).EQ.1)
     1CALL VECPRT (NDIM,A      ,N,
     1  60H(/54H      THE AREAS ARE                                      ))
C
      IF (PRINT(15).EQ.1)
     1CALL VECPRT (NDIM,EIR    ,N,
     1  60H(/54H      THE IR EMITTANCES ARE                              ))
C
      IF (PRINT(16).EQ.1)
     1CALL VECPRT (NDIM,ESOL   ,N,
     1  60H(/54H      THE SOLAR EMITTANCES ARE                           ))
C
      IF (PRINT(17).EQ.1)
     1CALL VECPRT (NDIM,ILUM   ,N,
     1  60H(/54H      THE ILLUMINATIONS ARE                              ))
C
      IF (PRINT(18).EQ.1)
     1CALL VECPRT (NDIM,THETA  ,N,
     1  60H(/54H      THE ANGLES THETA TO THE SUN ARE                    ))
C
      IF (PRINT(19).EQ.1)
     1CALL VECPRT (NDIM,CT     ,N,
     1  60H(/54H      THE CONSTANT TEMPERATURE NODES ARE                 ))
C
      IF (PRINT(20).EQ.1)
     1CALL VECPRT (NDIM,P      ,N,
     1  60H(/54H      THE POWERS ARE                                     ))
C
C     COMPUTE THE EXCITATION VECTOR
      DO 199 I=1,N
  199 L(I)=SOLCON*ILUM(I)*(1.D0-ESOL(I))*DCOS(0.01745329D0*THETA(I))
C
      CALL RADIOS (NDIM,F,N,ESOL,L,L,DETIR,S1,S2,  NCASE,NTITLS,NTITLE,
     1PRINT(21),
     1  60H(/54H  THE EXCITATION VECTOR IS                               ),




     1PRINT(22),
     1  60H(/54H  THE SOLAR TRANSFER MATRIX BEFORE INVERSION IS          ),
     1PRINT(23),
     1  60H(/54H  THE SOLAR TRANSFER MATRIX AFTER INVERSION IS           ),
```

```
     1PRINT(24),
     1  60H(/54H  THE RESPONSE VECTOR IS
C
C     RESTORE THE F MATRIX
      CALL READ14 (NDIM,F,N,NX2,NX3,2,BUFFER)
C
      DO 210 I=1,N
      QNET(I)=-A(I)*SOLCON*ILUM(I)*DCOS(0.01745329D0*THETA(I))
      DO 210 J=1,N
      IF (I.EQ.J) QSOL=(1.D0-F(I,J))*A(I)*L(J)
      IF (I.NE.J) QSOL=-F(I,J)*A(I)*L(J)
  210 QNET(I)=QNET(I)+QSOL
C
      IF (PRINT(25).EQ.1)
     1CALL VECPRT (NDIM,QNET  ,N,
     1  60H(/54H     THE SOLAR QNET VECTOR IS                           ))
C
      CALL        SCRPTF (NDIM,F,N,EIR,A,BOLTZ,
     1DETIR,S1,S2,NX2,NX3,BUFFER,            NCASE,NTITLS,NTITLE,
     1PRINT(26),
     1  60H(/54H     STEP 1 OF THE SCRIPT F MATRIX IS                   ),
     1PRINT(27),
     1  60H(/54H     STEP 2 OF THE SCRIPT F MATRIX IS                   ),
     1PRINT(28),
     1  60H(/54H     STEP 3 OF THE SCRIPT F MATRIX IS                   ),
     1PRINT(29),
     1  60H(/54H     THE SCRIPT F MATRIX IS                             ),
     1PRINT(30),
     1  60H(/54H     THE AREA SCRIPT F MATRIX IS                        ),
     1PRINT(31),
     1  60H(/54H     THE BOLTZ TIMES THE AREA SCRIPT F MATRIX IS        ))
C
      CALL TITLE (NCASE,NTITLS,NTITLE)
C
      DO 509 INDEX=1,NITER
      REWIND 14
C
      IF (INDEX.EQ.1) GO TO 499
      CALL DINVRT (NDIM,SMAT  ,N,ALPHA,1,DETIR,S1,S2)
      DO 508 I=1,N
      TF(I)=ALPHA(I)-ABSCVN
  508 T (I)=ALPHA(I)
C
  499 IEND=1
      DO 500 I=1,N
      DO 500 J=1,N
  500 SMAT(I,J)=0.D0
C
      DO 501 I=1,N
  501 ALPHA(I)=P(I)-DABS(QNET(I))
C
      DO 503 I=1,N
      IF (CT(I).LT.(-499.D0)) GO TO 503
      DO 502 J=1,N
  502 SMAT(I,J)=0.D0
      SMAT(I,I)=1.D0
      ALPHA(I)=CT(I)+ABSCVN




  503 CONTINUE
C
      DO 510 I=1,N
      READ (14) (BUFFER(J),J=1,NX3)
      DO 504 J=1,N
      IF (CT(I).GT.(-499.D0)) GO TO 504
      IF (I.EQ.J) GO TO 504
      J3=J+NX2
C     ADD TO DIAGONAL ELEMENT
      SMAT(I,I)=SMAT(I,I)-BUFFER(J)-BOLTZ*BUFFER(J3)*4.D0*(T(I)**3)
C     ADD TO OFF DIAGONAL ELEMENT
C     ADD TO POWER TERM
      SMAT(I,J)=             BUFFER(J)+BOLTZ*BUFFER(J3)*4.D0*(T(J)**3)
      ALPHA(I)=ALPHA(I)-BOLTZ*BUFFER(J3)*3.D0*((T(I)**4)-(T(J)**4))
  504 CONTINUE
C
C     COMPUTE AND PRINT UNBALLANCE
C
      QTOTAL(I)=P(I)-DABS(QNET(I))
      DO 506 J=1,N
      J3=J+NX2
      IF ((DABS(BUFFER(J))+DABS(BUFFER(J3))).GT.0.D0) GO TO 505
      GO TO 506
  505 QC=BUFFER  (J)*((T(I)    )-(T(J)    ))
      QIR=BUFFER(J3)*((T(I)**4)-(T(J)**4))*BOLTZ
      QTOTAL(I)=QTOTAL(I)+QC+QIR
  506 CONTINUE
C
C     IS THE RESIDUE IN TOLERENCE
      IF (CT(I).GT.(-499.D0)) GO TO 510
      IF (DABS(QTOTAL(I)).GT.RELTOL) IEND=0
  510 CONTINUE
C
  507 CALL VECPRT (NDIM,QTOTAL,N,
     1  60H(/54H     THE RESIDUES ARE                                   ))
C
      CALL VECPRT (NDIM,TF    ,N,
     1  60H(/54H     THE TEMPERATURES ARE                               ))
C
      IF (IEND.EQ.1) GO TO 300
C
C
  509 CONTINUE
```

```
 8900 FORMAT (///30H ITERATIONS DID NOT CONVERGE    )
      WRITE (6,8900)
C
C
 9000 FORMAT (/ 91H0   ENERGY PER UNIT TIME IN IS NEGATIVE AND ENERGY PE
     1R UNIT TIME OUT IS POSITIVE                                      )
 9100 FORMAT ( /// 16H  DETAIL OF NODE,I4,15H  TEMPERATURE = ,F8.2,3X,
     120H                AREA =,D11.4)
 9200 FORMAT ( 20X,                            15H IR EMITTANCE =,F7.4,4X,
     120H   SOLAR EMITTANCE =,F7.4)
 9300 FORMAT ( 20X,                            15H ILUM          =,D11.4  ,
     120H               THETA =,D12.5)
 9400 FORMAT ( 40H      THIS IS A CONSTANT TEMPERATURE NODE     )
 9500 FORMAT ( 110H    NODE CONDUCTANCE   Q COMP            F      ASCRIPTF
     1TIR   Q COMP   Q COMP           TOTAL                             /)
 9550 FORMAT (56X,12HDIRECT SOLAR,2D12.4)
 9600 FORMAT (I8,2D12.4,D12.4,4D12.4)
 9700 FORMAT (8H   POWER,72X,D12.4)




 9800 FORMAT (8H  TOTALS,12X,2D12.4,12X,D12.4,    2D12.4)
C
  300 CALL        TITLE (NCASE,NTITLS,NTITLE)
      REWIND 14
      WRITE (6,9000)
      DO 306 I=1,N
      WRITE (6,9100) I,TF(I),A(I)
      WRITE (6,9200) EIR(I),ESOL(I)
      WRITE (6,9300) ILUM(I),THETA(I)
      IF (CT(I).GT.-499.D0) WRITE (6,9400)
      WRITE (6,9500)
      QCT=0.D0
      FT=0.D0
      QIRT=0.D0
      QSOLT  =-A(I)*SOLCON*ILUM(I)*DCOS(0.01745329D0*THETA(I))
      QTOTAL(I)=QSOLT
      IF (DABS(QSOLT).GT.0.D0) WRITE (6,9550) QSOLT,QSOLT
      READ (14) (BUFFER(J),J=1,NX3)
      DO 304 J=1,N
      J2=J+N
      J3=J+NX2
      QC  =BUFFER(J)*((T(I)    )-(T(J)    ))
      QIR=BUFFER(J3)*((T(I)**4)-(T(J)**4))*BOLTZ
      IF (I.EQ.J) QSOL=(1.D0-BUFFER(J2))*A(I)*L(J)
      IF (I.NE.J) QSOL=-BUFFER(J2)*A(I)*L(J)
      QCT=QCT+QC
      FT=FT+BUFFER(J2)
      QIRT=QIRT+QIR
      QSOLT=QSOLT+QSOL
      QNTOT=        QC+QIR+QSOL
      QTOTAL(I)=QTOTAL(I)+QNTOT
      IF ((DABS(BUFFER(J))+DABS(QC)+DABS(BUFFER(J2))+DABS(BUFFER(J3))
     1+DABS(QIR)+DABS(QSOL)+DABS(QNTOT)).GT.0.0D0)
     1WRITE (6,9600) J,BUFFER(J),QC,BUFFER(J2),BUFFER(J3),QIR,QSOL,QNTOT
  304 CONTINUE
      IF (DABS(P(I)).GT.0.D0) WRITE (6,9700) P(I)
      QTOTAL(I)=QTOTAL(I)+P(I)
  305 WRITE (6,9800) QCT,FT,QIRT,QSOLT,QTOTAL(I)
  306 CONTINUE
      GO TO 99
      END
$IBFTC 10000B
      SUBROUTINE TITLE (NCASE,NTITLS,NTITLE)
      DIMENSION NTITLE (72,10)
 1000 FORMAT (57H1  TAS I,   MAY 6, 1969 VERSION,  JAH X2777, CASE NUMBE
     1R ,I2)
 1001 FORMAT (72A1)
      WRITE (6,1000) NCASE
      IF (NTITLS.NE.0) WRITE (6,1001) ((NTITLE(I,J),I=1,72),J=1,NTITLS)
      RETURN
      END
$IBFTC 10000C
      SUBROUTINE CEDIT (NDIM,N,CARD,NCASE,NTITLS,NTITLE,PRT1,FMT1)
      DOUBLE PRECISION C,DUMMY
      INTEGER CARD,ALPHAA,ALPHAB,ALPHAC
      COMMON C
      DIMENSION NTITLE (72,10)
      DIMENSION FMT1(24)
      INTEGER PRT1
      DIMENSION C(80,80)
      DIMENSION CARD(80)




      DIMENSION ALPHAA(2)
      DIMENSION ALPHAB(1)
      DIMENSION ALPHAC(4)
      DATA ALPHAA/1HC,1HT/
      DATA ALPHAB/1HC/
      DATA ALPHAC/1H$,1HE,1HN,1HD/
      NAMELIST /INPUT/C,DUMMY
C
      REWIND 3
      REWIND 13
      REWIND 14
C
C     WRITE $INPUT ON SCRATCH TAPE 3
 1001 FORMAT (20H $INPUT  DUMMY=1.D0,,80X)
      WRITE (3,1001)
C
C     READ A CARD IMAGE FROM THE INPUT SCRATCH TAPE
 1002 FORMAT (80A1)
    1 READ (13,1002) CARD
C
C     TEST FOR CT
```

```
      CALL MATCH (CARD,ALPHAA,2,I,J)
      GO TO (5,2),J
    5 GO TO 1
C
C     TEST FOR C
    2 CALL MATCH (CARD,ALPHAB,1,I,J)
      GO TO (6,3),J
    6 WRITE (3,1002) CARD
      GO TO 1
C
C     TEST FOR $END
    3 CALL MATCH (CARD,ALPHAC,4,I,J)
      GO TO (7,1),J
    7 WRITE (3,1002) CARD
C
C     FLOW TO THIS POINT INDICATES ALL CARD IMAGES HAVE BEEN PROCESSED
C
C     ZERO THE C MATRIX
      DO 4 I=1,N
      DO 4 J=1,N
    4 C(I,J)=0.D0
C
      REWIND 3
      READ (3,INPUT)
C
      CALL MATPOS (NDIM,C ,N)
      CALL MATSYM (NDIM,C ,N)
C     PRINT C MATRIX IF REQUESTED
      IF (PRT1.EQ.1) CALL MATPRT (NDIM,C,N,NCASE,NTITLS,NTITLE,FMI1)
      RETURN
      END
$IBFTC 10000D
      SUBROUTINE MATCH(CARD,NAME,NAMDIM,K,L)
      INTEGER CARD,BLANK
      DIMENSION CARD(80)
      DIMENSION NAME(NAMDIM)
      DATA BLANK/1H /
C
      L=1
      J=1




      DO 1 I=1,72
      K=I
C     SKIP BLANKS
      IF (CARD(I).EQ.BLANK) GO TO 1
C     LOOK FOR COLUMN MATCH
      IF (CARD(I).NE.NAME(J)) GO TO 2
C     FLOW TO THIS POINT INDICATES A SUCCESSFUL COLUMN MATCH
C     MAKE A SUCCESSFUL RETURN IF THE ENTIRE NAME HAS BEEN SCANNED
C     I CONTAINS THE COLUMN NUMBER OF THE LAST CHARACTER
      IF (J.EQ.NAMDIM) RETURN
C     INCREMENT THE NAME COLUMN INDEX BY ONE
      J=J+1
    1 CONTINUE
C     FLOW TO THIS POINT INDICATES AN UNSUCCESSFUL COLUMN MATCH
    2 L=2
      RETURN
      END
$IBFTC 10000E
      SUBROUTINE EDITA (NEOBD,BDCDCT,CARD,NTITLS,BDTICT,NCASE,NTITLE)
      INTEGER BDCDCT,BDTICT
      INTEGER CARD,ALPHA
      DIMENSION NTITLE (72,10)
      DIMENSION   CARD(80)
      DIMENSION ALPHA (35)
      DIMENSION NAMEA(14)
      DIMENSION NAMEB(9)
      DIMENSION NAMEC(12)
      DIMENSION NAMEG(6)
      DATA ALPHA/1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,1HM,1HN
     1,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ,1H ,1H(,1H),1H,,1
     1H+,1H-,1H*,1H.,1H$/
      DATA NAMEA/1HE,1HN,1HD,1HO,1HF,1HB,1HA,1HS,1HI,1HC,1HD,1HA,1HT,1HA
     1/
      DATA NAMEB/1HE,1HN,1HD,1HO,1HF,1HC,1HA,1HS,1HE/
      DATA NAMEC/1HE,1HN,1HD,1HO,1HF,1HP,1HR,1HO,1HB,1HL,1HE,1HM/
      DATA NAMEE/1HC/
      DATA NAMEF/1HT/
      DATA NAMEG/1H$,1HI,1HN,1HP,1HU,1HT/
C     REWIND THE INPUT SCRATCH TAPE
    1 REWIND 13
C     IS THIS A NEW PROBLEM
C     IF (NEOBD) EQUALS ZERO IT IS A NEW PROBLEM
      IF (NEOBD.EQ.0) GO TO 9
C     IF THIS IS A CASE SPACE OUT THE SCRATCH INPUT TAPE
 1000 FORMAT (80A1)
      DO 8 I=1,BDCDCT
    8 READ (13,1000)   CARD
      NTITLS=BDTICT
C     INCREASE THE CASE NUMBER BY ONE
    6 NCASE=NCASE+1
      CALL       TITLE (NCASE,NTITLS,NTITLE)
      GO TO 10
    9 NCASE=0
      NTITLS=0
      BDCDCT=1
      BDTICT=0
C     WRITE $INPUT ON THE INPUT SCRATCH TAPE
 1002 FORMAT (20H $INPUT  DUMMY=1.D0,,80X)
      WRITE (13,1002)
      CALL       TITLE (NCASE,NTITLS,NTITLE)
```

```
C     READ AN INPUT CARD FROM THE INPUT TAPE



   10 READ (5,1000)   CARD
C
C     TEST FOR $INPUT
      CALL MATCH(CARD,NAMEG,6,I,J)
      GO TO (50,900),J
C     FLOW TO THIS POINT INDICATES A $INPUT CARD
 1003 FORMAT (1H ,80A1,20H  DATA CARD          )
   50 WRITE (6,1003) CARD
C     BLANK THE $INPUT
      CARD(I  )=ALPHA(27)
      CARD(I-1)=ALPHA(27)
      CARD(I-2)=ALPHA(27)
      CARD(I-3)=ALPHA(27)
      CARD(I-4)=ALPHA(27)
      CARD(I-5)=ALPHA(27)
C
C     TEST FOR C
  900 IF (CARD(1).NE.NAMEE) GO TO 910
C     FLOW TO THIS POINT INDICATES A COMMENT CARD
 1004 FORMAT (1H ,80A1,20H  COMMENT CARD       )
  200 WRITE (6,1004)   CARD
      GO TO 10
C
C     TEST FOR T
  910 IF (CARD(1).NE.NAMEF) GO TO 400
C     FLOW TO THIS POINT INDICATES A TITLE CARD
C     IF THE TITLE ARRAY IS FULL, PRINT THE TITLE CARD AS A COMMENT CARD
  300 IF (NTITLS.EQ.10)GO TO 200
 1005 FORMAT (1H ,80A1,20H  TITLE CARD         )
      WRITE (6,1005)   CARD
C     INCREASE THE BASIC DATA TITLE COUNTER BY ONE
      IF (NEOBD.EQ.0) BDTICT=BDTICT+1
C     INCREASE THE TITLE COUNTER (NTITLS) BY ONE
      NTITLS=NTITLS+1
C     BLANK THE FIRST CHARACTER FOR LATER PRINTOUT
      CARD(01)=ALPHA(27)
C     LOAD INTO THE TITLE ARRAY (NTITLE)
      DO 310 I=1,72
  310 NTITLE(I,NTITLS)=  CARD(I)
      GO TO 10
C
C     IS THIS AN END OF BASIC DATA CARD
  400 CALL MATCH(CARD,NAMEA,14,I,J)
      GO TO (51,410),J
C     WRITE IT ON THE OUTPUT TAPE
 1006 FORMAT (1H ,80A1,20H  CONTROL CARD       )
   51 WRITE (6,1006)   CARD
C     SET NEOBD NOT EQUAL TO ZERO TO SHOW THAT AN END OF BASIC DATA
C     CARD HAS BEEN READ
      NEOBD=1
      GO TO 6
C
C     IS THIS AN END OF CASE CARD
  410 CALL MATCH(CARD,NAMEB,9,I,J)
      GO TO (52,420),J
C     WRITE IT ON THE OUTPUT TAPE
   52 WRITE (6,1006)   CARD
C     WRITE THE DUMMY CARD IMAGE ON THE INPUT SCRATCH TAPE
 1007 FORMAT (5H $END,75X)
      WRITE (13,1007)
      RETURN



C
C     IS THIS AN END OF PROBLEM CARD
  420 CALL MATCH(CARD,NAMEC,12,I,J)
      GO TO (53,425),J
C     WRITE IT ON THE OUTPUT TAPE
   53 WRITE (6,1006)   CARD
C     WRITE THE DUMMY CARD IMAGE ON THE INPUT SCRATCH TAPE
      WRITE (13,1007)
      IF (NEOBD.EQ.0) RETURN
      NEOBD=0
      GO TO 1
C
C     TEST FOR BLANK
  425 IF (CARD(1).NE.ALPHA(27)) GO TO 430
C     FLOW TO THIS POINT INDICATES A DATA CARD
      WRITE (6,1003) CARD
C     BLANK IDENTIFICATION
      DO 110 I=72,80
  110 CARD(I)=ALPHA(27)
C
C
C     SEARCH FOR THE LAST CHARACTER STARTING IN COL 72
      DO 122 J=1,72
C
C     REVERSE THE INDEX
      I=73-J
C
C     TEST FOR BLANK, FLOW TO NEXT COLUMN IF PRESENT
      IF (CARD(I).NE.ALPHA(27)) GO TO 120
      GO TO 122
C
C     TEST FOR COMMA
  120 IF (CARD(I).NE.ALPHA(30)) GO TO 121
```

```
      GO TO 124
C
C     TEST FOR DOLLAR SIGN, REPLACE WITH A COMMA IF PRESENT
  121 IF (CARD(I).NE.ALPHA(35)) GO TO 123
      CARD(I)=ALPHA(30)
      GO TO 124
C
  122 CONTINUE
C     FLOW TO THIS POINT INDICATES A BLANK CARD
      GO TO 124
C     FLOW TO THIS POINT INDICATES A COMMA IS NOT PRESENT, INSERT ONE
  123 CARD(I+1)=ALPHA(30)
C
C
  124 WRITE (13,1030)   CARD
C     COUNT THE CARDS FOR A POSSIBLE CASE RUN
C     INCREASE THE BASIC DATA CARD COUNT BY ONE
      IF (NEOBD.EQ.0) BDCDCT=BDCDCT+1
      GO TO 10
C
C     FLOW TO THIS POINT INDICATES A          CARD ERROR
 1001 FORMAT (1H ,80A1,20H  CARD ERROR          )
  430 WRITE (6,1001)   CARD
C     WRITE THE DUMMY CARD IMAGE ON THE INPUT SCRATCH TAPE
      WRITE (13,1007)
      RETURN
      END
$IBFTC 10000F



      SUBROUTINE RADIOS (NDIM,F,N,E,X,R,DETERM,S1,S2,
     1NCASE,NTITLS,NTITLE,PRT1,FMT1,PRT2,FMT2,PRT3,FMT3,PRT4,FMT4)
      DOUBLE PRECISION F,X,R,S2,E,DETERM
      DIMENSION F(80,80)
      DIMENSION X(80)
      DIMENSION R(80)
      INTEGER S1
      DIMENSION S1    (240)
      DIMENSION S2    (80)
      DIMENSION E     (80)
      DIMENSION NTITLE (72,10)
      DIMENSION FMT1(24)
      DIMENSION FMT2(24)
      DIMENSION FMT3(24)
      DIMENSION FMT4(24)
      INTEGER PRT1,PRT2,PRT3,PRT4
C
C
C     PRINT THE EXCITATION VECTOR IF REQUESTED
      IF (PRT1.EQ.0) GO TO 1
      CALL TITLE (NCASE,NTITLS,NTITLE)
      CALL VECPRT (NDIM,X,N,FMT1)
    1 DO 4 I=1,N
      DO 3 J=1,N
    3 F(I,J)=-(1.D0-E(I))*F(I,J)
    4 F(I,I)=1.D0+F(I,I)
C
C     PRINT THE TRANSFER MATRIX BEFORE INVERSION IF REQUESTED
      IF (PRT2.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT2)
C
      DO 6 I=1,N
    6 R(I)=X(I)
C
      CALL DINVRT (NDIM,F,N,R,1,DETERM,S1,S2)
C
C     PRINT THE TRANSFER MATRIX AFTER INVERSION IF REQUESTED
      IF (PRT3.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT3)
C
C     PRINT THE RESPONSE VECTOR IF REQUESTED
      IF (PRT4.EQ. 0) RETURN
      CALL TITLE (NCASE,NTITLS,NTITLE)
      CALL VECPRT (NDIM,R,N,FMT4)
C
      RETURN
      END
$IBFTC 10000G
      SUBROUTINE MATSYM (NDIM,F,N)
      DOUBLE PRECISION F
      DIMENSION F(NDIM,NDIM)
 9001 FORMAT (15HOMATRIX ELEMENT,I3,1H,,I3,19H AND MATRIX ELEMENT,I3,1H,
     1,I3,12HBOTH DEFINED)
      DO 6 I=1,N
      DO 6 J=1,N
      IF (J.LE.I) GO TO 6
      IF (DABS(F(I,J)).GT.0.D0) GO TO 1
      GO TO 5
    1 IF (DABS(F(J,I)).GT.0.D0) GO TO 2
      GO TO 3
    2 WRITE (6,9001)I,J,J,I
    3 F(J,I)=F(I,J)
      GO TO 6



    5 F(I,J)=F(J,I)
    6 CONTINUE
      RETURN
      END
$IBFTC 10000H
      SUBROUTINE MATPOS (NDIM,A,N)
```

```
      DOUBLE PRECISION A
      DIMENSION A(NDIM,NDIM)
 9001 FORMAT (15HOMATRIX ELEMENT,I3,1H,,I3,39H IS NEGATIVE, IT HAS BEEN
     1MADE POSITIVE)
      DO 1 I=1,N
      DO 1 J=1,N
      IF ((A(I,J)).GE.(0.D0)) GO TO 1
      WRITE (6,9001)I,J
      A(I,J)=DABS(A(I,J))
    1 CONTINUE
      RETURN
      END
$IBFTC 10000I
      SUBROUTINE SCRPTF (NDIM,F,N,E,A,BOLTZ,DETERM,S1,S2,NX2,NX3,BUFFER,
     1     NCASE,NTITLS,NTITLE,PRT1,FMT1,PRT2,FMT2,PRT3,FMT3,PRT4,FMT4,
     1PRT5,FMT5,PRT6,FMT6)
      DOUBLE PRECISION F,E,A,BOLTZ,DETERM,S2,BUFFER
      DIMENSION NTITLE (72,10)
      DIMENSION F(80,80)
      DIMENSION E      (80)
      DIMENSION A      (80)
      INTEGER S1
      DIMENSION S1     (240)
      DIMENSION S2     (80)
      DIMENSION BUFFER(240)
      DIMENSION FMT1(24)
      DIMENSION FMT2(24)
      DIMENSION FMT3(24)
      DIMENSION FMT4(24)
      DIMENSION FMT5(24)
      DIMENSION FMT6(24)
      INTEGER PRT1,PRT2,PRT3,PRT4,PRT5,PRT6
C
      DO 2 I=1,N
      DO 1 J=1,N
    1 F(I,J)=-(1.D0-E(I))*F(I,J)
    2 F(I,I)=1.D0+F(I,I)
C
C     PRINT THE MATRIX BEFORE INVERSION IF REQUESTED
      IF (PRT1.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT1)
C
    3 CALL DINVRT (NDIM,F,N,E,0,DETERM,S1,S2)
C
      IF (PRT2.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT2)
C
C
C     THE F MATRIX IS STORED BY ROWS ON TAPE 14
      REWIND 14
      REWIND 9
C
    5 DO 8 I=1,N
C
C     READ A ROW OF THE F MATRIX FROM SCRATCH TAPE 14
      READ (14) (BUFFER(J),J=1,NX3)
C



C     PERFORM THE ELEMENT SUM AND WRITE IT BY ROWS ON TAPE 9
      DO 7 J=1,N
      S2(J)=0.D0
      DO 7 K=1,N
      K2=K+N
      S2(J)=S2(J)+BUFFER(K2)*F(K,J)
    7 CONTINUE
      WRITE (9) (S2(J),J=1,N)
    8 CONTINUE
      REWIND 9
      DO 100 I=1,N
      READ (9) (S2(J),J=1,N)
      DO 100 J=1,N
      F(I,J)=S2(J)
  100 CONTINUE
C
C
      IF (PRT3.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT3)
C
   10 DO 11 I=1,N
      DO 11 J=1,N
   11 F(I,J)=E(I)*E(J)*F(I,J)
C
      IF (PRT4.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT4)
C
   13 DO 14 I=1,N
      DO 14 J=1,N
   14 F(I,J)=A(I)*F(I,J)
C
      IF (PRT5.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT5)
C
      CALL WRIT14 (NDIM,F,N,NX2,NX3,3,BUFFER)
C
   16 DO 17 I=1,N
      DO 17 J=1,N
   17 F(I,J)=BOLTZ*F(I,J)
      IF (PRT6.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT6)
      RETURN
      END
$IBFTC 10000J
      SUBROUTINE FEDIT (NDIM,N,A,CARD,NCASE,NTITLS,NTITLE,
     1PRT1,FMT1,PRT2,FMT2)
      INTEGER ALPHAA,ALPHAB,ALPHAC,ALPHAD,CARD
      DOUBLE PRECISION F,FA,A,DUMMY
      DIMENSION A(80)
```

```
      COMMON F
      DIMENSION F      (80,80)
      DIMENSION FA     (80,80)
      EQUIVALENCE (F,FA)
      INTEGER FAUSED
      DIMENSION NTITLE (72,10)
      DIMENSION FMT1(24)
      DIMENSION FMT2(24)
      INTEGER PRT1,PRT2
      DIMENSION ALPHAA(2)
      DIMENSION ALPHAB(1)
      DIMENSION ALPHAC(6)
      DIMENSION ALPHAD(4)
      DATA ALPHAA/1HF,1HA/
      DATA ALPHAB/1HF/
      DATA ALPHAC/1HF,1HA,1HU,1HS,1HE,1HD/
      DATA ALPHAD/1H$,1HE,1HN,1HD/
      DIMENSION CARD(80)
C
      NAMELIST /INPUT/F,FA,FAUSED,DUMMY
C
      REWIND 3
      REWIND 13
      REWIND 14
C
C     WRITE $INPUT ON SCRATCH TAPE 3
 1001 FORMAT (20H $INPUT   DUMMY=1.D0,,80X)
      WRITE (3,1001)
C
C     READ A CARD IMAGE FROM THE INPUT SCRATCH TAPE
 1002 FORMAT (80A1)
    1 READ (13,1002) CARD
C
C     TEST FOR FA
      CALL MATCH (CARD,ALPHAA,2,I,J)
      GO TO (10,2),J
   10 WRITE (3,1002) CARD
C
C     TEST FOR F
    2 CALL MATCH (CARD,ALPHAB,1,I,J)
      GO TO (11,3),J
   11 WRITE (3,1002) CARD
C
C     TEST FOR FAUSED
    3 CALL MATCH (CARD,ALPHAC,6,I,J)
      GO TO (12,4),J
   12 WRITE (3,1002) CARD
C
C     TEST FOR $END
    4 CALL MATCH (CARD,ALPHAD,4,I,J)
      GO TO (13,1),J
   13 WRITE (3,1002) CARD
C
C     FLOW TO THIS POINT INDICATES ALL CARD IMAGES HAVE BEEN PROCESSED
C
      FAUSED=0
C     ZERO THE F MATRIX
      DO 5 I=1,N
      DO 5 J=1,N
    5 F(I,J)=0.D0
C
      REWIND 3
      READ (3,INPUT)
C
      IF (FAUSED.EQ.1) GO TO 7
      CALL MATPOS (NDIM,F ,N)
      DO 6 I=1,N
      DO 6 J=1,N
    6 FA(I,J)=A(I)*F(I,J)
    7 CALL MATPOS (NDIM,FA,N)
      CALL MATSYM (NDIM,FA,N)
C
C     PRINT FA MATRIX IF REQUESTED
      IF (PRT1.EQ.1) CALL MATPRT (NDIM,FA,N,NCASE,NTITLS,NTITLE,FMT1)
C
C     CONVERT FA MATRIX TO F MATRIX
      DO 14 I=1,N
      IF (DABS(A(I)).GT.0.D0) GO TO 8
      GO TO 14
    8 DO 9 J=1,N
    9 F(I,J)= FA(I,J)/A(I)
   14 CONTINUE
C
C     PRINT F MATRIX IF REQUESTED
      IF (PRT2.EQ.1) CALL MATPRT (NDIM,F,N,NCASE,NTITLS,NTITLE,FMT2)
C
      RETURN
      END
$IBFTC 10000K
      SUBROUTINE WRIT14 (NDIM,MATRIX,N,NX2,NX3,MATNO,BUFFER)
      DOUBLE PRECISION MATRIX,BUFFER
      DIMENSION MATRIX (80,80)
      DIMENSION BUFFER(240)
C
      REWIND 9
      REWIND 14
      DO 7 I=1,N
      READ (14) (BUFFER(J),J=1,NX3)
      GO TO (1,2,3),MATNO
C
    1 DO 4 J=1,N
    4 BUFFER(J )=MATRIX(I,J)
      GO TO 65
C
    2 DO 5 J=1,N
      J2=J+N
    5 BUFFER(J2)=MATRIX(I,J)
      GO TO 65
C
    3 DO 6 J=1,N
      J3=J+NX2
    6 BUFFER(J3)=MATRIX(I,J)
C
   65 WRITE (9) (BUFFER(J),J=1,NX3)
    7 CONTINUE
C
      REWIND 9
      REWIND 14
      DO 8 I=1,N
      READ (9) (BUFFER(J),J=1,NX3)
      WRITE (14) (BUFFER(J),J=1,NX3)
    8 CONTINUE
      RETURN
      END
$IBFTC 10000L
      SUBROUTINE READ14 (NDIM,MATRIX,N,NX2,NX3,MATNO,BUFFER)
      DOUBLE PRECISION MATRIX,BUFFER
      DIMENSION MATRIX (80,80)
      DIMENSION BUFFER(240)
C
      REWIND 14
      DO 7 I=1,N
      READ (14) (BUFFER(J),J=1,NX3)
      GO TO (1,2,3),MATNO
    1 DO 4 J=1,N
    4 MATRIX(I,J)=BUFFER(J )
      GO TO 7
    2 DO 5 J=1,N
      J2=J+N
    5 MATRIX(I,J)=BUFFER(J2)
      GO TO 7
    3 DO 6 J=1,N
      J3=J+NX2
    6 MATRIX(I,J)=BUFFER(J3)
    7 CONTINUE
      RETURN
      END
$IBFTC 10000M
      SUBROUTINE VECPRT(NDIM,A,N,FMTT)
      DOUBLE PRECISION A
      DIMENSION A(NDIM)
      DIMENSION FMTT(24)
      WRITE (6,FMTT)
      DO 3 J=1,N,5
      K=J
      KK=J+4
      IF (KK.LE.N) GO TO 3
      KK=N
 1001 FORMAT (1H I4,2H = D16.8,
     1           I4,2H = D16.8,
     1           I4,2H = D16.8,
     1           I4,2H = D16.8,
     1           I4,2H = D16.8)
    3 WRITE (6,1001)(K,A(K),K=J,KK)
      RETURN
      END
$IBFTC 10000N
      SUBROUTINE MATPRT(NDIM,A,N,NCASE,NTITLS,NTITLE,FMTT)
      DOUBLE PRECISION A
      REAL NTITLE
      DIMENSION NTITLE (72,10)
      DIMENSION A(NDIM,NDIM)
      DIMENSION FMTT(24)
      CALL TITLE (NCASE,NTITLS,NTITLE)
      WRITE (6,FMTT)
      DO 3 I=1,N
 1000 FORMAT (6H0  ROW,I3)
      WRITE (6,1000)I
      DO 3 J=1,N,5
      K=J
      KK=J+4
      IF (KK.LE.N) GO TO 3
      KK=N
 1001 FORMAT (1H I4,2H = D16.8,
     1           I4,2H = D16.8,
     1           I4,2H = D16.8,
     1           I4,2H = D16.8,
     1           I4,2H = D16.8)
    3 WRITE (6,1001)(K,A(I,K),K=J,KK)
      RETURN
      END
$IBFTC 10000O
      SUBROUTINE DINVRT (NDIM,A,NORDER,B,MORDER,DETERM,S1,S2)
      DOUBLE PRECISION A,B,DETERM,S2,AMAX,T,SWAP
C
```

```
C     MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS
C
      DIMENSION A(NDIM,NDIM),B(NDIM,2)
C




C     PIVOT=S2
C     IPIVOT=S1
C     INDEX  (N,1) =S1((N+1)-(2N))
      DIMENSION S1(2),S2(2)
      INTEGER Z1,Z2,S1
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)
C
C     INITIALIZATION
C
   10 DETERM=1.0D0
      N=NORDER
      M=MORDER
   15 DO 20 J=1,N
   20 S1(J)=0
   30 DO 550 I=1,N
   31 Z1=I+N
   32 Z2=Z1+N
C
C     SEARCH FOR PIVOT ELEMENT
C
   40 AMAX=0.0D0
   45 DO 105 J=1,N
   50 IF (S1(J).EQ.1) GO TO 105
   60 DO 100 K=1,N
   70 IF (S1(K)-1) 80,100,740
   80 IF (ABS(AMAX)-ABS(A(J,K))) 85, 100, 100
   85 IROW=J
   90 ICOLUM=K
   95 AMAX=A(J,K)
  100 CONTINUE
  105 CONTINUE
  110 S1(ICOLUM)=S1(ICOLUM)+1
C
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
  130 IF (IROW.EQ.ICOLUM) GO TO 260
  140 DETERM=-DETERM
  150 DO 200 L=1,N
  160 SWAP=A(IROW,L)
  170 A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
  205 IF (M.LE.0) GO TO 260
  210 DO 250 L=1, M
  220 SWAP=B(IROW,L)
  230 B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
  260 S1(Z1)=IROW
  270 S1(Z2)=ICOLUM
  310 S2(I)=A(ICOLUM,ICOLUM)
  320 DETERM=DETERM*S2(I)
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  330 A(ICOLUM,ICOLUM)=1.0D0
  340 DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/S2(I)
  355 IF (M.LE.0) GO TO 380
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/S2(I)
C
C     REDUCE NON-PIVOT ROWS



C
  380 DO 550 L1=1,N
  390 IF (L1.EQ.ICOLUM) GO TO 550
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM)=0.0
  430 DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF (M.LE.0) GO TO 550
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C     INTERCHANGE COLUMNS
C
  600 DO 710 I=1,N
  610 L=N+1-I
  611 L1=L+N
  612 L2=L1+N
  620 IF (S1(L1).EQ.S1(L2)) GO TO 710
  630 JROW=S1(L1)
  640 JCOLUM=S1(L2)
  650 DO 705 K=1,N
  660 SWAP=A(K,JROW)
  670 A(K,JROW)=A(K,JCOLUM)
  700 A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
  740 RETURN
      END
$DATA
```

```
T     TEMPERATURE DISTRIBUTION OF AN L-SHAPE STEP CAVITY
T     STEP RISER=Y, STEP TREAD=X
C
C     LOCAL RADIATION EQUILIBRIUM TEMPERATURES IN SEMIGRAY ENCLOSURES,
C     BOBCO,R.P., ALLENY,G.E., AND OTHMER,P.W.,
C     AEROSPACE TECHNOLOGY RESEARCH REPORT,
C     SSD 60475R  REPORT NUMBER 17  DECEMBER 1966
C     HUGHES AIRCRAFT COMPANY
C     SPACE SYSTEMS DIVISION
C     LOSANGELES, CALIFORNIA
C
C     REF. 3, BOBCO, R.P., RADIATION FROM A DIRECTIONAL SOURCE, BEAM
C     DIVERGENCE IN SOLAR SIMULATORS, J. ENGR. FOR POWER, TRANS.ASME,
C     SER.A, VOL.87, NO 3, 1965, PP.259-269.
C
C     FIGURE 1.  TEMPERATURE DISTRIBUTION OF AN L-SHAPE, Y=2X
C             1         2         3         4         5         6         7
C23456789012345678901234567890123456789012345678901234567890123456789012
      N=13
      F(1,5)= .29289
      F(1,6)= .08907
      F(1,7)= .03689
      F(1,8)= .01959
      F(1,9)= .01204
      F(1,10)=.00813
      F(1,11)=.00585
      F(1,12)=.00441
      F(1,13)=.53113
C
      F(2,5)= .08907
      F(2,6)= .11475




      F(2,7)= .07454
      F(2,8)= .04712
      F(2,9)= .03144
      F(2,10)=.02218
      F(2,11)=.01638
      F(2,12)=.01254
      F(2,13)=.59198
C
      F(3,5)= .03689
      F(3,6)= .07454
      F(3,7)= .07002
      F(3,8)= .05461
      F(3,9)= .04104
      F(3,10)=.03107
      F(3,11)=.02399
      F(3,12)=.01894
      F(3,13)=.64890
C
      F(4,5)= .01959
      F(4,6)= .04712
      F(4,7)= .05461
      F(4,8)= .05025
      F(4,9)= .04234
      F(4,10)=.03464
      F(4,11)=.02821
      F(4,12)=.02311
      F(4,13)=.70013
C
      F(5,13)=.56156
      F(6,13)=.67452
      F(7,13)=.76394
      F(8,13)=.82843
      F(9,13)=.87314
      F(10,13)=.90398
      F(11,13)=.92557
      F(12,13)=.94100
C
      A(1)=1.0
      A(2)=1.0
      A(3)=1.0
      A(4)=1.0
      A(5)=1.0
      A(6)=1.0
      A(7)=1.0
      A(8)=1.0
      A(9)=1.0
      A(10)=1.0
      A(11)=1.0
      A(12)=1.0
      A(13)=8.944272
C
C
C
      THETA(1)=0.0
      THETA(2)=0.0
      THETA(3)=0.0
      THETA(4)=0.0
C
      EIR(1)=0.90
      EIR(2)=0.90
      EIR(3)=0.90




      EIR(4)=0.90
      EIR(5)=0.90
      EIR(6)=0.90
```

```
      EIR(7)=0.90
      EIR(8)=0.90
      EIR(9)=0.90
      EIR(10)=0.90
      EIR(11)=0.90
      EIR(12)=0.90
      EIR(13)=1.0
C
      ESOL(1)=0.18
      ESOL(2)=0.18
      ESOL(3)=0.18
      ESOL(4)=0.18
      ESOL(5)=0.18
      ESOL(6)=0.18
      ESOL(7)=0.18
      ESOL(8)=0.18
      ESOL(9)=0.18
      ESOL(10)=0.18
      ESOL(11)=0.18
      ESOL(12)=0.18
      ESOL(13)=1.0
      CT(13)=-459.0
      END OF BASIC DATA
T     CASE 1, Y=2X AND WHITE PAINT SURFACE
C
C     THE RESULTING TEMPERATURES ARE
C               CASE 1      CASE 4
C               DEG F       DEG C
C     T(1)      66.24       19.02
C     T(2)      49.20        9.56
C     T(3)      39.89        4.38
C     T(4)      34.11        1.17
C     T(5)      12.79      -10.67
C     T(6)     -27.19      -32.89
C     T(7)     -62.91      -52.73
C     T(8)     -94.37      -70.20
C     T(9)    -121.45      -85.25
C     T(10)   -144.50      -98.05
C     T(11)   -164.12     -108.96
C     T(12)   -180.92     -118.29
C     T(13)   -459.00     -272.78  A CONSTANT TEMPERATURE NODE
C
      END OF CASE
T     CASE 2, SAME CONDITIONS AS CASE 1, BUT DETAILED PRINTOUT REQUESTED
C        1         2         3         4         5         6         7
C2345678901234567890123456789012345678901234567890123456789012345678901 2
      PRINT(10)=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
      END OF CASE
T     CASE 3, Y=2X AND ALUMINUM SURFACE
C        1         2         3         4         5         6         7
C2345678901234567890123456789012345678901234567890123456789012345678901 2
      EIR(1)=0.10
      EIR(2)=0.10
      EIR(3)=0.10
      EIR(4)=0.10
      EIR(5)=0.10
      EIR(6)=0.10
      EIR(7)=0.10
      EIR(8)=0.10
      EIR(9)=0.10
      EIR(10)=0.10
      EIR(11)=0.10
      EIR(12)=0.10
C
      ESOL(1)=0.20
      ESOL(2)=0.20
      ESOL(3)=0.20
      ESOL(4)=0.20
      ESOL(5)=0.20
      ESOL(6)=0.20
      ESOL(7)=0.20
      ESOL(8)=0.20
      ESOL(9)=0.20
      ESOL(10)=0.20
      ESOL(11)=0.20
      ESOL(12)=0.20
      END OF CASE
T     SAME AS CASE ONE BUT WITH DIFFERENT UNITS, (WATTS, CM, DEG C)
      BOLTZ=.567593885510-11
      ABSCVN=273.3333333333
      SOLCON=.1394309344
      NITER=20
      CT(13)=-272.7777777777
      PRINT(10)=1
      END OF CASE
      END OF PROBLEM
'EOF
```

Nomenclature

A area

EIR, ϵ infrared emittance

$ESOL, \alpha$ solar emittance, equal to the solar absorptance

F form factor

$\mathcal{G}$ total radiation conductance, including multiple reflections

θ angle from the normal of a surface to the sun

G radiant flux per unit area on a surface

L radiosity or flux density streaming away from a surface

P power or electrical dissipation

Q radiant flux

$SOLCON, S$ solar constant

T temperature

ρ reflectance equal to 1 minus the emittance

σ Stefan-Boltzmann constant

References

1. Hottel, Hoyt C., "Radiant-Heat Transmission," in *Heat Transmission,* William H. McAdams, 3rd Edition, Chap. 4. McGraw-Hill Book Company, Inc., New York, 1954.

2. Hildebrand, F. B., *Introduction to Numerical Analysis,* pp. 450–451. McGraw-Hill Book Company, Inc., New York, 1956.

3. Bobco, R. P., "Radiation From a Directional Source: Beam Divergence in Solar Simulators," *J. Eng. Power*, Trans. ASME, Ser. A., Vol. 87, No. 3, pp. 259–269, July 1965.

4. Bobco, R. P., Allen, G. E., and Othmer, P. W., "Local Radiation Equilibrium Temperatures in Semigray Enclosures," *J. Spacecraft Rockets,* pp. 1076–1082, Aug. 1967. Also available as Report 17, SSD 60475R, Hughes Aircraft Company, Space Systems Division, Los Angeles, Dec. 1966.

5. Toups, K. A., *A General Computer Program for the Determination of Radiant-Interchange Configuration and Form Factors, CONFAC II,* SID 65-1043-2. North American Aviation, Inc., Space and Information Systems Division, Downey, Calif., Oct. 1965.

NASA — JPL — Coml., L.A., Calif.